Chemistry

Co-operative Education Option is available (see the Co-operative Education (http://www.carleton.ca/calendars/2012-13/undergrad/regulations/co-operativeeducation) section of this Calendar for details).

Graduation Requirements

In addition to the requirements listed below, students must satisfy:

1. the University regulations (see *the Academic Regulations of the University* section of this Calendar),
2. the common regulations applying to all B.Sc. programs including those relating to Science Continuation and Breadth requirements (see the *Academic Regulations for the Bachelor of Science Degree*),

Students should consult with the Department when planning their program and selecting courses.

Program Requirements

Chemistry
B.Sc. Honours (20.0 credits)

62

A. Credits Included in the Major CGPA (10.5 credits)		
1. 6.0 credits in:		6.0
CHEM 1001 [0.5]	General Chemistry I	
CHEM 1002 [0.5]	General Chemistry II	
CHEM 2103 [0.5]	Physical Chemistry I	
CHEM 2203 [0.5]	Organic Chemistry I	
CHEM 2302 [0.5]	Analytical Chemistry	
CHEM 2303 [0.5]	Analytical Chemistry	
CHEM 2501 [0.5]	Introduction to Inorganic and Bioinorganic Chemistry	
CHEM 3100 [0.5]	Physical Chemistry II	
CHEM 3101 [0.5]	Quantum Chemistry	
CHEM 3201 [0.5]	Advanced Organic Chemistry I	
CHEM 3503 [0.5]	Inorganic Chemistry I	
CHEM 3504 [0.5]	Inorganic Chemistry II	
2. 1.0 credit from:		1.0
CHEM 4907 [1.0]	Honours Essay and Research Proposal	
CHEM 4908 [1.0]	Research Project and Seminar	
3. 0.5 credit from:		0.5
CHEM 2204 [0.5]	Organic Chemistry II	
or CHEM 2206 [0.5]	Organic Chemistry IV	
4. 1.0 credit from:		1.0
CHEM 3106 [0.5]	Computational Chemistry Methods Laboratory	
CHEM 3107 [0.5]	Experimental Methods in Nanoscience	
CHEM 3205 [0.5]	Experimental Organic Chemistry	
CHEM 3305 [0.5]	Advanced Analytical Chemistry Laboratory	
5. 0.5 credit in:		0.5
CHEM 3401 [0.5]	Physical Aspects of Biochemistry (or any BIOC course)	
6. 1.0 credit at the 4000-level in CHEM, or 0.5 credit at the 4000-level in CHEM and:		1.0
BIOC 3102 [0.5]	General Biochemistry II	
7. 0.5 credit at the 3000- or 4000-level in Chemistry		0.5
B. Credits Not Included in the Major CGPA (9.5 credits)		
8. 2.0 credits in:		2.0
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1107 [0.5]	Linear Algebra I	
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
or MATH 2007 [0.5]	Elementary Calculus II	
MATH 2008 [0.5]	Intermediate Calculus	
9. 1.0 credit from:		1.0
PHYS 1003 [0.5] & PHYS 1004 [0.5]	Introductory Mechanics and Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I and Elementary University Physics II	
10. 0.5 credit in Science Continuation (not CHEM)		0.5
11. 1.0 credit in Science Faculty Electives at the 1000-level, not BIOL 1902		1.0
12. 2.0 credits in Science Faculty Electives or Science Continuation Courses, not BIOL 1902		2.0
13. 0.5 credit in:		0.5
NSCI 1000 [0.5]	Seminar in Science (or an Approved Arts or Social Sciences elective)	
14. 1.5 credits in Approved Arts or Social Sciences electives		1.5
15. 1.0 credit in free elective.		1.0
Total Credits		20.0

Note: normally the credits in Item 12 above will be chosen either from non-compulsory Chemistry courses or other Science Continuation courses. Students who wish to broaden and strengthen a non-Science interest by substituting non-Science courses must obtain written permission from the Undergraduate Adviser prior to registration.

Chemistry
B.Sc. General (15.0 credits)

62

A. Credits Included in the Major CGPA (6.0 credits)		
1. 4.5 credits in:		4.5
CHEM 1001 [0.5]	General Chemistry I	
CHEM 1002 [0.5]	General Chemistry II	
CHEM 2103 [0.5]	Physical Chemistry I	
CHEM 2203 [0.5]	Organic Chemistry I	
CHEM 2302 [0.5]	Analytical Chemistry	
CHEM 2303 [0.5]	Analytical Chemistry	
CHEM 2501 [0.5]	Introduction to Inorganic and Bioinorganic Chemistry	
CHEM 3100 [0.5]	Physical Chemistry II	
CHEM 3101 [0.5]	Quantum Chemistry	
2. 0.5 credit from:		0.5

CHEM 2204 [0.5]	Organic Chemistry II	
CHEM 2206 [0.5]	Organic Chemistry IV	
3. 0.5 credit from:		0.5
CHEM 3106 [0.5]	Computational Chemistry Methods Laboratory	
CHEM 3205 [0.5]	Experimental Organic Chemistry	
CHEM 3305 [0.5]	Advanced Analytical Chemistry Laboratory	
CHEM 3503 [0.5]	Inorganic Chemistry I	
CHEM 3107 [0.5]	Experimental Methods in Nanoscience	
4. 0.5 credit in CHEM at the 3000-level		0.5
B. Credits Not Included in the Major CGPA (9.0 credits)		
5. 2.0 credits in:		2.0
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1107 [0.5]	Linear Algebra I	
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
or MATH 2007 [0.5]	Elementary Calculus II	
MATH 2008 [0.5]	Intermediate Calculus	
6. 1.0 credit from:		1.0
PHYS 1003 [0.5] & PHYS 1004 [0.5]	Introductory Mechanics and Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I and Elementary University Physics II	
7. 0.5 credit in Science Continuation (not CHEM)		0.5
8. 1.0 credit in Science Faculty Electives at the 1000-level, not:		1.0
BIOL 1902 [0.5]	Natural History	
9. 1.5 credit in Science Faculty Electives or Science Continuation Courses, not BIOL 1902		1.5
10. 0.5 credit in NSCI 1000 or an Approved Arts or Social Sciences elective		0.5
11. 1.5 credits in Approved Arts or Social Sciences electives		1.5
12. 1.0 credit in free electives.		1.0
Total Credits		15.0

Chemistry with Concentration in Nanotechnology B.Sc.Honours (20.0 credits)

621

A. Credits Included in the Major CGPA (10.5 credits)		
1. 8.5 credits in:		8.5
CHEM 1001 [0.5]	General Chemistry I	
CHEM 1002 [0.5]	General Chemistry II	
CHEM 2103 [0.5]	Physical Chemistry I	
CHEM 2203 [0.5]	Organic Chemistry I	
CHEM 2302 [0.5]	Analytical Chemistry	
CHEM 2501 [0.5]	Introduction to Inorganic and Bioinorganic Chemistry	
CHEM 3100 [0.5]	Physical Chemistry II	
CHEM 2303 [0.5]	Analytical Chemistry	
CHEM 3101 [0.5]	Quantum Chemistry	
CHEM 3107 [0.5]	Experimental Methods in Nanoscience	
CHEM 3201 [0.5]	Advanced Organic Chemistry I	
CHEM 3503 [0.5]	Inorganic Chemistry I	
CHEM 3600 [0.5]	Introduction to Nanotechnology	
CHEM 4103 [0.5]	Surface Chemistry and Nanostructures	
CHEM 4104 [0.5]	Physical Methods of Nanotechnology	
CHEM 4908 [1.0]	Research Project and Seminar	
2. 0.5 credit from:		0.5
CHEM 2204 [0.5]	Organic Chemistry II	
CHEM 2206 [0.5]	Organic Chemistry IV	
3. 1.0 credit from:		1.0
CHEM 3106 [0.5]	Computational Chemistry Methods Laboratory	
CHEM 3205 [0.5]	Experimental Organic Chemistry	
CHEM 3305 [0.5]	Advanced Analytical Chemistry Laboratory	
CHEM 3504 [0.5]	Inorganic Chemistry II	
4. 0.5 credit in:		0.5
CHEM 3401 [0.5]	Physical Aspects of Biochemistry (or any BIOC course)	
B. Credits Not Included in the Major CGPA (9.5 credits)		
5. 2.0 credits in:		2.0
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1107 [0.5]	Linear Algebra I	
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
or MATH 2007 [0.5]	Elementary Calculus II	
MATH 2008 [0.5]	Intermediate Calculus	
6. 1.0 credit from:		1.0
PHYS 1003 [0.5] & PHYS 1004 [0.5]	Introductory Mechanics and Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I and Elementary University Physics II	
7. 0.5 credit in Science Continuation (not CHEM)		0.5
8. 1.0 credit in Science Faculty Electives at the 1000-level, not BIOL 1902		1.0
9. 2.0 credits in Science Faculty Electives or Science Continuation Courses, not BIOL 1902		2.0
10. 0.5 credit in NSCI 1000 or an Approved Arts or Social Sciences elective		0.5
11. 1.5 credits in Approved Arts or Social Sciences electives		1.5
12. 1.0 credit in free electives.		1.0
Total Credits		20.0

Chemistry and Earth Sciences B.Sc. Combined Honours (20.0 credits)

7Y

A. Credits Included in the Major CGPA (13.5 credits)		
1. 4.0 credits in:		4.0
CHEM 1001 [0.5]	General Chemistry I	
CHEM 1002 [0.5]	General Chemistry II	
CHEM 2103 [0.5]	Physical Chemistry I	
CHEM 2302 [0.5]	Analytical Chemistry	
CHEM 2303 [0.5]	Analytical Chemistry	

CHEM 2501 [0.5]	Introduction to Inorganic and Bioinorganic Chemistry	
CHEM 3100 [0.5]	Physical Chemistry II	
CHEM 3503 [0.5]	Inorganic Chemistry I	
2. 1.0 credit in CHEM at the 4000-level		1.0
3. 1.0 credit in:		1.0
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
4. 3.0 credits in:		3.0
ERTH 2102 [0.5]	Mineralogy to Petrology	
ERTH 2104 [0.5]	Igneous Systems, Geochemistry and Processes	
ERTH 2105 [0.5]	Geodynamics	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
ERTH 2406 [0.5]	Geology and Map Interpretation	
ERTH 2802 [0.5]	Field Geology	
5. 0.5 credit from:		0.5
ERTH 3203 [0.5]	Applied Sedimentology (See Note, below)	
ERTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records	
6. 2.0 credits in:		2.0
ERTH 3003 [0.5]	Geochemistry and Geochronology	
ERTH 3204 [0.5]	Mineral Deposits	
ERTH 3207 [0.5]	Metamorphic Petrology and Processes	
ERTH 3806 [0.5]	Structural Geology	
7. 1.0 credit in ERTH at the 4000-level		1.0
8. 1.0 credit from:		1.0
CHEM 4908 [1.0]	Research Project and Seminar	
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 [0.5]	Research in Earth Sciences (plus 0.5 credit ERTH at the 4000-level)	
B. Credits Not Included in the Major CGPA (6.5 credits)		
9. 1.5 credits in:		1.5
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1107 [0.5]	Linear Algebra I	
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
or MATH 2007 [0.5]	Elementary Calculus II	
10. 0.5 credit in:		0.5
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
11. 0.5 credit in GEOM		0.5
12. 1.0 credit from:		1.0
PHYS 1003 [0.5] & PHYS 1004 [0.5]	Introductory Mechanics and Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I and Elementary University Physics II	
13. 0.5 credit in:		0.5
BIOL 1004 [0.5]	Introductory Biology II	
14. 0.5 credit in Science Faculty Electives (not CHEM or ERTH)		0.5
15. 0.5 credit in NSCI or, 0.5 credit in Approved Arts or Social Sciences		0.5
16. 1.5 credits in Approved Arts or Social Sciences		1.5
Total Credits		20.0

Note: For Item 5 above, ERTH 3203 is required if prerequisite conditions are met.

Chemistry and Physics
B.Sc. Combined Honours (20.0 credits)

6Z

A. Credits Included in the Major CGPA (13.0 credits)		
1. 1.0 credit from:		1.0
PHYS 1001 [0.5] & PHYS 1002 [0.5]	Foundations of Physics I and Foundations of Physics II (recommended)	
PHYS 1003 [0.5] & PHYS 1004 [0.5]	Introductory Mechanics and Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I and Elementary University Physics II (with an average grade of B- or higher)	
2. 4.0 credits in:		4.0
PHYS 2202 [0.5]	Wave Motion and Optics	
PHYS 2604 [0.5]	Modern Physics I	
PHYS 3007 [0.5]	Third Year Physics Laboratory: Selected Experiments and Seminars	
PHYS 3308 [0.5]	Electromagnetism	
PHYS 3606 [0.5]	Modern Physics II	
PHYS 3701 [0.5]	Elements of Quantum Mechanics	
PHYS 3807 [0.5]	Mathematical Physics I	
PHYS 4707 [0.5]	Introduction to Quantum Mechanics I	
3. 1.0 credit in PHYS at the 4000-level		1.0
4. 4.5 credits in:		4.5
CHEM 1001 [0.5]	General Chemistry I	
CHEM 1002 [0.5]	General Chemistry II	
CHEM 2103 [0.5]	Physical Chemistry I	
CHEM 2203 [0.5]	Organic Chemistry I	
CHEM 2501 [0.5]	Introduction to Inorganic and Bioinorganic Chemistry	
CHEM 3100 [0.5]	Physical Chemistry II	
CHEM 3102 [0.5]	Methods of Computational Chemistry	
CHEM 3503 [0.5]	Inorganic Chemistry I	
CHEM 4102 [0.5]	Advanced Topics in Physical Chemistry II	
5. 0.5 credit from:		0.5
CHEM 2204 [0.5]	Organic Chemistry II	
CHEM 2206 [0.5]	Organic Chemistry IV	
6. 0.5 credit from:		0.5
CHEM 3106 [0.5]	Computational Chemistry Methods Laboratory	
CHEM 3107 [0.5]	Experimental Methods in Nanoscience	
7. 0.5 credit in CHEM at the 4000-level		0.5
8. 1.0 credit from:		1.0

CHEM 4908 [1.0]	Research Project and Seminar	
PHYS 4909 [1.0]	Fourth-Year Project	
PHYS 4907 plus 0.5 credit 4000-level PHYS		
PHYS 4908 plus 0.5 credit 4000-level PHYS		
B. Credits Not Included in the Major CGPA (7.0 credits)		
9. 3.0 credits in:		3.0
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
MATH 1104 [0.5]	Linear Algebra for Engineering or Science	
MATH 2004 [0.5]	Multivariable Calculus for Engineering or Physics	
STAT 3502 [0.5]	Probability and Statistics	
MATH 3705 [0.5]	Mathematical Methods I	
10. 0.5 credit from:		0.5
COMP 1005 [0.5]	Introduction to Computer Science I	
ECOR 1606 [0.5]	Problem Solving and Computers	
11. 0.5 credit from:		0.5
MATH 3800 [0.5]	Modeling and Computational Methods for Experimental Science	
ECOR 2606 [0.5]	Numerical Methods	
12. 0.5 credit in:		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences elective)	
13. 1.5 credits in Approved Arts or Social Sciences electives		1.5
14. 1.0 credit in free electives.		1.0
Total Credits		20.0

Minor in Chemistry (4.0 credits)

M12

The Minor in Chemistry is available to degree students registered in programs other than those associated with the Department of Chemistry.

Requirements

1. 1.0 credit in:		1.0
CHEM 1001 [0.5]	General Chemistry I	
CHEM 1002 [0.5]	General Chemistry II	
2. 3.0 credits in Chemistry at 2000-level or higher		3.0
3. The remaining requirements of the major discipline(s) and degree must be satisfied.		
Total Credits		4.0

Chemistry (CHEM) Courses

Chemistry

Faculty of Science

CHEM 1001 [0.5 credit]
General Chemistry I
This maths-intensive course covers introduction to periodicity, gas laws, equilibrium, bonding, electrochemistry, and organic chemistry. This is a specialist course for students intending to take second year chemistry.
Precludes additional credit for CHEM 1000 (no longer offered), CHEM 1005, CHEM 1101.
Prerequisite(s): Ontario 4U/M in Chemistry or equivalent.
Lectures three hours a week, laboratory and tutorial three hours a week.

CHEM 1002 [0.5 credit]
General Chemistry II
This maths-intensive course covers an introduction to solution chemistry, acids and bases, thermodynamics, and kinetics. Specialist course for students intending to take second year chemistry.
Precludes additional credit for CHEM 1000 (no longer offered), CHEM 1006.
Prerequisite(s): CHEM 1005 with a minimum grade of B-, or CHEM 1001.
Lectures three hours a week, laboratory and tutorial three hours a week.

CHEM 1003 [0.5 credit]
The Chemistry of Food, Health and Drugs
Aspects of chemistry relating to food, food additives, drugs (both illicit and beneficial) and their relation to metabolism and health. Topics may include: proteins, carbohydrates, fats, vitamins and cofactors, enzymes, steroids, electrolyte and pH balance, trace elements.
Available only as a free option for Science students.
Prerequisite(s): a course in Chemistry (e.g. Ontario Grade 11).
Lectures three hours a week.

CHEM 1004 [0.5 credit]
Drugs and the Human Body
Intended for students with little or no background in Science. Topics include the pharmaceutical industry, the placebo effect, origin of drugs, laws, metabolism, drug dependence, over the counter medications, antibiotics, pain killers, stimulants, alcohol, caffeine and nicotine, marijuana, hallucinogens, birth control and steroids.
Available as a free elective only for Science students.
Lectures three hours a week.

CHEM 1005 [0.5 credit]
Elementary Chemistry I
Introduction to stoichiometry, periodicity, gas laws, equilibrium, bonding, and organic chemistry with emphasis on examples of relevance to the life sciences. For students who lack the prerequisite for CHEM 1001 or who are not intending to take upper year chemistry.
Precludes additional credit for CHEM 1000 (no longer offered), CHEM 1001, CHEM 1101.
Lectures four hours a week, laboratory and tutorial three hours a week.

CHEM 1006 [0.5 credit]
Elementary Chemistry II
Introduction to solution chemistry, acids and bases, thermodynamics, and kinetics, with emphasis on examples of relevance to the life sciences. For students who lack the prerequisite for CHEM 1002 or who are not intending to take upper year chemistry.
Precludes additional credit for CHEM 1000 (no longer offered), CHEM 1002.
Prerequisite(s): CHEM 1001 or CHEM 1005.
Lectures three hours a week, laboratory and tutorial three hours a week.

CHEM 1007 [0.5 credit]
Chemistry of Art and Artifacts
Aspects of chemistry relating to art history and archaeology. Topics include the properties of materials of historical and cultural importance, the nature of colour, the properties of such materials and the chemical and physical processes leading to their deterioration. The course requires only minimal previous chemistry, and gives descriptions which are aimed at students who do not have an extensive science background. Available only as a free elective for Science students.
Lectures three hours a week.

CHEM 1101 [0.5 credit]
Chemistry for Engineering Students
Topics include stoichiometry, atomic and molecular structure, thermodynamics and chemical equilibrium, acid-base chemistry, carbon dioxide in water, alkalinity, precipitation, electrochemistry, kinetics and basic organic chemistry. Laboratory component emphasizes techniques and methods of basic experimental chemistry.
Precludes additional credit for CHEM 1000 (no longer offered), CHEM 1001, and CHEM 1005.
Prerequisite(s): Ontario 4U/M in Chemistry or equivalent.
Lectures three hours a week, laboratory three hours a week.

CHEM 2103 [0.5 credit]
Physical Chemistry I
Basic principles of thermodynamics. Development of the laws of thermodynamics, enthalpy, entropy and free energy, and their applications to phase equilibria, electrochemistry, and kinetics. Brief introduction to quantum mechanics.
Precludes additonal credit for BIOC 2300, CHEM 2101 and CHEM 2102. Students presenting both CHEM 2103 and CHEM 2207 or CHEM 2203 will not receive additional credit for CHEM 2800. Students in the B.Sc. program with CHEM 2203 may use CHEM 2800 only as a free elective.
Prerequisite(s): CHEM 1006 with a minimum grade of B-, or CHEM 1002, and MATH 1004 and MATH 1107, and Grade 12 Physics or PHYS 1007 and PHYS 1008.
Lectures three hours a week, problems one hour a week, laboratory three hours a week.

CHEM 2203 [0.5 credit]
Organic Chemistry I
Structure, organization, and scope of organic chemistry including molecular structures of well-known and important organic chemicals, types of chemical reactions, and spectroscopic methods used in identification. Training in the handling and purification of organic compounds, organic chemical reactions, and the use of infrared spectroscopy.
Precludes additional credit for CHEM 2207. Students presenting both CHEM 2203 and CHEM 2101 will not be able to receive additional credit for CHEM 2800. Students in the B.Sc. program with CHEM 2203 will only be able to use CHEM 2800 in the free elective category, except for students in the Environmental Science Program, who may include CHEM 2203 in the Approved Science Course category while maintaining CHEM 2800 as a mandatory course requirement.
Prerequisite(s): CHEM 1006 with a minimum grade of B-, or CHEM 1002.
Lectures three hours a week, laboratory and tutorial three hours a week.

CHEM 2204 [0.5 credit]
Organic Chemistry II
Further discussion of chemical bonding in organic compounds, nomenclature, stereochemistry, and a systematic coverage of the chemical reactions of organic functional groups. Laboratory experience in organic chemical reactions, use of infrared spectroscopy and other techniques to determine the structure of unknown organic compounds. Precludes additional credit for CHEM 2208 and CHEM 2206.
Prerequisite(s): CHEM 2203.
Lectures three hours a week, laboratory and tutorial three hours a week.

CHEM 2206 [0.5 credit]
Organic Chemistry IV
Further discussion of the chemical bonding in organic compounds, nomenclature, stereochemistry, and a systematic coverage of the chemical reactions of the organic functional groups. The laboratory consists of computational experiments and calculations on organic structures and reactions.
Precludes additional credit for CHEM 2204 and CHEM 2208.
Prerequisite(s): CHEM 2203 or CHEM 2207.
Lectures three hours a week, laboratory and tutorial three hours a week.

CHEM 2207 [0.5 credit]
Introduction to Organic Chemistry I
Structure, organization, and scope of organic chemistry, including molecular structures of well-known and important organic chemicals, types of chemical reactions, and spectroscopic methods used in identification.
Precludes additional credit for CHEM 2203. Students presenting both CHEM 2207 and CHEM 2101 will not be able to receive additional credit for CHEM 2800. Students in the B.Sc. program with CHEM 2207 will only be able to use CHEM 2800 in the free elective category, except for students in the Environmental Science Program, who may include CHEM 2207 in the Approved Science Course category while maintaining CHEM 2800 as a mandatory course requirement.
Prerequisite(s): CHEM 1006 with a minimum grade of B-, or CHEM 1002.
Lectures three hours, tutorial one hour a week.

CHEM 2208 [0.5 credit]
Introduction to Organic Chemistry II
Further discussion of the chemical bonding in organic compounds, nomenclature, stereochemistry, and a systematic coverage of chemical reactions of the organic functional groups.
Precludes additional credit for CHEM 2204 and CHEM 2206.
Prerequisite(s): CHEM 2207 or CHEM 2203.
Lectures three hours a week, tutorial one hour a week.

CHEM 2302 [0.5 credit]
Analytical Chemistry
An introduction to quality assurance measures, calibration strategies and the fundamentals of solution-based analytical measurement processes. Qualitative and quantitative analysis using potentiometric and electrolysis techniques including ion selective electrodes, coulometry, amperometry and voltammetry. Redox, acid/base and EDTA titrations in the context of various buffer systems.
Precludes additional credit for CHEM 2300.
Prerequisite(s): CHEM 1006 with a minimum grade of B-, or CHEM 1002, or CHEM 1101, (MATH 1007 or MATH 1004) and MATH 1107. .
Lectures three hours a week, laboratory three hours a week.

CHEM 2303 [0.5 credit]
Analytical Chemistry
Spectrophotometric analysis using Uv-Vis, fluorescence and FTIR instrumentation. Modern separation methods including CE, GC and LC. Recent techniques and applications using mass spectrometry. Applications of all of the above to real-world analysis including the advancement of environmental, biochemistry and health-related research.
Precludes additional credit for CHEM 2300 and CHEM 2301.
Prerequisite(s): CHEM 1006 with a minimum grade of B-, or CHEM 1002, or CHEM 1101, (MATH 1007 or MATH 1004) and MATH 1107.
Lectures three hours a week, laboratory three hours a week.

CHEM 2501 [0.5 credit]
Introduction to Inorganic and Bioinorganic Chemistry
The basic concepts of inorganic chemistry, including the origins of elemental properties, simple theories of bonding, intermolecular forces, main group and transition metal chemistry, coordination chemistry. Inorganic ions in biochemistry, including ion transport and storage, oxygen carriers and hydrolases, redox proteins.
Precludes additional credit for CHEM 3506.
Prerequisite(s): CHEM 1006 with a minimum grade of B-, or CHEM 1002.
Lectures three hours a week, tutorial one hour a week.

CHEM 2800 [0.5 credit]
Foundations for Environmental Chemistry
A basis of chemistry needed to understand the environment: composition of the atmosphere and natural waters; equilibrium; surface properties; kinetics and spectroscopy; physical and chemical properties of chemicals in the environment. This is a limited enrolment course; therefore top priority will be given to students registered in the Environmental Science program. Students in the B.Sc. program with CHEM 2203 or CHEM 2207 will only be able to use CHEM 2800 in the free elective category, except for students in the Environmental Science program, who may include CHEM 2203 or CHEM 2207 in the Approved Science Course category while maintaining CHEM 2800 as a mandatory course requirement.
Prerequisite(s): CHEM 1006 with a minimum grade of B- or CHEM 1002, or CHEM 1101, (MATH 1007 or MATH 1004). .
Lectures three hours a week, laboratory three hours a week.

CHEM 3100 [0.5 credit]
Physical Chemistry II
Further development of thermodynamic equations and their applications to mass changes, chemical potential, chemical equilibria, transport properties and advanced phase equilibria. Use of partial differentials and development of Maxwell's relations will also be covered.
Precludes additional credit for CHEM 2102.
Prerequisite(s): CHEM 2103 or BIOC 2300, and MATH 1005 or MATH 2007.
Lectures three hours a week, problems one hour a week, laboratory three hours a week.

CHEM 3101 [0.5 credit]
Quantum Chemistry
Classical equations of motion, harmonic oscillator, diatomic and polyatomic molecules, molecular mechanics, quantum mechanics, Schrödinger equation and wave functions, vibrational spectra, hydrogen atom, quantum numbers, electronic spectra, bonding in small molecules.
Prerequisite(s): CHEM 2103, MATH 2007 and MATH 2008.
Lectures and problems three hours a week.

CHEM 3102 [0.5 credit]
Methods of Computational Chemistry
Molecular orbital theory of organic and inorganic chemistry. Applications of computational chemistry to chemical bonding, aromaticity, molecular spectra. Semi-empirical and ab initio electronic structure theory. Comparison of theoretical methods used to obtain molecular properties. Introduction to statistical thermodynamics.
Prerequisite(s): CHEM 3101.
Lectures and problems three hours a week.

CHEM 3106 [0.5 credit]
Computational Chemistry Methods Laboratory
Industry-standard quantum chemistry software is used for Hartree-Fock, density functional, and post Hartree-Fock correlation calculations. Results are applied to problems in molecular structure, thermodynamics, vibrational spectroscopy, and kinetics. The UNIX operating system, Bourse-shell programming, and Python scripting are also introduced.
Prerequisite(s): CHEM 3102 (may be taken concurrently).
Laboratory four hours a week.

CHEM 3107 [0.5 credit]
Experimental Methods in Nanoscience
Thin film production and characterization, scanning electron microscopy, synthesis of metal nanoparticles and particle size determination, computational modeling of nanostructures.
Prerequisite(s): CHEM 3100.
Laboratories and tutorials four hours a week.

CHEM 3201 [0.5 credit]
Advanced Organic Chemistry I
Instrumental methods for determining organic structures. Selected organic reactions with emphasis on mechanisms and reactive intermediates.
Prerequisite(s): CHEM 2204 or CHEM 2206 or CHEM 2208.
Lectures three hours a week.

CHEM 3202 [0.5 credit]
Advanced Organic Chemistry II
Continued mechanistic survey of additional organic reactions with emphasis on synthetic usefulness and stereochemistry. Interspersed with selected topics such as instrumental methods, photochemistry, literature of organic chemistry, natural and synthetic polymers, heterocycles, terpenes and alkaloids.
Prerequisite(s): CHEM 3201 or equivalent.
Lectures three hours a week.

CHEM 3205 [0.5 credit]
Experimental Organic Chemistry
A laboratory-based course including advanced concepts and techniques in organic synthesis, structure determination, and the rates and mechanisms of reactions. Students are responsible for literature surveys, acquisition of theoretical background, and design of experimental procedures.
Note: failure to complete CHEM 3201 by the end of the fall term will require deregistration from CHEM 3205.
Prerequisite(s): CHEM 2204 or CHEM 2206, CHEM 3201 or BIOC 3101 (may be taken concurrently).
Laboratory four hours a week.

CHEM 3305 [0.5 credit]
Advanced Analytical Chemistry Laboratory
Advanced instrumentally based techniques of analysis. Emphasis on identification and quantitation of low-level contaminants in environmental matrices using chromatographic and spectroscopic methods, including sampling, cleanup, measurement and reporting of results.
Prerequisite(s): CHEM 2302 and CHEM 2303.
Laboratory four hours a week.

CHEM 3401 [0.5 credit]
Physical Aspects of Biochemistry
Chemistry, structure and function of nucleic acids, proteins, carbohydrates, and lipids. Thermodynamics of biological systems, chemical mechanisms and organic transformations. Intended for Chemistry Majors.
Precludes additional credit for BIOC 2200, BIOL 2200, and BIOC 3101
Prerequisite(s): CHEM 2103 and CHEM 2204.
Lectures three hours a week.

CHEM 3503 [0.5 credit]
Inorganic Chemistry I
Symmetry, identification of Raman and infrared active vibrations, symmetry-adapted molecular orbital theory of polyatomic molecules, electron deficient bonding, bonding in coordination complexes, solid state bonding, ionic lattices. Laboratory will introduce the student to a range of synthetic techniques and physical methods of characterization.
Precludes additional credit for CHEM 3507.
Prerequisite(s): CHEM 2501.
Lectures three hours a week, laboratory and tutorial four hours a week.

CHEM 3504 [0.5 credit]
Inorganic Chemistry II
Physical properties of coordination complexes, ligand substitutions and electron transfer reaction mechanisms, organometallic chemistry: bonding, nomenclature and catalysis. Laboratory will introduce the student to a range of synthetic techniques and physical methods of characterization.
Precludes additional credit for CHEM 3508.
Prerequisite(s): CHEM 3503.
Lectures three hours a week, laboratory and tutorials four hours a week.

CHEM 3507 [0.5 credit]
General Inorganic Chemistry I
Symmetry, identification of Raman and infrared active vibrations, symmetry-adapted molecular orbital theory of polyatomic molecules, electron deficient bonding, bonding in coordination complexes, solid state bonding, ionic lattices.
Precludes additional credit for CHEM 3503.
Prerequisite(s): CHEM 2501.
Lectures three hours a week, tutorial one hour a week.

CHEM 3508 [0.5 credit]
General Inorganic Chemistry II
Physical properties of coordination complexes, ligand substitutions and electron transfer reaction mechanisms, organometallic chemistry: bonding, nomenclature and catalysis.
Precludes additional credit for CHEM 3504.
Prerequisite(s): CHEM 3503 or CHEM 3507.
Lectures three hours a week, tutorial one hour a week.

CHEM 3600 [0.5 credit]
Introduction to Nanotechnology
Nanoscale units, bulk vs. nanoproperties, electrons, atoms and ions, metals, band structure, electrical conduction, biosystems , molecular devices, quantum mechanics and optics, tools for measuring nanostructures. Production of nanostructures: self assembly, nanoscale crystal growth, polymerization. Applications to sensors, magnets, electronics, drug delivery. Toxicology of nanostructures.
Prerequisite(s): CHEM 3100.
Lectures three hours a week.

CHEM 3700 [0.5 credit]
Industrial Applications of Chemistry
Uses of chemistry in a number of industries: fertilizers, electrochemical, metallurgical, petrochemical, pulp and paper, plastics, pharmaceutical. Interaction of chemistry with economic, political, engineering, environmental, health, legal considerations. Guest lecturers.
Prerequisite(s): CHEM 2103 and one of CHEM 2207 or CHEM 2203.

CHEM 3800 [0.5 credit]
The Chemistry of Environmental Pollutants
Inorganic and organic environmental pollutants: their toxicology, production, use pattern and known effects on the environment. Aspects of risk and regulation. Chemistry involved in water and sewage treatment.
Prerequisite(s): CHEM 2207 or CHEM 2203 or CHEM 2800.
Lectures three hours a week.

CHEM 3999 [0.0 credit]
Co-operative Work Term

CHEM 4100 [0.5 credit]
Advanced Topics in Physical Chemistry I
Principles of Group Theory as applied to Chemistry. Point groups, character tables, symmetry orbitals, molecular orbitals, aromaticity, allowed and forbidden reactions, sandwich complexes. Selection rules in spectroscopy, molecular vibrations.
Prerequisite(s): CHEM 3102.
Lectures three hours a week.

CHEM 4102 [0.5 credit]
Advanced Topics in Physical Chemistry II
Statistical thermodynamics, energy states, equilibrium, partition functions for diatomic molecules. Chemical kinetics: rate laws, solution of differential equations, transition state theory, bimolecular reactions in gases and in solution, chain reactions, catalysis, atmospheric chemical reactions and photochemistry.
Prerequisite(s): CHEM 3102.
Lectures and seminars three hours a week.

CHEM 4103 [0.5 credit]
Surface Chemistry and Nanostructures
Surface structure, thermodynamics and kinetics, specifically regarding adsorption/desorption and high vacuum models. Nanoscale structures and their formation, reactivity and characterization. Thin films, carbon nanotubes, self-assembled monolayers and supramolecular aggregates.
Prerequisite(s): CHEM 3600 and CHEM 3107.
Lectures three hours a week.

CHEM 4104 [0.5 credit]
Physical Methods of Nanotechnology
An overview of methods used in nanotechnology. Principles of scanning probe techniques ranging from surface physics to biology. State of the art methods to create nanostructures for future applications in areas such as nanolithography, nanoelectronics, nano-optics, data storage and bio-analytical nanosystems.
Prerequisite(s): CHEM 3600 and CHEM 3107.
Lectures three hours a week.

CHEM 4201 [0.5 credit]
Macromolecular Nanotechnology
Biological and synthetic macromolecules related to nanoscale phenomena. Challenges and opportunities associated with natural and synthetic polymers on the nanoscale. Molecular recognition, self-assembled nanostructures, scaffolds and templates, functional nanomaterials, amphiphilic architectures, nanocomposites, and nanomachines. Applications to sensing, biomaterials, drug delivery, and polymer based devices.
Prerequisite(s): CHEM 3600 or permission of the department.

CHEM 4202 [0.5 credit]
Advanced Topics in Organic Chemistry I
Topics include 2-dimensional 1H and 13CNMR spectroscopy and structure determination of complex organic molecules.
Prerequisite(s): CHEM 3201.
Also offered at the graduate level, with different requirements, as CHEM 5407, for which additional credit is precluded.
Lectures and seminars three hours a week.

CHEM 4203 [0.5 credit]
Synthetic Organic Chemistry
The application of reactions to the synthesis or organic molecules. Emphasis on design of synthetic sequences, new reagents, and stereoselectivity. Topics include advanced methods for synthesis and reactions of alkenes, carbonyls, and enolates. Functional group interconversion, oxidation and reduction, protecting groups, rearrangements, and metal-catalyzed cross-coupling are also discussed.
Prerequisite(s): CHEM 3201 and CHEM 3202. Lectures and seminars three hours a week.

CHEM 4204 [0.5 credit]
Organic Polymer Chemistry
Introduction to basic principles of polymer chemistry, industrial and synthetic polymers, different types of polymerization and polymer characterization. Study of commodity plastics, engineering thermoplastics, and specialty polymers, with emphasis on their synthesis.
Prerequisite(s): CHEM 3201 or equivalent. Lectures three hours a week.
Also offered at the graduate level, with different requirements, as CHEM 5406, for which additional credit is precluded.

CHEM 4205 [0.5 credit]
Reactivity and Mechanism in Organic Chemistry
The application of frontier molecular orbital theory (HOMO-LUMO interactions) to organic reactions, including thermal and photochemical cycloadditions of pi-systems (including 1,3-dipoles) and rearrangements. Reactions of radicals and carbenes; conformational analysis, stereochemical effects, and methods for the determination of reaction mechanisms.
Prerequisite(s): CHEM 3202 and CHEM 3503 (may be taken concurrently).
Lectures and seminars three hours a week.

CHEM 4206 [0.5 credit]
Natural Products Chemistry
A survey of the major classes of natural products with respect to their structural elucidation, synthesis, biosynthesis and bioactivity, with emphasis on compounds that have medicinal importance.
Prerequisite(s): CHEM 3201 and CHEM 3202,.
Lectures and seminars three hours a week.

CHEM 4301 [0.5 credit]
Advanced Topics in Analytical Chemistry I
Trace and ultratrace analytical chemistry. Sampling and sample preservation. The problems of the blank. Trace and ultratrace analysis. Sampling and sample preparation. Atomic absorption, fluorescence and emission spectroscopy.
Prerequisite(s): CHEM 2103 and one of CHEM 2302 or CHEM 2303.
Lectures and seminars three hours a week.

CHEM 4302 [0.5 credit]
Advanced Topics in Analytical Chemistry II
Solutions and separations in analytical chemistry. Stability of aqueous solutions of standards and samples. Complex formation, multi-step and competing equilibria and their application to the design of selective methods of separation and determination. Electroanalytical techniques. Electroanalytical chemistry of aqueous solutions. Phase equilibria and solvent extraction.
Prerequisite(s): CHEM 2103 and one of CHEM 2302 or CHEM 2303.
Lectures and seminars three hours a week.

CHEM 4304 [0.5 credit]
Advanced Applications In Mass Spectrometry
Detailed breakdown of the physical, electrical and chemical operation of mass spectrometers. Examination of the different mass spectrometric geometries / configurations that are currently employed. Applications in mass spectrometry ranging from the analysis of small volatile organic molecules to large non-volatile biological macromolecules. Descriptions of the use of mass spectrometry in industry as well as commercial opportunities in the field.
Prerequisite(s): CHEM 2103 or BIOC 2300, and one of CHEM 2302 or CHEM 2303.
Lectures and seminars three hours a week.

CHEM 4406 [0.5 credit]
Pharmaceutical Drug Design
Important elements of rational drug design. Ligand-receptor interactions, structure-activity relationships, molecular modeling of pharmacophores, structure and mechanism-based approaches to drug design. Enzyme inhibition in chemotherapy and design of anti-viral drugs.
Prerequisite(s): CHEM 2103 and (CHEM 2203 or CHEM 2207), BIOC 3101 and (BIOC 3102 or BIOC 3008).
Lectures and laboratory five hours a week.

CHEM 4407 [0.5 credit]
Polymer Modeling
Polymer architectures; Flexible and rigid rod polymers; Rotational isomeric states (RIS); Molecular mechanics, Ramachandran Map, Helix parameters; internal and external parameters; regular and random coil structures; molecular dynamics; calculation of end-to-end distance, NMR chemical shifts; conformational entropy and properties.
Prerequisite(s): MATH 1107 and CHEM 2204 or permission of the department.
Lectures three hours per week.

CHEM 4502 [0.5 credit]
Radiochemistry
A study of nuclear stability and decay; chemical studies of nuclear phenomena. Applications of radioactivity.
Prerequisite(s): CHEM 2302, CHEM 2303, and CHEM 3100, or permission of the Department.
Lectures and seminars three hours a week.

CHEM 4503 [0.5 credit]
Advanced Topics in Inorganic Chemistry I
A quantitave basis for ligand field theory; unreal and real wavefunctions of d-orbitals; derivation of the energies of d-orbitals using variational principle, secular determinants, and ligned field operators; the effect of ligand field on free ion term symbols, wavefunction descriptions of terms symbols; applications.
Prerequisite(s): CHEM 3504 and CHEM 3101.
Lectures three hours a week.

CHEM 4504 [0.5 credit]
Advanced Topics in Inorganic Chemistry II
Reactivity of inorganic coordination compounds. Thermodynamic and kinetic factors affecting reactivity. Industrial and biochemical processes catalyzed by metal coordination compounds. Experimental methodologies, data analysis and rate law evaluation used to obtain reaction mechanisms leading to improved methods of catalysis.
Prerequisite(s): CHEM 3504 or equivalent.
Lectures three hours a week.

CHEM 4700 [0.5 credit]
Special Topics in Chemistry
A topic of current interest in any branch of chemistry. Only one special topics course may be presented for credit.
Prerequisite(s): permission of the Department.

CHEM 4800 [0.5 credit]
Atmospheric Chemistry
Properties of natural atmospheric constituents; biogeochemical cycles involving gases; chemical reactions in the atmosphere; anthropogenic atmospheric pollutants (e.g., chlorofluorocarbons, sulphur and nitrogen oxides, photochemical smog sources and effects on the biosphere. Relation between the structure of molecules and their spectral and reactive properties.
Prerequisite(s): CHEM 2103 or CHEM 2800.
Lectures three hours a week.

CHEM 4907 [1.0 credit]
Honours Essay and Research Proposal
An independent research study using library resources. The candidate will prepare a critical review of a topic approved by a faculty advisor.
Precludes additional credit for CHEM 4908 [1.0], FOOD 4907 [1.0] and FOOD 4908 [1.0].
Prerequisite(s): fourth year standing in an Honours Chemistry program and permission of the department.

CHEM 4908 [1.0 credit]
Research Project and Seminar
Senior students in Honours Chemistry carry out a research project under the direction of one of the members of the Department. A written report and an oral presentation of the work are required before a grade can be assigned.
Precludes additional credit for CHEM 4907, FOOD 4907 and FOOD 4908.
Prerequisite(s): any two of CHEM 3106, CHEM 3107, CHEM 3205, CHEM 3305 and CHEM 3504.
Laboratory and associated work equivalent to at least eight hours a week for two terms.

Food Science (FOOD) Courses

Chemistry

Faculty of Science

FOOD 1001 [0.5 credit]
Introduction to Food Science
Overview of the food industry. Production, processing, product development, packaging, chemistry, analysis, microbiology. Elements risk assessment, policy making and regulation.
Lectures three hours a week.

FOOD 2001 [0.5 credit]
Principles of Nutrition
Roles of nutrients, lipids, proteins, carbohydrates, fluids and electrolytes. Digestion, absorption, transport, energy metabolism. Disorders including diabetes, cardiovascular disease and osteoporosis. Nutrition through the life cycle.
Prerequisite(s): CHEM 1001, CHEM 1002, BIOL 1003.
Lectures three hours a week.

FOOD 3001 [0.5 credit]
Food Chemistry
Chemistry of the major components of foods such as proteins, lipids, carbohydrates and of the minor components such as enzymes, vitamins and various additives and their relationships to food stability and degradation.
Prerequisite(s): FOOD 2001, CHEM 2203, BIOC 2200, BIOL 2303.
Lectures three hours a week, laboratory three hours a week.

FOOD 3002 [0.5 credit]
Food Analysis
Techniques for analysis of food for moisture, fat, protein, ash and fibre as well as some of the minor components of food. Titrations, extractions, calorimetry, spectroscopy, immunoassays.
Prerequisite(s): FOOD 3001.
Lectures three hours a week, laboratory three hours a week.

FOOD 3003 [0.5 credit]
Food Packaging and Shelf Life
An introduction to the materials used for food packaging, including their chemical and physical characteristics. Interactions of these materials with food products, and their effects on shelf life of food.
Prerequisite(s): FOOD 2001, CHEM 2303.
Lectures three hours a week.

FOOD 3004 [0.5 credit]
Food Engineering
Basic engineering principles applicable to a wide range of food engineering and food processing situations, illustrating the uses of engineering concepts in industrial food processing applications. Energy and material balances, fluid mechanics, heat transfer.
Prerequisite(s): MATH 1007, MATH 1107.
Lectures three hours a week.

FOOD 3005 [0.5 credit]
Food Microbiology
Foodborne diseases, microbial growth and survival, food spoilage, food fermentation. Techniques for detecting and quantifying microorganisms in foods.
Prerequisite(s): BIOL 2303.
Lectures three hours a week, laboratory three hours a week.

FOOD 4001 [0.5 credit]
Food Quality Control
Factors affecting quality in manufacturing and processing of foods and principles of quality control and quality assurance. Sampling plans and statistical methods. Applications of physical, chemical, biological and microbiological tests in quality control. Quality systems and standards.
Prerequisite(s): FOOD 3004.
Lectures three hours a week.

FOOD 4102 [0.5 credit]
Regulation of the Food Industry
Regulation of the food industry with particular emphasis on Canadian regulations. Advertising, labelling, packaging, Food additives, supplements and fortifications. Regulation of organic, genetically modified and irradiated foods. Inspection, enforcement and compliance.
Prerequisite(s): ECON 3300.
Lectures three hours a week.

FOOD 4103 [0.5 credit]
Food Safety Risk Assessment, Communication and Management I
The role of risk management in providing science-based approaches to solving food safety problem. Risk management models and practical applications in critical risk management. An examination of actual risk assessments. Risk communication is addressed.
Prerequisite(s): third- or fourth-year standing in the Food Science and Nutrition program.
Lectures three hours a week.

FOOD 4201 [0.5 credit]
Advanced Nutrition and Metabolism
Metabolism of macronutrients in the human body. Detailed catabolic and anabolic reactions of carbohydrates, lipids and proteins. Regulatory control points in healthy and diseased states. Discussion of the literature pertaining to nutrition, metabolism and chronic disease.
Prerequisite(s): FOOD 2001 .
Lectures three hours a week.

FOOD 4202 [0.5 credit]
Micronutrients and Health
Animal and plant-based sources of micronutrients. Metabolism of vitamins and minerals in the human body and associated diseases throughout the life cycle. Micronutrient supplementation to promote human health.
Prerequisite(s): FOOD 2001.
Lectures three hours a week.

FOOD 4907 [1.0 credit]
Food Science and Nutrition Honours Essay and Research Proposal
Students conduct an independent research study using library resources, and prepare a critical review and study proposal on a topic approved by a faculty supervisor. A written report and an oral poster presentation of the work are required before a grade can be assigned.
Precludes additional credit for FOOD 4908, CHEM 4907 and CHEM 4908.
Prerequisite(s): fourth-year standing in the Food Science and Nutrition program.

FOOD 4908 [1.0 credit]
Food Science and Nutrition Research Project
Students in Food Science and Nutrition carry out a research project under the direction of a faculty member. A written report and an oral presentation of the work are required before a grade can be assigned. Laboratory and associated work equivalent to at least eight hours per week for two terms.
Precludes additional credit for FOOD 4907, CHEM 4907 and CHEM 4908.
Prerequisite(s): fourth year standing in the Food Science and Nutrition program.

Summer session: some of the courses listed in this Calendar are offered during the summer. Hours and scheduling for summer session courses will differ significantly from those reported in the fall/winter Calendar. To determine the scheduling and hours for summer session classes, consult the class schedule at central.carleton.ca

Not all courses listed are offered in a given year. For an up-to-date statement of course offerings for the current session and to determine the term of offering, consult the class schedule at central.carleton.ca