

Environmental Science – Major and Minor

Objective

The purpose of the Environmental Science program at Bishop's University is to provide students with an interdisciplinary, scientific education in the science of the environment, from a quantitative, physical science-based approach. The program is offered as both a Major, leading to a Bachelor of Science degree, and as a minor, to complement a student's other Honours or Major program of study.

Major Program – Outcomes

A student in the Major program will become versed in the chemical and physical aspects of the environment (atmosphere, energy, thermodynamics, fluid dynamics, etc.) in order to understand global phenomena such as climate change, pollution, environmental impact, and resource management. Students will gain knowledge of the Earth's ecosystems and how they are affected in both negative and positive ways by human activity. A broad selection of electives related to this field of study will allow students to pursue their own interests as they relate to the environment as well. Given that the search for solutions of complex environmental problems involves not only scientific, but also economic (and social and political) aspects, the Major program includes an Economics component to better prepare students to face such issues in their professional lives. Graduates from this program will be qualified to pursue further studies in graduate school or environmental law, or to seek employment in the ever expanding fields and disciplines involving environmental issues.

Minor Program – Outcomes

A student may add a Minor in Environmental Science to any other degree program (except a Major in Environmental Science). The exposure to introductory scientific and quantitative aspects of the physics and chemistry of the environment gained from this Minor program, will complement and broaden the education and skills of students majoring in other fields of study.

Entrance Requirements

Students are considered for admission to a B.Sc. degree program, Major in Environmental Science, based on the criteria specified in the Admissions section at the beginning of this academic calendar. Please refer to the Admissions section for all details concerning application and admission. Normally, students will have completed a Québec Diploma of Collegial Studies (DEC), or possess a high-school, grade 12 diploma, or the equivalent level of education from international origins. Students are admitted to a four-year, -120-credit program of study. Québec CEGEP graduates will receive up to one year of advanced standing (30 credits). If a student's DEC (from a Québec cegep) does not include some or all of the following seven courses: General Biology, General Chemistry, Solutions Chemistry, Mathematics: Differential Calculus, Mathematics: Integral Calculus, Physics: Mechanics, Physics: Electricity and Magnetism, then the advanced standing received for their DEC will be reduced accordingly.

Humanities Requirement

All Environmental Science Majors must complete six credits (two courses) of humanities studies, normally in their first year at Bishop's. Students who have a Québec Collegial Diploma (DEC), students admitted as "mature students", and 2nd Bachelor's degree students, are all given advanced credit to exempt them from this requirement. The Humanities Requirement is: ELA 116 Effective Writing, or another English course (coded "ENG"), and one additional course selected from courses in Classical Studies, English, History, Liberal Arts, Philosophy or Religion (courses coded CLA, ENG, HIS, LIB, PHI, or REL).

Arts and Science Requirement

All successful Environmental Science Majors will have automatically filled the University's Arts and Sciences requirement.

Environmental Science Major

Program Requirements

Students in the major program must fulfill the following credit requirements:

U1 science courses	21 credits / 7 courses
U1 humanities requirement *	6 credits / 2 courses
Environmental Science core.....	33 credits / 11 courses
Concentration Stream.....	21 credits / 7 courses
Environmental Studies and Geography cognates	9 credits / 3 courses
Economics cognates	12 credits / 4 courses
Free Electives	18 credits / 6 courses
Total	120 credits / 40 courses

**All students with a Québec DEC will be given advanced standing to satisfy this requirement.*

Notes:

1. Students with a Québec DEC will receive up to 30 credits of advanced standing in this program. Such students who are missing some/all of the collegial equivalents of the seven Bishop's U1 science courses: BIO 196, CHM 191 / 192, MAT 191 / MAT 192 and PHY 191 / PHY 192 (see table below) will have their advanced standing reduced accordingly.
2. Many science lecture courses have co-requisite laboratories, worth one additional "laboratory" credit. While the laboratories are mandatory, the lab credits earned do not count as lecture credits in meeting the program's total (lecture) credit requirements, as per the list above.
3. All students must also satisfy the English Writing Proficiency requirement, either by an exam or by registering in the course, EWP 099.

Required Courses – Program Schedule*(120 lecture credits + EWP + labs)*

Fall	Winter
U1 ENV 101 (Intro. Env. Science) CHM 191 / CHL 191 PHY 191 / PHL 191 MAT 191 ELA 116	CHM 192 / CHL 192 PHY 192 / PHL 192 MAT 192 HUMANITIES OPTION FREE OPTION 1
U2 CHM 111 / CHL 111 (Org. Chem. I) PHY 101 (Stats for Exp. Sci.) BIO 196 / BIL 196 ESG 127 (Intro. Phys. Geog.) Stream Course 1	CHM 141 / CHL 141 (Anal. Chem.) ENV 241 (Env. Chem. I) PHY 207 (Thermal & Fluid Phy.) ESG cognate 1 (chosen from list below) Stream Course 2
U3 ECO 102 (Microeconomics) BIO 207 / BIL 207 (Ecology) ESG cognate 2 (from list below) Stream Course 3 Stream Course 4	ECO 103 (Macroeconomics) ENV 242 / EVL 242 (Env. Chem. II) BIO 327 / BIL 327 (Adv. Ecology) ESG cognate course 3 (from list below) FREE OPTION 2
U4 ENV 337 (Economics of the Env.) Stream Course 5 Stream Course 6 FREE OPTION 3 FREE OPTION 4	ENV 437 (Ecological Economics) ENV 375 (Environmental Physics) Stream Course 7 FREE OPTION 5 FREE OPTION 6

Concentration Streams

In addition to completing the required courses listed above, all students must choose either the Environmental Chemistry, or the *Environmental Physics concentration stream*. There are 7 courses to complete in the chosen concentration stream as per the lists below.

Environmental Chemistry Stream – 7 courses*(courses with an * have an associated lab)*

CHM 121	Inorganic Chemistry (winter)
CHM 131a*	Physical Chemistry I (fall)
CHM 211b*	Organic Chemistry II (winter)
CHM 222a*	Elements and Minerals (fall)
CHM 231b*	Physical Chemistry II (winter)
CHM 311a*	Organic Chemistry III (fall)
CHM 341a*	Molecular Spectroscopy (fall)

Environmental Physics Stream – 7 courses*(courses with an * have an associated lab)*

PHY 206*	Waves and Optics (fall)
PHY 319	Electric Circuits & Electronics
PHY 270	Ordinary Differential Eqns. (fall)
CS 211*	Programming Methodology (fall or winter)
MAT 108	Matrix Algebra (fall)
MAT 206	Advanced Calculus I (fall)
MAT 207	Advanced Calculus II (winter)

Environmental Studies and Geography Cognate Courses*All ENV students (3-year and 4-year) must choose 3 ESG courses from the following list:*

ESG 226	Physical Oceanography
ESG 227	Biogeochemical and Environmental Oceanography
ESG 250	Geomorphology
ESG 251	Soils and Vegetation
ESG 265	The Atmosphere and Weather
ESG 267	Global Environmental Change: a physical perspective
ESG 361	Glacial Environments
ESG 367	Climate Change

Required Course List by components*(120 credits + EWP + labs)***I. U1 Science and Humanities Requirements***(9 courses / 27 credits + labs)*

BIO 196 / BIL 196	Introductory Biology (and lab)
CHM 191 / CHL 191	General Chemistry I (and lab)
CHM 192 / CHL 192	General Chemistry II (and lab)
MAT 191	Calculus I
MAT 192	Calculus II
PHY 191 / PHL 191	Introductory Physics I: Mechanics (and lab)
PHY 192 / PHL 192	Introductory Physics II: Electricity and Magnetism (and lab)
ELA 116	Effective Writing
Humanities Elective Course 1xx	– chosen from CLA, ENG, HIS, LIB, PHI, REL

II. Environmental Science Core*(11 courses / 33 credits + labs)*

ENV 101	Introduction to Environmental Science
CHM 141 / CHL 141	Analytical Chemistry – An Environmental Approach (and lab)
CHM 111 / CHL 111	Organic Chemistry I (and lab)
ENV 241	Environmental Chemistry I – Energy and the Atmosphere
PHY 207	Thermal and Fluid Physics
BIO 207 / BIL 207	Introduction to Ecology (and lab)
ENV 242 / EVL 242	Environmental Chemistry II (and lab)
BIO 327 / BIL 327	Advanced Ecology (and lab)
ENV 375	Environmental Physics
ESG 127	Physical Geography
PHY 101	Statistics

III. Concentration Stream*(7 courses / 21 or 22 credits + labs)*

All ENV students choose one concentration stream as per the table above.

IV. Environmental Studies & Geography Cognate Courses*(3 courses / 6 credits)*

All ENV students must choose 3 ESG courses from the list above.

V. Economics Cognate Courses*(4 courses / 12 credits)*

ECO 102	Introduction to Microeconomics
ECO 103	Introduction to Macroeconomics
ECO 237 / ENV 337	Economy of the Environment
ECO 337 / ENV 377	Ecological Economics

VI. Free Elective Courses (6 courses / 18 credits)*

TOTAL	40 courses + labs
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*One of these courses must be chosen from the Divisions of Humanities or Social Sciences (to fulfill the "Arts and Science" requirement).

Recommended Courses for Free Electives

Students in the four-year program must complete six free electives courses while the three-year students only complete five free electives. All courses in the concentration stream not chosen are recommended, plus any in the lists below:

Biology

BIO 197	The Evolution of Life
BIO 205 / BIL 205	Diversity of Life I (fall)
BIO 208 / BIL 208	Genetics (winter)
BIO 321	Biogeography
BIO 359	Human Genetics

Biochemistry

BCH 210	General Biochemistry
BCH 382	Environmental Biochemistry and Toxicology
BCH 383	Molecular Genetics

Chemistry

CHM 222 / CHL 222	Transition Metals and Bioinorganic Chemistry
CHM 331 / CHL 331	Physical Chemistry III (winter)
CHM 411	Organic Chemistry IV
CHM 431	Computational Chemistry and Molecular Modeling

Computer Science

CS 305	Data Mining for Scientists
CS 308	Scientific Programming

Mathematics

MAT 103	Environmental Modeling
MAT 209	Linear Algebra (winter)

Physics

PHY 208	Introduction to Mechanics (winter)
PHY 317	Statistical and Thermal Physics
PHY 371	Mathematical Methods of Physics (winter)

Environmental Studies and Geography

ESG 100	Introduction to Environmental Studies
ESG 126	Introduction to Human Geography
ESG 224	Human Impact on the Environment
ESG 249	Resource Management
ESG 266	Environmental Policy
ESG 358	International Environmental Issues
ESG 366	Ethical Perspectives on Environmental Problems

Marketing & Economics

ECO 270	Public Economics (winter)
BMK 350	Marketing Strategies for Environment Sustainability

Environmental Science Minor (24 Credits)

A Minor in Environmental Science consists of 24 credits or 8 courses after the completion of collegial science, or of receiving credit for U1 science at Bishop's, or the equivalent.* Among the 8 courses, 4 are required, namely,

ENV 101a	Introduction to Environmental Science
PHY 101a	Statistical Methods in Experimental Science
ESG 127a	Introduction to Physical Geography
ENV 241b / CHM 241b	Environmental Chemistry I: Atmosphere and Energy

The remaining 4 courses must be chosen from the following list** (and must include any co-requisite laboratories):

CHM 141a	Analytical Chemistry
CHM 111a	Organic Chemistry I: Introductory
PHY 207	Thermal and Fluid Physics
BIO 207a	General Ecology
ENV 242b / CHM 242b	Environmental Chemistry II: Water and Soil
ENV 337 / ECO 237	Economics of the Environment
BIO 327b	Advanced Ecology
ENV 375 / PHY 335	Environmental Physics
ENV 437 / ECO 337	Ecological Economics

Note: PHY 207, ECO 237, ECO 337, ENV 375 also require MAT 191a, MAT 192b, and/or ECO 102, and ECO 103 as pre-requisites (or equivalent prerequisite calculus and introductory economics credit).

* Students without the CEGEP science background would be required to add the following U1 science courses to this minor: BIO 191a, CHM 191a, CHM 192b, PHY 191a and PHY 192b (and each of their co-requisite laboratory courses).

** One (1) of the 4 choices may be either MAT 103 Environmental Modeling, or an ESG course (200 level or higher), chosen from the "ESG cognate" list for the BSc. Environmental Science Major (list is above).

Courses

ENV 101 Introduction to Environmental Science 3-3-0

This survey course introduces the student to environmental science from the physical, chemical, and biological points of view. Contents include a general introduction to the environment, energy, pollution, climate and weather, limits on renewable resources, and the Hubbert model. All of these topics are examined from a rigorous scientific perspective and include empirical analyses.

ENV 241 Environmental Chemistry I: Atmosphere and Energy 3-3-0

Note: See CHM 241. Students may not take this course for credit if they have received credit for CHM 241.

ENV 242 Environmental Chemistry II 3-3-0

Note: See CHM 242. Students may not take this course for credit if they have received credit for CHM 242.

EVL 242 Environmental Chemistry Laboratory 1-0-4

Note: See CHL 242. Students may not take this course for credit if they have received credit for CHL 242.

ENV 337 Economics of the Environment 3-3-0

Note: See ECO 237. Students may not take this course for credit if they have received credit for Economics 237.

ENV 375 Environmental Physics 3-3-0

This quantitative, calculus-based, course discusses fundamental environmental problems within a physical context. Topics covered include: the greenhouse effect, blackbody radiation, the ozone problem, mathematical techniques, heat transfer, electricity, the transport of pollutants, plumes, and basic groundwater hydrology.

Prerequisites: ENV 101; PHY 207.

Note: See PHY 335. Students may not take this course for credit if they have received credit for PHY 335

ENV 437 Ecological Economics 3-3-0

Note: See ECO 337. Students may not take this course for credit if they have received credit for ECO 337.

Mathematics

Mathematics is the language of the sciences, a language which allows scientists to quantify, model, understand and predict behaviour in an enormously diverse range of phenomena of interest. Simultaneously, Mathematics is often regarded as an art, as it is the creative study of patterns and of problem solving. Mathematics covers a wide range of disciplines including algebra, analysis, combinatorics and discrete mathematics, and differential equations. In first-year courses, mathematics students are joined by other science students, particularly from Physics and Computer Science. In the advanced courses, classes are very small, and some are given on an individual or tutorial basis.

The highest level of specialization is Honours, and Honours programs prepare students for direct entry into graduate work leading to a Master's or Ph.D. degree. All honours mathematics students have an opportunity to study independently and thus develop their reading and problem solving skills, and there is some chance to pursue special interests. The Majors programs provide students with an excellent general preparation for the career world, while not preventing entrance into graduate school (sometimes after a qualifying year). The Majors programs have sufficient electives to allow students to combine their major with a second major or at least a minor (the least specialized type of program) in another discipline. Students are encouraged to add a minor or major and many do so. Popular choices include computer science, physics, music, English, French, Spanish, drama, and philosophy. The Department of Mathematics offers several specialized, interdisciplinary programs, jointly with other departments, including Hispanic Studies and the School of Education.

Entrance Requirements

To enter a Mathematics program, a student will normally have completed either a Québec Collegial Diploma (DEC), or grade 12 in another Canadian province or the U.S.A., or the equivalent level of education internationally. All students will be admitted into a 120-credit program. Students with a DEC will generally be granted 30 advanced credits. All Bishop's students must additionally complete the English Writing Proficiency (EWP) requirement.

Students entering a Mathematics program at Bishop's from another Canadian University or College, or from accredited international post-secondary institutions, will have their transcripts of grades examined individually for possible transfer credit against a Bishop's program's requirements.

The requirements for Mathematics students differ depending

on whether the degree being pursued is a B.Sc. or a B.A., and whether the student entered Bishop's after completing CEGEP in Québec, or after completing grade 12 (or the equivalent) in another province or elsewhere. Two or more Mathematics programs may not be combined in any Bishop's degree.

First-year Calculus requirement

All Mathematics students require six course credits of Calculus studies, normally in their first year. Students with a Québec collegial diploma (DEC) shall be granted advance credit for these courses if they have completed a course in Differential Calculus and a course in Integral Calculus at CEGEP. If one or both of these courses were not completed at CEGEP, they must be completed at Bishop's and advanced credits shall be reduced accordingly. Students entering four-year programs in Mathematics with a grade 12 diploma (or equivalent) must register in MAT 191 and MAT 192 in their first year. These courses are included in the 120 total credit requirement. Students transferring into Mathematics programs may use credit for MAT 198 to replace MAT 191, and MAT 199 to replace MAT 192. Credit for MAT 197 with a grade of 80% or higher will also be accepted to replace MAT 191. Mathematical Contexts Minor program students normally complete MAT 198 and MAT 199 (instead of MAT 191 and MAT 192, although these are also acceptable), and do not need to do so in their first year.

First-year Physics requirement

Mathematics students pursuing the Bachelor of Science (B.Sc.) degree require six course credits of introductory physics studies in their first year. Students in the Bachelor of Arts (B.A.) degree program are exempt from this requirement. Students with any DEC are exempt from this requirement if they have completed two introductory Physics courses, Mechanics, and Electricity and Magnetism, at CEGEP. If one or both of these courses were not completed, they must be completed at Bishop's and advanced credits shall be reduced accordingly. Students entering four-year B.Sc. programs in Mathematics with a grade 12 diploma (or equivalent) must register in PHY 191 and PHY 192 in their first year.

Humanities requirement

Students must complete six course credits of humanities studies, normally in their first year at Bishop's. Students who have a Québec Collegial Diploma (DEC), students admitted as "Mature Students", and 2nd Bachelor's degree students are all exempt from this requirement. The Humanities requirement must include ELA 116 Effective Writing, or another English course (coded 'ENG'), and one additional course selected from Humanities courses in Classical Studies, English, History, Liberal Arts, Philosophy or Religion (courses coded CLA, ENG, HIS, LIB, PHI, or REL).

Arts and Science requirement

In addition to the Humanities requirement above, all students are required to complete at least three credits in either the Division of Humanities or the Division of Social Sciences. Students with program combinations which require more than 72 credits are exempt from this requirement.

Computer Science requirement

All Mathematics majors and honours students (except those in the Mathematics Education double major program) are required to complete the course CS 211 Programming Methodology.