PHYSICAL SCIENCES - BACHELOR OF SCIENCE

Overview

Physical Sciences covers small to big (subatomic particles to gigantic rock formations) and near to far (the chemistry that makes up your own body to the physics that lets you explore the farthest reaches of the solar system). Delve into current and relevant research in the fields of chemistry, Earth and planetary sciences, and physics. Access state-of-the-art technology, including robotic telescopes and our very own nuclear magnetic resonance spectrometer.

To major in physical sciences, students complete courses in chemistry, Earth and planetary sciences, and physics. Students can also choose to minor in any of the other disciplines offered in the Bachelor of Science program.

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Bachelor of Science

Faculty of Arts and Science
MacEwan.ca/Science (http://MacEwan.ca/Science/)

The Bachelor of Science (BSc) is a foundational general degree that provides broad and widely applicable knowledge and abilities rather than a niche specialization. This broad base equips graduates with generalist knowledge and skills that give the flexibility and agility so highly valued in a dynamic world economy. It also offers students a solid foundation to specialize in future employment or further schooling.

The degree provides a breadth of study across various Arts and Science disciplines and sets the foundation for later years. The major and minor areas of study allow students to focus and gain in-depth expertise in complementary or entirely disparate disciplines; there is a wide array of possible combinations. Finally, options enable students to explore courses outside their disciplines or even within their program, enhancing their diversity of learning. The small classes, close interaction between instructors and students, opportunities for individual study, and faculty with a strong focus on teaching are signature strengths of this program.

General Program Information

The BSc requires students to complete 120 credits of non-duplicative coursework. The BSc emphasizes breadth and depth and has been designed for exceptional flexibility and customization. Students can complete a major and a minor, a double major, or a major and two minors. Students can choose a secondary major in an Arts or Science discipline, but the primary major must be in a Science discipline.

All newly admitted students enter the BSc program as “Undeclared.” Undeclared means a student has not yet chosen their major(s) and minor(s). Students may declare at any time after being accepted to the BSc, and typically, they declare after completing a minimum of 45 credits. The Arts and Science Academic Advising Office will send information about majors and minors via email and newsletters; please contact the Advising Office if you require further assistance with this decision.

Science Disciplines

Discipline	Major	Minor	Honours
Applied Statistics	◉	-	◉
Biological Sciences	◉	◉	◉
Chemistry	◉	◉	-
Computer Science	◉	◉	-
Earth and Planetary Sciences	-	◉	-
Environmental Sciences	-	◉	-
Mathematics	◉	◉	◉
Mathematical Sciences	◉	-	-
Planetary Physics	-	◉	-
Physical Sciences	◉	-	-
Physics	-	◉	-
Psychology	◉	◉	◉
Statistics	-	◉	-

Arts Disciplines

Discipline	Major	Minor
Anthropology	◉	◉
Classics		◉
Creative Writing		◉
Economics	◉	◉
English	◉	◉
Film Minor for Arts and Science		◉
French		◉
Gender Studies		◉
History	◉	◉
Philosophy	◉	◉
Political Science	◉	◉
Sociology	◉	◉
Spanish		◉

Out of Faculty Minors

Discipline	Minor
Accounting Minor for Arts and Science	◉
Arts and Cultural Management	◉

Business Law	◉
Business Studies	◉
Digital Experience Design	◉
Finance Minor for Arts and Science	◉
Human Resources Minor for Arts and Science	◉
Marketing Minor for Arts and Science	◉

Laddering a Diploma into the Bachelor of Science

Students with an accredited diploma can ladder into the Bachelor of Science (BSc) and use some of their diploma coursework towards their degree requirements. If you have questions about the diploma laddering process, please visit www.macewan.ca/bscstudent or contact artsandscience@macewan.ca.

Preparing for Professional Studies

Students intending to enter professional programs at other universities can take their pre-professional programs in the Faculty of Arts and Science at MacEwan University. The university offers the first and second years of several pre-professional programs, including chiropractic medicine, dental hygiene, dentistry, medical laboratory science, medicine, optometry, pharmacy, and veterinary medicine. All courses in these pre-professional programs are credit courses, and, as such, they may apply to the degrees offered by MacEwan University.

Students are advised to consult the admissions requirements for the universities and programs of their choice and to select their MacEwan University courses accordingly. Completing pre-professional courses at MacEwan University does not guarantee admission to the subsequent professional program. Each professional program requires a separate application, and entry is competitive, not automatic.

Degree Requirements

Breadth Requirements

All Bachelor of Science degrees require Breadth Requirements. Courses can satisfy both the breadth requirements and requirements for the major(s), minor(s), Honours, or options. BIOL, CHEM, EASC, or PHYS courses must include a laboratory component.

Breadth Element	Description	Credits
Biological or Earth and Planetary Sciences	BIOL or EASC (not including BIOL 101, BIOL 102, or BIOL 103)	6
Chemistry or Physics	CHEM or PHYS	6
English	ENGL 102 and 3 credits in university English (not including ENGL 111, ENGL 108, or ENGL 211)	6
Humanities	CLAS, COMP, HIST, HUMN, PHIL or a language other than English	6
Mathematical Sciences	One of MATH 114, MATH 120, or MATH 125, and 3 credits in MATH, STAT, or CMPT (not including MATH 160, MATH 170, or CMPT 104)	6
Social Sciences	ANTH, ECON, GEND, LING, POLS, PSYC, or SOCI	6

Bachelor of Science Degree

Program Element	Description	Credits
Primary Major	The Science major will range from 42 to 60 credits with a minimum 36 credits taken at the senior-level.[1]	42-60
Secondary Major or Minor(s)	Students have the option of completing a second Science or Arts major, or one or two minors. Minor courses must be completed at the senior-level.[1]	18-60
Options	Students can complete up to 18 credits in out-of-faculty options, with no more than 3 credits in physical activity (PACT) courses	Up to 60
	Total Degree Credits Including Breadth	120

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Multi-disciplinary majors consist of 60-72 junior- and senior-level credits. Students majoring in mathematical or physical sciences may pursue a minor but are not required to do so.

Bachelor of Science Honours

Program Element	Description	Credits
Minimum Honours Requirements	Honours requirements are determined by each discipline.	63

Option Courses, Non-Compulsory Honours Courses, and/or a Minor	Students have the option of completing a minor from outside of the Honours discipline. Some disciplines may require a minor.	57
	Total Degree Credits Including Breadth	120

The minimum passing grade for a course at MacEwan University is a D unless otherwise noted next to the appropriate course in the program of study. In the Faculty of Arts and Science, students typically require a minimum grade of C- to use a course as a prerequisite. Please check course descriptions for more information.

Cross-Faculty Course Recognitions

Cross-Faculty course recognition represents an agreement between programs within MacEwan University and consists of a number of approved courses that have the potential to be recognized within another degree. These courses are not considered transfers or equivalents as the original course will show within a student's transcript and their Academic Planning and Progress Report (APPR). How the courses listed below might be used within a student's degree are determined by the student's program of study. They are dependent on a number of factors including year of declaration, year of completion, and individual program requirements.

Out-of-Faculty Course	Course Recognition	Course Used For
ACUP 117	ARTOP 1XX	Options; fulfills Humanities Breadth
ACUP 209	SCIOP 2XX	Options
ACUP 220, ACUP 303, and ACUP 304 (must complete all three courses)	COSL 200 (6 credits)	Options
ACUP 320	SCIOP 3XX	Options
AGAD 300	COSL 300	Options
AGAD 435	WINL 300	Options
ARTE 104	ARTOP 1XX	Options; fulfills Humanities Breadth
ARTE 214	ARTOP 2XX	Options; fulfills Humanities Breadth
ARTE 224	ARTOP 2XX	Options; fulfills Humanities Breadth
ARTE 234	ARTOP 2XX	Options; fulfills Humanities Breadth
ARTE 304	ARTOP 3XX	Options; fulfills Humanities Breadth
ARTE 314	ARTOP 3XX	Options; fulfills Humanities Breadth
ARTE 324	ARTOP 3XX	Options; fulfills Humanities Breadth
CORR 102	SOCI 1XX	Options or Sociology program requirements; fulfills Social Science Breadth
CORR 104	SOCI 1XX	Options or Sociology program requirements; fulfills Social Science Breadth
CORR 110	SOCI 225	Options or Sociology program requirements; fulfills Social Science Breadth
CORR 120	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
CORR 202	ARTOP 2XX	Options
CORR 208	ARTOP 2XX	Options
CORR 214	COSL 200	Options
CORR 218	SOCI 321	Options or Sociology program requirements; fulfills Social Science Breadth
CORR 224	COSL 200	Options
CYCW 100	PSYC 2XX	Options or Psychology program requirements; fulfills Social Science Breadth
CYCW 108 and CYCW 112	SOCI 1XX	Options or Sociology program requirements; fulfills Social Science Breadth
CYCW 115	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
CYCW 114	ARTOP 1XX	Options
CYCW 201	PSYC 2XX	Options or Psychology program requirements; fulfills Social Science Breadth
CYCW 204	COSL 200	Options
CYCW 205	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
CYCW 206	ARTOP 2XX	Options
CYCW 208	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
CYCW 211	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
CYCW 302	ARTOP 3XX	Options; fulfills Social Science Breadth
CYCW 303	ARTOP 3XX	Options; fulfills Social Science Breadth
CYCW 339	ARTOP 3XX	Options; fulfills Social Science Breadth

CYCW 340	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
CYCW 350	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
CYCW 360	SOCI 3XX	Options or Sociology program requirements; fulfills Social Science Breadth
CYCW 361	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
CYCW 466	ARTOP 4XX	Options
DESN 270	ARTOP 2XX	Options; fulfills Humanities Breadth
DESN 271	ARTOP 2XX	Options; fulfills Humanities Breadth
ECCS 110	PSYC 1XX	Options or Psychology program requirements; fulfills Social Science Breadth
ECCS 115	ARTOP 1XX	Options
ECCS 160	PSYC 2XX	Options or Psychology program requirements; fulfills Social Science Breadth
ECCS 180	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science breadth
ECCS 220	COSL 200	Options
ECCS 255	ARTOP 2XX	Options
ECCS 260	SOCI 2XX	Options or Psychology program requirements; fulfills Social Science Breadth
ECCS 270	COSL 200	Options
ECCS 310	SOCI 3XX	Options or Sociology program requirements; fulfills Social Science Breadth
ECCS 355	SOCI 3XX	Options or Sociology program requirements; fulfills Social Science Breadth
ECCS 360	SOCI 3XX	Options or Sociology program requirements; fulfills Social Science Breadth
ECCS 425	SOCI 4XX	Options or Sociology program requirements; fulfills Social Science Breadth
ECDV 160	ARTOP 1XX	Options
ECDV 220	COSL 200	Options
ECDV 255	ARTOP 2XX	Options
ECDV 260	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
ECDV 270	COSL 270	Options
ECDV 280	PSYC 2XX	Options or Psychology program requirements; fulfills Social Science Breadth
FNCE 301	ECON 3XX	Options or Economics program requirements; fulfills Social Science Breath
HAPR 101	SCIOP 1XX	Options
HAPR 104	ARTOP 1XX	Options
HAPR 114	WINL 200	Options
HAPR 201	ARTOP 2XX	Options
HAPR 212	WINL 200	Options
HEED 110	ARTOP 1XX	Options
HEED 120	SCIOP 1XX	Options
HLSC 104	SCIOP 1XX	Options
HLSC 105	SCIOP 1XX	Options
HLSC 120	BIOL 1XX	Options or Biological Sciences program requirements
HLSC 124	BIOL 1XX	Options or Biological Sciences program requirements
HLSC 126	BIOL 1XX	Options or Biological Sciences program requirements
HLSC 128	BIOL 2XX	Options or Biological Sciences program requirements
HLST 150	SCIOP 1XX	Options
HLST 210	ARTOP 2XX	Options
HLST 290	SCIOP 1XX	Options
INFM 101	ARTOP 1XX	Options
INFM 202	ARTOP 2XX	Options
INFM 208	ARTOP 2XX	Options
INFM 209	ARTOP 2XX	Options
INFM 210	ARTOP 2XX	Options
INFM 260	COSL 200	Options
INTA 210	ARTOP 2XX	Options; fulfills Humanities Breadth
INTA 362	ARTOP 3XX	Options
MTST 120	BIOL 1XX	Options or Biological Sciences program requirements
MTST 122	BIOL 1XX	Options or Biological Sciences program requirements

MTST 125	BIOL 1XX	Options or Biological Sciences program requirements
MTST 126	BIOL 1XX	Options or Biological Sciences program requirements
MTST 161, MTST 162, MTST 260, MTST 261, MTST 262	COSL 200	Options
MUSC 104	ARTOP 1XX	Options
MUSC 123	ARTOP 1XX	Options; fulfills Social Science Breadth
MUSC 124	ARTOP 1XX	Options; fulfills Social Science Breadth
PEDS 100	BIOL 1XX	Options or Biological Sciences program requirements
PEDS 101	BIOL 1XX	Options or Biological Sciences program requirements
PEDS 103	BIOL 2XX	Options or Biological Sciences program requirements
PEDS 109	SCIOP 1XX	Options
PEDS 200	BIOL 2XX	Options or Biological Sciences program requirements
PEDS 203	SCIOP 2XX	Options
PEDS 206	BIOL 2XX	Options or Biological Sciences program requirements
PEDS 207	BIOL 2XX	Options or Biological Sciences program requirements
PEDS 209	ARTOP 2XX	Options
PEDS 240	SCIOP 1XX	Options
PERL 104	ARTOP 1XX	Options
PERL 204	ARTOP 2XX	Options
PERL 207	ARTOP 2XX	Options
PSSC 102	ARTOP 1XX	Options
PSSC 112	ARTOP 1XX	Options
PSSC 121	SOCI 1XX	Options or Sociology program requirements; fulfills Social Science Breadth
PSSC 203	ARTOP 2XX	Options
PSSC 204	ARTOP 2XX	Options
PSSC 212	ARTOP 2XX	Options
PSSC 252	ARTOP 2XX	Options
PSSC 253	ARTOP 2XX	Options
PSSC 272	COSL 200	Options
PSSC 273	COSL 200	Options
SOWK 101	ARTOP 1XX	Options; fulfills Humanities Breadth
SOWK 111	ARTOP 1XX	Options
SOWK 112	ARTOP 1XX	Options
SOWK 203	ARTOP 2XX	Options
SOWK 204	SOCI 2XX	Options or Sociology program requirements; fulfills Social Science Breadth
TAST 101	ARTOP 1XX	Options
TAST 129 and TAST 130	COSL 200	Options
THAR 240	ARTOP 2XX	Options
THAS 101	ARTOP 1XX	Options
THAS 102	SCIOP 1XX	Options
THAS 115	ARTOP 1XX	Options
THAS 203	COSL 200	Options
THAS 210	COSL 200	Options
THAS 211	COSL 200	Options
THAS 214	COSL 200	Options
THAS 222	ARTOP 2XX	Options
THPR 205	ARTOP 2XX	Options; fulfills Humanities Breadth
THPR 206	ARTOP 2XX	Options; fulfills Humanities Breadth
THPR 214	COSL 200	Options
THPR 224	COSL 200	Options

Physical Sciences Requirements

Physical Sciences Major

The Bachelor of Science (BSc) in Physical Sciences program requires students to complete 120 credits of non-duplicative coursework. The major is comprised of three disciplines – chemistry, Earth and planetary sciences, and physics. Students select two of the three as primary disciplines. While students in this major are not required to complete a minor, if chemistry, Earth and planetary sciences or physics disciplines are chosen as a minor, all senior-level credits in that discipline will only count toward the minor.

Students are required to complete option courses as well as the Physical Sciences Major and the possible minor. All BSc degrees require Breadth Requirements. Courses can satisfy both the breadth requirements and requirements for the major(s), minor(s), or options.

The Physical Sciences Major is 60 to 72 credits with a minimum of 42 senior-level credits. Students must complete a minimum of three credits at the 300- or 400-level in each primary discipline and a minimum of 12 credits at the 300- or 400-level across all primary disciplines.

NOTE: MATH 114 or MATH 115 is a prerequisite for most 300-level and higher PHYS courses. Students considering future enrollment in 300-level or higher PHYS courses are strongly encouraged to take MATH 114 (or MATH 114 and one of MATH 120 or MATH 125) to satisfy the mathematics requirements.

Bachelor of Science - Physical Sciences Major

Code	Title	Credits
Specific Major Requirements		
Choose 6 credits from each of the following disciplines:		18
Chemistry		
CHEM 101	Introductory University Chemistry I	
CHEM 102	Introductory University Chemistry II	

Earth and Planetary Science		
EASC 101	Introduction to Physical Science	
EASC 102	Introduction to Environmental Earth Science	
Physics		
PHYS 124 & PHYS 126	Physics for Life Sciences I and Physics for Life Sciences II	
PHYS 144 & PHYS 146	Mechanics and Electromagnetism	
General Major Requirements		
Three Disciplines - Chemistry (CHEM), Earth and Planetary Sciences (EASC), and Physics (PHYS). PHSC can be used wherever CHEM, EASC, or PHYS is used.		
Primary Discipline I		
Choose 18 to 24 credits from senior-level courses from the first primary discipline		18-24
Primary Discipline II		
Choose 18 to 24 credits from senior- level courses from the second primary discipline		18-24
General Requirements		
Choose 6-12 credits from senior- level courses from the third discipline		6-12
Minor		
Students have the option of completing a minor. Minor courses must be completed at the senior-level.		0-18
Options		
Students can complete up to 18 credits in out-of-faculty options, with no more than 3 credits in physical activity (PACT) courses.		30-60
Total Credits		**120**

Degree Regulations

Students are strongly encouraged to seek advice from the faculty advisors about program planning.

Academic Residency - Credit Requirements

In addition to the academic residency requirements of the University, upon admission to the Bachelor of Science (BSc), students must complete at MacEwan University:

- A minimum of 24 credits at the senior-level in the major discipline, with 12 of those senior credits completed at the 300- or 400-level. All 400-level requirements are to be completed at MacEwan University.
- If applicable, a minimum of nine credits in a minor at the senior-level, with at least three of those credits completed at the 300- or 400-level.

Students with a previous MacEwan University credential are required to complete a minimum of 45 credits upon admission to the BSc.

Students who hold a baccalaureate degree from another post-secondary institution must complete a minimum of 60 additional MacEwan University credits applicable to the BSc. Forty-five of these credits must be completed while the students is enrolled in the BSc. This credit requirement applies to students who began their studies at MacEwan University and completed a credential at another institution.

Students who interrupt their program and who must apply for readmission to the program will be required to comply with any new regulations upon resumption of their studies.

Breadth Requirements

Courses taken to fulfil the major, minor, or option requirements can also be used to satisfy breadth requirements.

Declaration of a Major and Minor

Students are advised to declare a primary major and minor, or primary major and a secondary major, or a major and two minors by the time they have completed 45 credits. Primary majors are selected from Science disciplines and consist of 42 to 60 junior- and senior-level credits; secondary majors can be from an Science or Arts discipline. Multi-disciplinary majors consist of 60-72 junior- and senior-level credits. Except for students in an Honours program, a maximum of 60 credits may be completed from any one discipline for credit towards the degree. A major and minor cannot be in the same discipline and students may not declare more than one out-of-faculty minor. Students can re-declare their major(s) and/or minor(s) if required.

For students completing multiple majors or minors, the Faculty cannot guarantee a schedule of classes that will permit students to complete their degree in eight consecutive fall and winter semesters. Furthermore, depending on the configuration of the student's degree, meeting the requirements for the degree may require the completion of more than 120 credits for graduation. Students are strongly encouraged to consult with an academic advisor in the Faculty of Arts and Science Advising Office and a discipline advisor in their major and minor prior to this declaration. Students majoring in mathematical or physical sciences may pursue a minor but are not required to do so.

Restricted Enrolment Courses

The Faculty of Arts and Science strives to accommodate all students wishing to enrol in a given course when it is appropriate to their program: however, classes in some courses must, for academic reasons, be restricted in size. If such a course is found to be oversubscribed, priority in registration will be given to those students whose programs may require it (e.g., majors, Honours, and/or minors) and then to other students as space permits.

Graduation Grade Point Average

As part of the Graduation Grade Point Average regulation above, Bachelor of Science students must obtain an overall GGPA of 2.0 or higher, with a minimum GPA of 2.0 on all courses credited toward the major(s) and a minimum GPA of 2.0 on all courses credited toward the minor(s).

Graduation Requirements

Graduation requirements are governed by the date on which a student declares their major(s) and minor(s). Students who declare their major(s) and minor(s) on or before the published deadline are bound by the requirements of the current academic year. Those students who declare after this date are bound by the programs of study and degree requirements of the upcoming academic year as published in the MacEwan Academic Calendar.

Junior - and Senior-Level Courses

Courses numbered from 100 to 199 are considered junior-level and courses numbered from 200 to 499 are considered senior-level.

Major or Minor 300- and 400- Level Requirements

The 300- and 400-level requirements in the major or minor cannot consist solely of project, field placement, and/or individual study courses.

Maximum Independent Courses

The maximum number of credits for independent work (project, field placement, and/or individual study courses) excluding the Honours Thesis, is 15 credits. Specific disciplines may have further restrictions.

Maximum Junior-Level Courses

A maximum of 48 credits at the 100-level are permitted in completion of the B.Sc. degree. Additional courses at the 100-level are extra to the 120 credits required to complete the B.Sc. degree and will not be counted toward fulfilment of graduation requirements.

Minimum Science Courses

Students are required to complete successfully a minimum of 72 total credits from Science courses.

Minimum Passing Grade

A minimum grade of D or credit CR is required for all Science degree courses unless otherwise noted next to the appropriate course in the program of study.

Minimum Transfer Grade for Credit

A minimum grade of D is required on any transfer credit granted for the program. Unless otherwise stated, Arts and Science courses require a minimum grade of C- when the course is used as a prerequisite. Transfer credit decisions made by the university are final and cannot be appealed.

Out-of-Faculty Options Requirements

Students may take a maximum of 18 credits from courses offered by a MacEwan University Faculty or School other than Arts and Science. Students completing an out-of-faculty minor or laddering students who have met the minor requirements with a MacEwan University diploma must complete their degree requirements from courses offered within the Faculty of Arts and Science or from the list of *Cross-Faculty Course Recognitions* in the Academic Calendar. Courses deemed as *Cross-Faculty Course Recognitions* are used to fulfill in-Faculty courses within the BSc and do not count as out-of-Faculty options.

Progression of Studies

Students are responsible for ensuring they meet the prerequisite and/or co-requisite requirements as noted on all courses that may fulfill Bachelor of Science program requirements.

Honours Regulations

Overall Requirements

The Honours program of study consists of 63 to 84 credits as determined by the discipline. Students in the Honours program may choose to complete a minor outside of the Honours discipline. Some disciplines may require a minor.

Acceptance to Honours

For consideration of admittance/acceptance into Honours, students must present a minimum of 45 university-level credits applicable to the program of study, with a GPA of 3.0 or higher. They must complete 24 of the 45 credits in the last 12 months; however, exceptions to this rule may occur with the approval of the Honours discipline advisor. Individual departments may have additional requirements noted in their program of study.

Course Load

Students accepted into an Honours program must complete 24-credits in each twelve consecutive months they are in the program. Exceptions to this rule may occur with the approval of the Honours discipline advisor.

Grade Point Average

Students accepted and enrolled in the Science Honours program must maintain a minimum overall GPA of 3.0 across all courses in the degree. As well, students must maintain a minimum GPA of 3.3 across a set of courses designated by each discipline for each twelve consecutive months following acceptance into the Honours program. Failure to do so will result in the student's program status reverting to BSc with a major in the previous Honours discipline.

Graduation Grade Point Average

In order to graduate, students must obtain an overall GGPA of 3.0 or higher, with a minimum GPA of 3.3 on all courses credited toward the Honours program of study.

Program Learning Outcomes

Faculty of Arts and Science Degree-Level Learning Outcomes

Thinking about knowledge is at the core of University education and learning within the Faculty of Arts and Science. Students develop capacities to "think-through" - to practice wonder, reflection, and engage in thoughtful inquiry and dialogue. Thinking-through involves questioning beyond the confines of one's immediate personal, social, and disciplinary surroundings. First, knowledge is acquired and understood. Learning moves beyond acquiring information and data to a formally disciplined manner of thinking about knowledge. Next, knowledge is interrogated by asking and answering questions, distinguishing between opinion and knowledge, and developing tools to assess reasons and evidence. Finally, knowledge is synthesized as students develop coherent arguments, and link ideas together beyond what is immediately apparent. Learning is a lifelong creative process of discovery and action that happens beyond the classroom and the degree. Our graduates interact with and contribute to their community by integrating and applying the research and communication skills and ways of knowing developed through their education. Learning outcomes capture the observable knowledge, skills, and abilities graduates acquire that are the foundation of learning.

Graduates will demonstrate their ability to "think-through" by:

i. Analysing puzzles, problems, concepts, and theories.
ii. Conceptualizing questions based on disciplinary knowledge.
iii. Evaluating knowledge within and across disciplines in ways that acknowledge historical, cultural, and social contexts.

Graduates will demonstrate research and scholarship skills by:

iv. Applying appropriate research skills and ethical principles.
v. Interpreting results appreciating the value and limits of conclusions.
vi. Recognizing how research involves an ongoing process of reflection, dialogue, and reassessment.

Graduates will demonstrate diverse skills for communication by:

vii. Conveying complex ideas coherently in a variety of formats.
viii. Appraising information in ways that consider context and audience.

ix. Interpreting the ideas and arguments of others in ways that reflect their knowledge, judgement, and comprehension.

Graduates will demonstrate durable skills necessary for learning beyond their degree by:

x. Collaborating with diverse groups.
xi. Examining different perspectives and challenging biases and preconceptions.
xii. Exploring the continuous impact and limitations of disciplinary knowledge and expertise.

Physical Sciences Value Statement

At the core of our physical sciences program, we uphold a set of values that guide our approach to education, research, and the pursuit of knowledge. We strive for excellence in all aspects of our physical sciences program, maintaining rigorous academic standards, promoting scholarly achievements, and fostering a culture of continuous improvement. We are dedicated to providing a high-quality education by encouraging curiosity, creativity, collaboration, diversity, integrity, and interdisciplinary approaches that prepares students for successful careers and lifelong learning.

Program Learning Outcomes

Upon completion of a BSc with a major in Physical Sciences students should be able to:

1. Independently demonstrate a comprehensive understanding of the fundamental concepts, theories, and principles in physical sciences, including physics, chemistry, and related disciplines, such as
   - chemical principles, including organic, inorganic, physical, and analytical chemistry, etc.
   - geological concepts, including plate tectonics, mineralogy, and geochemistry, etc.
   - physical concepts, including mechanics, electromagnetism, and thermodynamics, etc.

2. Apply scientific inquiry methods and critical thinking skills to investigate and analyze scientific problems, formulate hypotheses, design experiments, collect and interpret data, and draw meaningful conclusions.

3. Identify, define, and solve complex problems in physical sciences by applying appropriate scientific theories, mathematical models, and experimental techniques.

4. Possess proficient laboratory skills, including the ability to safely and accurately use scientific instruments, design and conduct experiments, collect data, and analyze results.

5. Work collaboratively in interdisciplinary teams, demonstrating effective interpersonal skills, ethical and leadership abilities, and the capacity to contribute positively to group dynamics.

6. Effectively communicate scientific ideas and findings through oral presentations, written reports, and scientific publications, using appropriate terminology and formatting.

Student Plan

- The student plan provides a suggested course sequence with the minimum number of credits required for the major
- The suggested course sequence depends on course availability, the student's schedule, and the selection of primary and secondary disciplines
- It is highly recommended that students complete their Breadth Requirements by the end of year 2
- The major is comprised of three disciplines - chemistry, Earth and planetary sciences, and physics. Students select two of the three as primary disciplines

Year 1	Credits
CHEM 101	3
CHEM 102	3
EASC 101	3
EASC 102	3
Choose one of the following pairs of PHYS courses:	6
PHYS 124 and PHYS 126	
PHYS 144 and PHYS 146	
MATH 114	3
Choose 3 credits (1 course) from the following	3
MATH 120	
MATH 125	
Breadth Requirements	6
	30

Year 2	Credits
MATH 115	3
Chose 9 or senior-level credits (3 courses) from the first primary discipline	9
Choose 9 senior-level credits (3 courses) from the second primary discipline	9
Breadth, Option, Minor(s), or Primary or Secondary Major Requirements	9
	30

Year 3	Credits
Choose 6 senior-level credits (2 courses) with a minimum of 3 credits (1 course) at the 300-level from the first primary discipline	6
Choose 6 senior-level credits (2 courses) with a minimum of 3 credits (1 course) at the 300-level from the second primary discipline	6
Choose 3 senior-level credits (1 course) from the third discipline	3
Options, Minor(s), or Primary or Secondary Major Requirements	15
	30

Year 4	Credits
Choose 6 senior-level credits (2 courses) with a minimum of 3 credits (1 course) at the 300- or 400-level from the first primary discipline	6
Choose 6 senior-level credits (2 courses) with a minimum of 3 credits (1 course) at the 300- or 400-level from the second primary discipline	6
Choose 3 senior-level credits (1 course) from the third discipline	3
Options, Minor(s), or Primary or Secondary Major Requirements	15
	30

Total Credits 120

Expected Course Offerings

Following is a list of expected course offerings for fall 2024 and winter 2025. While some might change, students can be assured that required courses will be available. Please refer to myStudentSystem for up-to-date course offerings.

Chemistry Course Offerings

Fall 2024

CHEM 101	Introductory University Chemistry I
CHEM 102	Introductory University Chemistry II
CHEM 211	Applied Analytical Chemistry
CHEM 242	Fundamentals of Physical Chemistry
CHEM 261	Organic Chemistry I
CHEM 263	Organic Chemistry II
CHEM 320	Introduction to Geochemistry
CHEM 333	Organometallic Chemistry
CHEM 353	Forensic Chemistry
CHEM 372	Environmental Chemistry
CHEM 391	Applied Spectroscopy
CHEM 464	Advanced Synthetic Medicinal Chemistry

Winter 2025

CHEM 101	Introductory University Chemistry I
CHEM 102	Introductory University Chemistry II
CHEM 232	Inorganic Chemistry
CHEM 261	Organic Chemistry I
CHEM 263	Organic Chemistry II
CHEM 311	Advanced Chemical Analysis
CHEM 322	Introduction to Biogeochemistry
CHEM 342	Materials Chemistry
CHEM 364	Introduction to Medicinal Chemistry
CHEM 380	Process and Flow Chemistry
CHEM 466	Modern Catalysis
CHEM 472	Advanced Environmental Chemistry
CHEM 496	Techniques in Applied Laboratory Chemistry
CHEM 497	Chemistry Internship Practicum

Earth and Planetary Sciences Course Offerings

Fall 2024

EASC 101	Introduction to Physical Science
EASC 102	Introduction to Environmental Earth Science
EASC 219	Mineralogy
EASC 221	Introduction to Geographic Information Systems
EASC 225	Introduction to Geomorphology
EASC 271	The Oceans
EASC 321	Structural Geology and Tectonics
EASC 373	Anthropogenic Climate Change
EASC 495	Special Topics

Winter 2025

EASC 101	Introduction to Physical Science
EASC 102	Introduction to Environmental Earth Science
EASC 206	Geology of the Solar System
EASC 221	Introduction to Geographic Information Systems
EASC 240	Sedimentology and Stratigraphy
EASC 322	Introduction to Biogeochemistry
EASC 324	Quaternary Environments
EASC 330	Igneous, Sedimentary, and Metamorphic Petrology
EASC 334	Remote Sensing
EASC 409	Geology of Western Canada

Physics Course Offerings

Fall 2024

PHYS 124	Physics for Life Sciences I
PHYS 126	Physics for Life Sciences II
PHYS 144	Mechanics
PHYS 208	Quantum Aspects of Physics
PHYS 224	Fluids and Heat
PHYS 244	Mechanics
PHYS 261	Physics of Energy
PHYS 324	Origins of Planetary Systems

Winter 2025

PHYS 124	Physics for Life Sciences I
PHYS 126	Physics for Life Sciences II
PHYS 146	Electromagnetism
PHYS 226	Optics and Sound Waves
PHYS 242	Physics of Planetary Exploration
PHYS 252	Physics of the Earth
PHYS 301	Nuclear Physics
PHYS 308	An Introduction to Semiconductors and Superconductors
PHYS 390	Advanced Physics Laboratory

Admission Requirements

Applicants may be admitted to one of the following:

Regular Admission

To be evaluated through the Office of the University Registrar

Applicants must have a minimum overall average of 65 percent, with no course grade lower than 50 percent, in the following high school courses:

1. ELA 30-1
2. Mathematics 30-1
3. Two of Biology 30, Chemistry 30, Mathematics 31, Physics 30, or Computing Science-Advanced Career and Technology Studies (5 credits)
4. One subject from Group A, B, C or D

Notes:

- A maximum of one Group D subject may be presented. Group D subjects used for admission must be 5-credit or any credit combination of at least 5 credits (e.g., two 3-credit subjects).

Applicants with nine to 23 university-level credits must also present a minimum Admission Grade Point Average (AGPA) of 2.0 on a 4.0 scale. Applicants with 24 or more university-level credits will be considered under Previous Post-Secondary Work.

Mature Admission

To be evaluated through the Office of the University Registrar

Applicants must be Canadian Applicants, 20 years of age or older, and have been out of full-time high school at least one year by the beginning of the intake term. Applicants must have a minimum overall average of 60 percent, with no course grade lower than 50 percent, in the following high school courses:

1. ELA 30-1
2. Mathematics 30-1
3. Two of Biology 30, Chemistry 30, Mathematics 31, Physics 30, or Computing Science-Advanced Level Career and Technology Studies (5 credits)

Applicants with nine to 23 university-level credits must also present a minimum Admission Grade Point Average (AGPA) of 2.0 on a 4.0 scale. Applicants with 24 or more university-level credits will be considered under Previous Post-Secondary Work.

Previous Post-Secondary Work

To be evaluated through the Office of the University Registrar

Admission in this category does not imply or guarantee the transfer of any coursework and/or credential unless a block transfer agreement (internal or external) is in effect and published in the calendar by the Office of the University Registrar. In addition, transfer of coursework does not imply or guarantee that an applicant will be admitted.

Applicants must have successfully completed the following:

- A minimum of 24 university-level credits, from a recognized institution, with a minimum Admission Grade Point Average (AGPA) of 2.0 on a 4.0 scale.
- The required mathematics and science courses listed under the Regular or Mature Admission category.

Additional Admission Criteria

All applicants must meet the following:

1. English Language Proficiency

To be evaluated through the Office of the University Registrar

Applicable to All Admission Categories

All applicants must meet an acceptable level of English language proficiency. We will require official documents such as high school or post-secondary transcripts or proof of successful completion of standardized language evaluation. Full details are available in MacEwan University's academic calendar or online at MacEwan.ca/ELP (http://MacEwan.ca/ELP/).

2. Other Admission Criteria

To be evaluated through the Office of the University Registrar

Applicable to All Admission Categories

Applicants who have been assigned two unsatisfactory academic records within the past five years will not be considered for admission or re-admission to the program until a minimum three years from the date of the assignment of the last unsatisfactory academic record. For the purpose of admission or re-admission, an unsatisfactory record is defined as a transcript with the notation 'required to withdraw' or equivalent.

Physical Sciences Courses

Chemistry Courses

CHEM 101
Introductory University Chemistry I
3 Credits Weekly (4-3-0)
This course serves as a foundation for all subsequent chemistry courses. Atomic properties as they relate to the periodic table are considered, along with quantum mechanics for hydrogen-like orbitals and electron configurations. The course provides an introduction to bonding theories as they apply to the stability, molecular geometry and intermolecular interactions of atomic, ionic and molecular species. Topics include chemical nomenclature, stoichiometry, classification of chemical reactivity, gases (both ideal and real) and thermochemistry. Note: Credit may be obtained in only one of CHEM 101 or CHME 103.
Prerequisites: Chemistry 30.

CHEM 102
Introductory University Chemistry II
3 Credits Weekly (4-3-0)
This course emphasizes the importance of chemical equilibrium as it applies to gases, acids and bases, solubility and precipitation reactions and complex ion formation. Also studied are kinetics (rates of reactions, differential and integrated rate laws, the Arrhenius equation), catalysts, thermodynamics (spontaneity, entropy, free energy), and electrochemistry (balancing redox reactions, calculating standard and non-standard cell potentials), with emphasis on some practical applications related to batteries, corrosion and industrial processes. A special topic, selected by the instructor, is covered if time permits. Note: Credit may only be obtained in one of CHEM 102 or CHME 105.
Prerequisites: Minimum grade of C- in CHEM 101.

CHEM 211
Applied Analytical Chemistry
3 Credits Weekly (3-4-0)
This course surveys the principles, methods, and experimental applications of classical analytical chemistry, emphasizing solution phase equilibria, titrimetry, volumetric laboratory skills, and the evaluation of experimental data. This course includes real life examples of organic and inorganic analysis and analytical chemistry literature. Students are introduced to principles, methods, and experimental applications of separation techniques, atomic and molecular spectrometry, potentiometry, and the evaluation of experimental data.
Prerequisites: Minimum grade of C- in CHEM 102 or CHME 105.

CHEM 232
Inorganic Chemistry
3 Credits Weekly (3-3-0)
This course examines the bonding models used for inorganic compounds (main group and transition metal elements). Reactivity patterns of inorganic compounds are considered to gain an understanding of the role of thermodynamics and kinetics in their preparation and reactivity. Physical methods that are used to characterize inorganic compounds are discussed. The relevance and importance of inorganic compounds in the environment, industry and biology are emphasized.
Prerequisites: Minimum grade of C- in CHEM 102.

CHEM 242
Fundamentals of Physical Chemistry
3 Credits Weekly (3-3-0)
This course is about the use of methods to design experiments, analyze measured data, and devise quantitative models in chemistry. These models are applied to explain observations, to optimize experimental conditions, and to predict and control the direction, extent and rate of physicochemical processes. Internal energy, enthalpy, entropy and free energy functions are applied to perform the materials and energy balances of reactions, phase transitions, transport of matter, and coupled processes thereof. Focus is placed on nonequilibrium and steady-state processes. The laws of energy conservation, entropy production, and equilibrium are applied to phenomena occurring inside systems consisting of several components and phases. Fundamentals cover the methods to determine the kinetic parameters and mechanism of chemical reactions.
Prerequisites: A minimum grade of C- in CHEM 102 and MATH 114.

CHEM 261
Organic Chemistry I
3 Credits Weekly (3-3-0)
This course covers the molecular structure and reactivity of organic compounds based on their functional groups. The course provides an introduction to nomenclature, three dimensional structure and physical properties of organic compounds as well as reaction mechanisms and infrared spectroscopy. Although most organic functional groups are discussed, the focus is on the chemistry of alkanes, alkenes, alkynes and alkyl halides. Mechanisms of nucleophilic substitution and elimination reactions of alkyl halides are discussed.
Prerequisites: Minimum grade of C- in either CHEM 102 or CHME 105.

CHEM 263
Organic Chemistry II
3 Credits Weekly (3-3-0)
The nomenclature, structure, physical properties, synthesis and selected reactions of the basic functional groups in organic chemistry are discussed. Functional groups covered include alkenes, alkynes, aromatic compounds, alcohols, phenols, ethers, aldehydes, ketones, amines, carboxylic acids and carboxylic acid derivatives. An emphasis will be placed on understanding the fundamental mechanistic processes behind these chemical transformations. The application of spectroscopic methods for structure determination in simple organic molecules is discussed.
Prerequisites: Minimum grade of C- in CHEM 261.

CHEM 311
Advanced Chemical Analysis
3 Credits Weekly (3-4-0)
This course discusses instrumentation and analytical applications of spectroscopic, chromatographic, and electroanalytical methods. The theory governing each analytical technique and its advantages and disadvantages are discussed. Emphasis is placed on choosing the appropriate method for a particular analysis.
Prerequisites: A minimum grade of C- in one of CHEM 211, CHEM 270, or CHEM 372.

CHEM 320
Introduction to Geochemistry
3 Credits Weekly (3-3-0)
This course provides an introduction to the interdisciplinary science of geochemistry. The first part of the course examines our home planet from a geochemical perspective and includes formation of the Earth and our solar system, the origin of the elements and their distribution within the Earth, and evolution of the crust, mantle and core. An introduction to the essential geochemical tools of thermodynamics and kinetics, isotope geochemistry and trace element geochemistry is also provided. The second part of the course examines the geochemistry of igneous, sedimentary and metamorphic rocks and covers topics as diverse as the melting and crystallization of rocks to the contamination of our water supplies and the stability of carbonates in our oceans. Note: Credit can only be obtained in one of CHEM 320 or EASC 320.
Prerequisites: Minimum grades of C- in a 200-level CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*) course and a 200-level* EASC *(*https://calendar.macewan.ca/course-descriptions/easc/*) course.*

CHEM 322
Introduction to Biogeochemistry
3 Credits Weekly (3-3-0)
Biogeochemistry is the study of the chemical, physical, geological, and biological processes and reactions that govern planet Earth. This course provides an introduction to the discipline, focusing on the exchange of energy and elements between the biosphere and the geosphere. The fundamental components of the Earth's system are examined, including the atmosphere, hydrosphere, biosphere, and geosphere, alongside their evolutionary histories and linkages. Topics include the principle biogeochemical cycles, such as the carbon, sulfur, and nitrogen cycles, and their histories. These cycles are assessed in the context of recent environmental and climate change driven by anthropogenic activities. This course incorporates a multitude of disciplines, spanning geology, chemistry, biology, and environmental science. Note: Credit cannot be obtained in both CHEM 322 and EASC 322.
Prerequisites: Minimum grades of C- in a 200-level CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*) course and a 200-level* EASC *(*https://calendar.macewan.ca/course-descriptions/easc/*) course.*

CHEM 333
Organometallic Chemistry
3 Credits Weekly (3-3-0)
This course surveys the basic principles of the organometallic chemistry as they apply to metals of the d-block elements and main group metals. Topics include a survey of ligands and coordination chemistry/geometry of transition metals and main group metals. The properties and reactions of organometallic complexes, and applications of organotransition metal compounds in catalysis, organic synthesis, bioinorganic chemistry and medicinal chemistry are reviewed.
Prerequisites: Minimum grades of C- in CHEM 232 and CHEM 263.

CHEM 342
Materials Chemistry
3 Credits Weekly (3-3-0)
This course is about the relationships among processing, structure, properties, performance, applications and sustainability of materials. It covers the materials classed as metal alloys, crystals, glasses, ceramics, plastics and composites. It examines the structural assembling of materials at the macroscopic, microscopic, nanoscopic and atomistic scales of size. The interatomic and intermolecular bonding at play in the assembling of such structures is analyzed. How mechanical, optical, electrical, surface, bonding and catalytic properties arise from the structural assemblage is discussed. Emphasis is placed on the methods of processing chemical substances to manufacture materials with desired structure and properties, as well as on integration of materials in technological devices.
Prerequisites: A minimum grade of C- in CHEM 242, or in CHEM 102 and PHYS 208, or in CHEM 102, MATH 114, and PHYS 224.

CHEM 353
Forensic Chemistry
3 Credits Weekly (3-3-0)
This course examines the theory and practice of forensic chemistry. The course focuses on chemical analytical techniques used for the detection, identification, and comparison of forensic evidence such as illicit drugs, poisons, gunshot residues, fire accelerants, and explosives. The theory of a variety of analytical techniques along with their scope and limitations is embedded in this discussion. The practical application of these techniques is considered with reference to appropriate examples and forensic case studies. This is further reinforced in the laboratory, where students will gain hands-on experience in the use of a range of analytical techniques for the investigation of simulated crime scenarios. The structure and function of forensic chemistry laboratory services and the key issues of cross-contamination and laboratory quality control and quality assurance will be examined.
Prerequisites: A minimum grade of C- in CHEM 261 and either CHEM 211 or CHEM 252.

CHEM 362
Advanced Organic Chemistry
3 Credits Weekly (3-3-0)
This course is designed to build upon the concepts introduced in Chemistry 261 and Chemistry 263, offering a more advanced and sophisticated insight into the physical properties and chemical reactions of organic compounds. A focal point will be the chemistry of carbonyl compounds. Mechanistic understanding of reaction pathways and multistep synthesis of more complex compounds will be emphasized.
Prerequisites: Minimum grade of C- in CHEM 263.

CHEM 364
Introduction to Medicinal Chemistry
3 Credits Weekly (3-0-0)
Students will be introduced to pharmaceutical drug discovery and the pivotal role played by chemistry. The principles and processes involved in modern drug design and development are presented and, throughout, are emphasized by reference to compounds in current clinical usage. Particular emphasis is placed on cancer therapeutics and antiviral agents. Recent advances in the use of computational and combinatorial chemistry in drug design are discussed.
Prerequisites: Minimum grade of C- in CHEM 263.

CHEM 372
Environmental Chemistry
3 Credits Weekly (3-3-0)
The chemistry of natural environmental process and the impact of anthropogenic activity on those processes will be examined. Topics include atmospheric chemistry, including photochemical reactions, ozone depletion and urban air pollution; aquatic chemistry, including complex equilibria, buffering, and oxidation and reduction; and an introduction to sources and fate of organic and inorganic pollutants. In the laboratory, students will gain hands on experience in common methods of environmental testing and remediation. Note: Credit cannot be received for both CHEM 270 and CHEM 372.
Prerequisites: A minimum grade of C- in CHEM 102 and CHEM 261.

CHEM 380
Process and Flow Chemistry
3 Credits Weekly (3-3-0)
This course provides an introduction and training in the different types of chemical and physical methods, and equipment that may be employed in process and flow chemistry. The use and installation of process analytical technology/chemistry is also explored. On-line and in-line monitoring of chemical processes is strongly emphasized, both in the lecture and the laboratory environment.
Prerequisites: A minimum grade of C– in CHEM 211 or CHEM 263.

CHEM 391
Applied Spectroscopy
3 Credits Weekly (3-2-0)
This course focuses on the practical aspects of preparing samples for analysis, collecting and analyzing data, and characterizing organic, inorganic and/or biological compounds. Methods are explored from a theoretical and practical perspective and include infrared spectroscopy, mass spectrometry, and nuclear magnetic resonance. Note: Credit cannot be obtained for both CHEM 291 and CHEM 391.
Prerequisites: A minimum grade of C- in CHEM 263.

CHEM 398
Independent Study
3 Credits Total (0-0-72)
This course permits an intermediate-level student to work with a faculty member to explore a specific topic in depth through research or through directed reading in primary and secondary sources. The student plans, executes and reports the results of their research or study project under the direction of a faculty supervisor. To be granted enrollment in the course, the student must have made prior arrangements with a faculty member willing to supervise his or her project. This course can be taken twice for credit.
Prerequisites: Any 200-level chemistry course and permission of the department, Faculty mentors may require additional prerequisites according to the project needs.

CHEM 410
Industrial Chemistry
3 Credits Weekly (3-0-0)
An introduction to the principles and practice of industrial chemistry with a special emphasis on modern and emerging chemical technology processes. Selected industrial processes will be discussed, such as the production of primary petrochemicals and their associated secondary products, including polymers, pharmaceuticals, dyes, perfumes, and pesticides. Students will be introduced to the production of such products based on emerging principles of sustainable industrial chemistry. The focus will be on chemical plant design processes, chemo/biocatalysis, biowaste valorization, and pollution control. Principles of green and environmental chemistry and how they impact the United Nations Sustainable Development Goals (UN SDGs) will be emphasized. Students will also learn professional ethics as they relate to chemistry practice. This course includes presentations by guest industrial chemists and tours of chemical plants and industrial laboratories.
Prerequisites: A minimum grade of C- in any 300-level CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*) course.*

CHEM 441
Molecular Modelling
3 Credits Weekly (3-3-0)
This introduction to molecular modelling deals with the application of quantum mechanical methods to compute structural models, molecular and bulk properties of matter, and the mechanisms by which molecules interact and react. Students use up-to-date software to build, render and visualize molecular structures generated with wave function and density functional methods; to compute molecular properties and spectra of substances; to design reaction mechanisms of uncatalyzed and catalyzed reactions, and to compute their associated rate constants. Students devise structural and computational models for acid-base, redox, enzyme and surface reactions relevant to life, environment and technology.
Prerequisites: A minimum grade of C- in CHEM 342.

CHEM 442
Soft Matter Chemistry
3 Credits Weekly (3-3-0)
This course is about the spontaneous formation, preparation, properties, stability, and applications of soft matter. It focuses on the complex and easily deformable structures that emerge in between atomic and macroscopic length scales in solutions of polymers and surfactants, colloids, liquid crystals, granular and soft biological matter. It examines the physical mechanisms of structural assembling and self-organization of molecules to form thin films, micelles, lipid bilayers, vesicles and liposomes under the action of intermolecular and surface forces. Topics include surfaces, charged interfaces, effects of surface tension and curvature on capillarity and wetting, optical, electrokinetic, flow and rheological properties. Emphasis is placed on the applications of soft matter phenomena in petroleum, pharmaceutical, cosmetics and food technologies and products.
Prerequisites: A minimum grade of C- in CHEM 342.

CHEM 464
Advanced Synthetic Medicinal Chemistry
3 Credits Weekly (3-1.5-0)
This advanced medicinal chemistry course examines the application of organic chemistry in the design and synthesis of small-molecule drugs. Students will utilize the principles of the drug discovery process to identify targets for pharmaceutical development and gain an in-depth understanding on how to chemically modify a drug through each stage of the development process. Emphasis will be placed on examining the structure-activity relationship between molecules and their targets, drug delivery, drug modes of action, and the fate of drugs once inside the body.
Prerequisites: A minimum grade of B- in either CHEM 364 or CHEM 362.

CHEM 466
Modern Catalysis
3 Credits Weekly (3-0-0)
This course provides a comprehensive review of current research and practice in the field of modern catalysis. The topics covered include, catalytic design, catalysis and energy, chemical transformations, biocatalysts, and environmental catalysts. The mechanisms by which enzymes operate in living matter and the use of both organic and inorganic catalysts by the chemical industry for the production of bulk chemicals, fine chemicals and fuels will be covered.
Prerequisites: A minimum grade of C- in CHEM 333.

CHEM 472
Advanced Environmental Chemistry
3 Credits Weekly (3-2-0)
This course presents an advanced study of anthropogenic pollutants in the environment. Fate and transport processes of legacy and emerging anthropogenic pollutants, including important physio-chemical processes, such as partitioning, hydrolysis, photolysis and biotransformation, are discussed on both a local and global scale. Understanding of these processes is applied in the context of environmental modeling. In the laboratory, students gain hands on experience with the techniques used to determine the environmental fates of pollutants via investigations of their physio-chemical properties. Credit cannot be received for both CHEM 370 and CHEM 472.
Prerequisites: A minimum grade of C– in CHEM 261 and in either CHEM 270 or CHEM 372.

CHEM 474
Environmental Analytical Chemistry
3 Credits Weekly (3-3-0)
Students will learn the theory and develop practical skills in the quantitative and qualitative analysis of chemicals in the environment. Proper procedures for environmental sampling design will be discussed, followed by a detailed treatment of environmental sampling, extraction, and cleanup techniques. The theory and application of modern analytical techniques will be discussed in the context of environmental monitoring. In the laboratory, students will design and carry out field-based measurements and apply lecture material in a practical setting.
Prerequisites: A minimum grade of B- in CHEM 311, and in one of CHEM 270 or CHEM 372.

CHEM 484
Sustainable and Green Chemistry
3 Credits Weekly (3-0-0)
This course introduces Green Chemistry and examines industrial sources of contaminants and the modification of industrial processes to minimize environmental impact. In addition, the course reviews industrial waste management, control, and treatment. Students will gain an understanding of modern green chemistry which considers both the application and use of the 12 principles of green chemistry and life cycle analysis. In this regard, both the advantages and limitations of the various green chemistry approaches will be examined.
Prerequisites: A minimum grade of C- in any 300-level CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*) course and permission of the department.*

CHEM 495
Special Topics
3 Credits Weekly (0-0-3)
This course involves reading, discussing and critically evaluating current research on specialized topics in chemistry. Topics covered vary with the interests of students and faculty. Students should consult with faculty members in the Department of Physical Sciences for details regarding current offerings. Note: This course is intended for students in the final year of their degree. This course may be taken up to two times for credit.
Prerequisites: A minimum grade of B- in a 300-level CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*) course and permission of the department.*

CHEM 496
Techniques in Applied Laboratory Chemistry
3 Credits Weekly (0-6-0)
This is a laboratory-based course focusing on techniques utilized in a research or industrial laboratory setting. Students will gain an understanding of the theory and application of modern experimental methods and build practical skills through project-based applications. The specific topics covered will vary with the interests of the faculty member teaching the course, and students should consult with the Department of Physical Sciences for details regarding current offerings. Note: This course may be taken up to two times, provided the topic of the course is different.
Prerequisites: A minimum grade of B- in a 300-level chemistry course and consent of the department.

CHEM 497
Chemistry Internship Practicum
3 Credits Total (45-0-90)
This course provides students with practical experience in a chemistry related work environment. Students engage in work integrated learning through employment or internship at a chemistry-related industry. Students learn in practice the professional aspects (work and ethics) of a chemist. At the end of the placement, students provide a presentation to demonstrate the learning accomplished. The contact hours are a minimum of 90 hours but can involve more depending on the placement. This course may be taken two times for credit. All placements require departmental approval.
Prerequisites: A minimum grade of C- in 6 credits of any 300 level CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*) courses and consent of the Department.*

CHEM 498
Advanced Independent Study
3 Credits Total (0-0-72)
This course permits a senior-level student to work with a faculty member to explore a specific topic in depth through research or through directed reading in primary and secondary sources. The student plans, executes and reports the results of their research or study project under the direction of a faculty supervisor. To be granted enrollment in the course, the student must have made prior arrangements with a faculty member willing to supervise his or her project. This course can be taken twice for credit.
Prerequisites: A minimum grade of B- in a 300-level CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*) course, a minimum grade of C- in SCIE 201, and permission of the department; faculty mentors may require additional prerequisites according to the project needs.*

Earth and Planetary Sciences Courses

EASC 101
Introduction to Physical Science
3 Credits Weekly (3-3-0)
Learn how the Earth formed and evolved through time! We'll explore how minerals and rocks form and change, what causes volcanoes and earthquakes, how faults and folds form, and how plate tectonics affects it all. In the lab, you'll learn how to identify different minerals and rocks, how to interpret topographic and geologic maps, and learn more about geologic time and earthquakes.

EASC 102
Introduction to Environmental Earth Science
3 Credits Weekly (3-3-0)
The Earth is changing in many ways all the time, and right now it's changing rapidly. Learn about different Earth systems such as energy pathways, the atmosphere, the hydrosphere, and the cryosphere and how they all interact with each other and affect climate. In this course, the global energy budget and major energy pathways, the Earth's patterns of weather systems and their impact on temperature, precipitation, moisture and winds are covered. Atmospheric and oceanic circulation systems and their effect on the global environmental system are discussed. Components of the atmosphere and their interactions to create weather and climate are also topics dealt with in this course, including paleoclimates and anthropogenic climate change. The hydrologic cycle and local water balance calculations are examined, extending to discussions on groundwater, river systems and the cryosphere. The description and development of soils and human impact on soils are discussed.

EASC 206
Geology of the Solar System
3 Credits Weekly (3-0-0)
This course demonstrates how information gleaned from both manned and robotic space missions, as well as astromaterials available for direct study, are used to gain an understanding of the geology of our Solar System. Geological processes that were, and continue to be, active in the Solar System are examined with a special emphasis on impact cratering. The similarities and differences in the geology of planets, how these relate to the origin and evolution of the Solar System, and their implications for the search for life are also investigated.
Prerequisites: A minimum grade of C- in EASC 101 or ASTR 120.

EASC 219
Mineralogy
3 Credits Weekly (3-3-0)
This course employs a theory and lab-oriented approach to understanding mineralogy. Topics include mineral origin and formation, classification and crystallography. Hands-on mineral identification will be undertaken in the labs with a focus on major rock forming minerals, such as the silicates. The opportunity to examine rare meteorites in thin section will also be provided. Students will be assigned their own petrographic microscope for use during the term, with an additional lab designed to utilize the Raman spectrometer. A field trip to the Royal Alberta Museum will be conducted during the term.
Prerequisites: Minimum grade of C- in EASC 101.

EASC 221
Introduction to Geographic Information Systems
3 Credits Weekly (3-3-0)
This course provides a theoretical and practical introduction to Geographic Information Systems (GIS) as applied to geologic and environmental sciences. Lectures combine an overview of the general principles of GIS with a theoretical treatment of the nature and analytical use of spatial information. Laboratories impart the technical aspects through hands-on experience with appropriate software.
Prerequisites: A minimum grade of C- in one of EASC 101, EASC 102, or ANTH 206.

EASC 225
Introduction to Geomorphology
3 Credits Weekly (3-3-0)
This course introduces students to geomorphology - the study of landforms and landscape-shaping processes. Fluvial, glacial, periglacial, slope, and aeolian landforms and processes are examined. A special emphasis is placed on Alberta's landscape and the geomorphology of the Late Cenozoic, especially the Quaternary Period. Central to this course is fieldwork in Edmonton's river valley.
Prerequisites: Minimum grades of C- in EASC 101 and EASC 102.

EASC 226
Introduction to Soil Science
3 Credits Weekly (3-3-0)
This course examines the fundamental aspects of soil formation and soil occurrence in natural landscapes. Physical, chemical, mineralogical, and biological properties of soils are emphasized, and how these properties relate to plant growth and environmental quality. Identification of soils is practiced and estimates of their performances in both natural and agricultural ecosystems are analyzed. Note: A 100-level chemistry course is strongly recommended.
Prerequisites: Minimum grade of C- in EASC 100, EASC 101, EASC 102 or ANTH 206.

EASC 230
Invertebrate Paleontology
3 Credits Weekly (3-3-0)
This course addresses principles and problems associated with paleontology in areas such as origin of life, evolution, mass extinction, paleoecology, functional morphology, biogeography and biostratigraphy. There is a systematic coverage of invertebrate fossils, including microfossils, Porifera, Cnidaria, Brachiopoda, Bryozoa, Mollusca, Echinodermata, and Arthropoda. Labs promote recognition of fossils and their attributes.
Prerequisites: Minimum grade of C- in EASC 101 or EASC 103.

EASC 238
Geology of Natural Resources
3 Credits Weekly (3-0-0)
This course consists of the geological study of the major types of economically important metallic and nonmetallic ore minerals and energy resources. Basic processes which form and concentrate these materials in the Earth are examined. Various methods of exploration and mining of the resources are detailed. Alberta's coal and petroleum resources are emphasized. Environmental effects of the production and use of mineral and energy resources are discussed.
Prerequisites: Minimum grade of C- in EASC 101.

EASC 240
Sedimentology and Stratigraphy
3 Credits Weekly (3-3-0)
Focusing on the production, transport, and deposition of sediment, this course explores sedimentary depositional environments, processes, controls, and structures. The course further examines stratigraphic relationships between sediments (including litho-, bio-, chemo-, and chrono-stratigraphic approaches), and facies analysis – the examination and interpretation of sedimentary characteristics that reflect specific environmental conditions under which a given material was deposited or formed. Course topics include the environmental controls on sediment generation, transport, and deposition; properties and classification of clastic, carbonate and evaporitic sediments and rocks; sequence stratigraphy, correlation, and facies analysis; tectonic development of sedimentary basins; hydrocarbon formation and generation; and the interface between sedimentary processes and environmental contamination and rehabilitation. The subsurface characterization of the Western Canada Sedimentary Basin will be introduced as part of this course. In laboratory sections, students will identify characteristics of common sedimentary facies, describe and classify sedimentary rocks in hand specimen, map and correlate sedimentary units, and create stratigraphic sections.
Prerequisites: Minimum grade of C- in EASC 101 and in EASC 102.

EASC 270
The Atmosphere
3 Credits Weekly (3-0-0)
This course provides an introduction to atmospheric science, weather, and climate. Topics include the composition and vertical structure of the atmosphere, humidity and clouds, atmospheric dynamics, circulation, weather systems, weather forecasting and maps, atmospheric boundary layer, and climate dynamics. Training for reading and interpreting weather maps, and modeling atmospheric processes is provided. Note: MATH 114 is recommended.
Prerequisites: A minimum grade of C- in any 100-level EASC *(*https://calendar.macewan.ca/course-descriptions/easc/*),* CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*), or* PHYS *(*https://calendar.macewan.ca/course-descriptions/phys/*), or in either BIOL 107 or BIOL 108.*

EASC 271
The Oceans
3 Credits Weekly (3-3-0)
Covering nearly three quarters of the Earth's surface, the oceans play a fundamental role in the Earth system. This course provides an overview of the discipline of oceanography, as well as highlighting the importance of the oceans within a global context. The course examines the physical, chemical, biological, and geological properties of the oceans. Topics include the origins of the oceans, the physical and chemical properties of seawater, water mass structure and chemistry, the physical structure of ocean basins and marine provinces, ocean circulation, wave and tide dynamics, ocean sediments and sedimentary records, biological oceanography and primary productivity, and the role of, and consequences for, the oceans in a changing climate. Furthermore, relevant methods in oceanographic research and data analysis are discussed and applied within the laboratory component of this course. Emphasis is placed on the interdisciplinarity of oceanography, alongside the linkages of the oceans to other spheres of planet Earth, including the atmosphere, biosphere, hydrosphere, and cryosphere. EASC 271 includes an optional field trip to a coastal area.
Prerequisites: A minimum grade of C- in either EASC 102 or EASC 103.

EASC 320
Introduction to Geochemistry
3 Credits Weekly (3-3-0)
This course provides an introduction to the interdisciplinary science of geochemistry. The first part of the course examines our home planet from a geochemical perspective and includes formation of the Earth and our solar system, the origin of the elements and their distribution within the Earth, and evolution of the crust, mantle and core. An introduction to the essential geochemical tools of thermodynamics and kinetics, isotope geochemistry and trace element geochemistry is also provided. The second part of the course examines the geochemistry of igneous, sedimentary and metamorphic rocks and covers topics as diverse as the melting and crystallization of rocks to the contamination of our water supplies and the stability of carbonates in our oceans. Note: Credit can only be obtained in one of EASC 320 or CHEM 320.
Prerequisites: Minimum grades of C- in a 200-level EASC *(*https://calendar.macewan.ca/course-descriptions/easc/*) course and a 200-level* CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*) course.*

EASC 321
Structural Geology and Tectonics
3 Credits Weekly (3-3-0)
The globe has been shaped by enormous forces that have created mountains and oceans and destroyed continents. In this course, students will learn to interpret geologic maps and cross sections, calculate the stress and strain involved in creating faults, folds, and joints, as well as those involved in orogenies, rift formation, and other crustal tectonics.
Prerequisites: Minimum grades of C- in one of EASC 225 or EASC 240 and in one of PHYS 124 or PHYS 144.

EASC 322
Introduction to Biogeochemistry
3 Credits Weekly (3-3-0)
Biogeochemistry is the study of the chemical, physical, geological, and biological processes and reactions that govern planet Earth. This course provides an introduction to the discipline, focusing on the exchange of energy and elements between the biosphere and the geosphere. The fundamental components of the Earth's system are examined, including the atmosphere, hydrosphere, biosphere, and geosphere, alongside their evolutionary histories and linkages. Topics include the principle biogeochemical cycles, such as the carbon, sulfur, and nitrogen cycles, and their histories. These cycles are assessed in the context of recent environmental and climate change driven by anthropogenic activities. This course incorporates a multitude of disciplines, spanning geology, chemistry, biology, and environmental science. Note: Credit cannot be obtained in both CHEM 322 and EASC 322.
Prerequisites: Minimum grades of C- in a 200-level EASC *(*https://calendar.macewan.ca/course-descriptions/easc/*) course and a 200-level* CHEM *(*https://calendar.macewan.ca/course-descriptions/chem/*) course.*

EASC 324
Quaternary Environments
3 Credits Weekly (3-3-0)
This course offers an introduction to the Quaternary Period. It provides a broader context for studying modern environmental phenomena and delivers an overview of the key techniques and proxies used in reconstructing Quaternary environmental histories. The course situates the Quaternary within a broad history of Earth's climate, discussing Quaternary glaciations and conditions during and since the last Ice Age in detail. This course also reviews the methodologies used to reconstruct past conditions, focusing on how these methods are used as windows into the past. The course concludes with the detailed examination of several Canadian case studies using the latest research and environmental reconstructions, such as (but not restricted to) the glaciation and deglaciation of Alberta; Quaternary environmental change in the Canadian Arctic Archipelago; and the paleoenvironments of Beringia. The laboratory classes give hands-on experience with basic environmental reconstruction methodologies.
Prerequisites: Minimum grade of C- in one of EASC 208, EASC 225 or ANTH 206.

EASC 330
Igneous, Sedimentary, and Metamorphic Petrology
3 Credits Weekly (3-3-0)
This course highlights Earth's chemistry, the chemistry of minerals, the chemistry of rocks in different environments, and physical processes in the context of mineral stability and different rock chemistry. There are three main regimes in which rocks form: igneous (from a molten rock material that originated in the interior of the Earth), sedimentary (from weathering of rocks on the Earth's surface and lithification of loose sediment), and metamorphic (when rocks get exposed to different temperature/pressure regimes within the Earth). Hands-on laboratory exercises provide professional skills for complete mineral and rock identification, and interpretation of rock textures using hand lens, petrographic microscope, and chemical analyses.
Prerequisites: A minimum grade of C- in EASC 219.

EASC 334
Remote Sensing
3 Credits Weekly (3-3-0)
Satellite imagery is being used more and more frequently to assess everything from oil spills to fire hazards, from mining potential to archaeology, from water on Mars to methane lakes on Titan. In this course, students learn to analyze and interpret images from several different satellite and airborne instruments for applications in geology, environmental studies, urban planning, mining, archaeology, forestry, and planetary science.
Prerequisites: A minimum grade of C- in EASC 221, EASC 225, or ANTH 206.

EASC 373
Anthropogenic Climate Change
3 Credits Weekly (3-0-0)
This course provides an advanced examination of the natural physical processes that have driven the global climate system in the past and present. It focuses in particular on how humans are interfering with the climate system and the potential future consequences. It further provides an introduction to simple on-line computer models of the climate system.
Prerequisites: Minimum grade of C- in EASC 208 or EASC 270.

EASC 375
Paleoclimatology
3 Credits Weekly (3-0-0)
This course provides an extensive overview of the methods used in paleoclimate research and an in-depth examination of important climate events since the Late Proterozoic, with a concentration on the Late Mesozoic and Cenozoic. Aspects of creating paleoclimate reconstructions, climate effects on geological and biological processes, and the modeling of present climate and extrapolation to past and future climates are emphasized.
Prerequisites: A minimum grade of C- in EASC 324, or in both EASC 270 and one of EASC 101, EASC 103, or EASC 208.

EASC 398
Independent Study
3 Credits Total (0-0-72)
This course permits an intermediate-level student to work with a faculty member to explore a specific topic in depth through research or through directed reading in primary and secondary sources. The student plans, executes and reports the results of their research or study project under the direction of a faculty supervisor. To be granted enrollment in the course, the student must have made prior arrangements with a faculty member willing to supervise his or her project. This course can be taken twice for credit.
Prerequisites: A minimum of one 200-level course in EASC *(*https://calendar.macewan.ca/course-descriptions/easc/*) and permission of the department; faculty mentors may require specific prerequisites according to the project needs.*

EASC 406
Planetary Materials
3 Credits Weekly (3-0-0)
A fundamental goal of planetary science is to understand the timing and process by which our solar system formed and evolved. Planetary materials - meteorites, interplanetary dust particles and returned sample missions including Apollo, Hayabusa and Stardust - provide us with tangible samples from the vast reaches of our solar system from which high-precision analytical measurements can be made. In this course, we will explore the earth's current inventory of planetary materials, with a focus on their mineralogy, petrology and geochemistry, with the goal of gaining insights derived from their study.
Prerequisites: Minimum grade of C- in EASC 219 and EASC 206 and a B- in any 300-level EASC *(*https://calendar.macewan.ca/course-descriptions/easc/*) course, or a minimum grade of B- in EASC 320.*

EASC 409
Geology of Western Canada
3 Credits Weekly (3-0-0)
This course presents an overview of the geology in Western Canada. This course will cover the rich history of marine life, mountain building, vast river networks, and glaciation that has shaped the western landscapes. Geological processes of mountain building and past and present landscape evolution are emphasized. In addition, the economic resources that formed as a result of these geologic processes will be addressed. Important paleontological sites will be described and their history outlined. The National Parks within Western Canada will be examined in context of their geology and formation, describing why they are important regions to conserve. Students can only receive credit for one of EASC 209 and EASC 409.
Prerequisites: Minimum grades of C- in each of EASC 219, EASC 240, and EASC 321, or consent of the department.

EASC 495
Special Topics
3 Credits Weekly (0-0-3)
This course involves reading, discussing and critically evaluating current research on specialized topics in Earth and Planetary Science. Topics covered vary with the interests of students and faculty. Students should consult with faculty members in the Earth and Planetary Science area for details regarding current offerings. Note: This course is intended for students in the final year of their degree. This course may be taken twice for credit.
Prerequisites: Minimum grade of B- in a 300-level EASC *(*https://calendar.macewan.ca/course-descriptions/easc/*) course and permission of the department.*

EASC 498
Advanced Independent Study
3 Credits Total (0-0-72)
This course permits a senior-level student to work with a faculty member to explore a specific topic in depth through research or through directed reading in primary and secondary sources. The student plans, executes and reports the results of their research or study project under the direction of a faculty supervisor. To be granted enrollment in the course, the student must have made prior arrangements with a faculty member willing to supervise his or her project. This course can be taken twice for credit.
Prerequisites: A minimum grade of B- in a 300-level EASC *(*https://calendar.macewan.ca/course-descriptions/easc/*) course and permission of the department; faculty mentors may require specific prerequisites according to the project needs.*

Physical Sciences Courses

PHSC 200
Physical Science Field Skills
3 Credits Total (18-80-0)
This course is an introduction to field work in the areas of physics, chemistry and Earth and planetary science, which together constitute the Physical Sciences. It involves classroom field preparation in Edmonton, work in the field on the Big Island in the Hawaiian Island chain, and sample analysis and working up the data back in Edmonton. The course concludes with the submission of a final written report. The skills that the participants acquire in this course include mapping of geological features, reproducible sampling procedures, field note taking, strike and dip measurements, the use of star charts and sextants to locate constellations and stars, measurements and observations with a telescope and the analysis of water and air samples.
Prerequisites: Consent of the Department.

Physics Courses

PHYS 124
Physics for Life Sciences I
3 Credits Weekly (3-3-0)
This is an algebra based physics course on motion of matter intended for students in life and medical sciences. Topics include kinematics, Newtonian mechanics, conservation of momentum and energy, rotational motion, statics and dynamics of extended bodies and simple harmonic motion. Students are introduced to aspects of modern physics. During the course students develop a conceptual understanding of physical principles, develop reasoning and problem-solving skills, and relate these physical principles to real-world situations relevant to biology and medicine. NOTE: Physics 30 is strongly recommended. Credit can only be obtained in one of PHYS 108, PHYS 124, PHYS 144, or ENPH 131.
Prerequisites: Mathematics 30-1 and Physics 20.

PHYS 126
Physics for Life Sciences II
3 Credits Weekly (3-3-0)
This course is an algebra-based physics course on electromagnetism intended for students in life and medical sciences. Topics include electrostatics, direct current circuits, magnetic fields, electromagnetic induction and alternating current circuits. Students are introduced to aspects of modern physics. During the course students develop a conceptual understanding of physical principles, develop reasoning and problem-solving skills, and relate these physical principles to real-world situations relevant to biology and medicine. NOTE: Credit can only be obtained in one of PHYS 109, PHYS 126, or PHYS 146.
Prerequisites: A minimum grade of C- in PHYS 124.

PHYS 130
Wave Motion, Optics and Sound
3.8 Credits Total (45-18-0)
This is a calculus based course intended for engineering students. Topics include spherical mirrors, thin lenses, simple harmonic motion, wave motion, interference, sound waves, light waves and diffraction. Note: Restricted to Engineering students.
Prerequisites: Mathematics 30-1, Mathematics 31 and Physics 30.

PHYS 144
Mechanics
3 Credits Weekly (3-3-0)
This is a calculus based physics course intended for students in the physical sciences or for students who completed physics in high school. Topics include kinematics, Newtonian mechanics, conservation of momentum and energy, rotational motion, statics and dynamics of extended bodies and simple harmonic motion. Students are introduced to aspects of modern physics. During the course students develop a conceptual understanding of physical principles, develop reasoning and problem-solving skills, and relate these physical principles to real-world situations. NOTE: Credit can only be obtained in one of PHYS 124, PHYS 144, or ENPH 131.
Prerequisites: Mathematics 31, Mathematics 30-1, and Physics 30.

PHYS 146
Electromagnetism
3 Credits Weekly (3-3-0)
This is a calculus-based physics course on electromagnetism intended for students in physical sciences or for students who completed physics in high school. Topics include electrostatics, direct current circuits, magnetic fields, electromagnetic induction and alternating current circuits. Students are introduced to aspects of modern physics. During the course students develop a conceptual understanding of physical principles, develop reasoning and problem-solving skills, and relate these physical principles to real-world situations. NOTE: Credit can only be obtained in one of PHYS 126 or PHYS 146.
Prerequisites: A minimum grade of C- in PHYS 144.

PHYS 200
Introduction to Relativity
3 Credits Weekly (3-0-0)
If you're curious about what Einstein's famous equation E=mc^2 actually means, or how you could end up twenty years older than your twin, then this is the course for you! We'll learn how Einstein's special theory of relativity addresses the limitations of classical physics, including time dilation and length contraction in fast-moving reference frames, the twin paradox, the Doppler effect, and conservation of relativistic momentum and energy. We'll finish off by discussing curved spacetime and black holes as a brief introduction to the general theory of relativity. Note: Students considering future enrolment in 300-level or higher PHYS (https://calendar.macewan.ca/course-descriptions/phys/) courses are strongly encouraged to take MATH 114 (or both MATH 114 and one of MATH 120 or MATH 125) to satisfy the mathematics requirement.
Prerequisites: A minimum grade of C- in one of PHYS 126 or PHYS 146, and one of MATH 114, MATH 120, or MATH 125.

PHYS 208
Quantum Aspects of Physics
3 Credits Total (45-18-0)
Quantum mechanics gives us some of the strangest phenomena in physics, but its principles are actually behind the technology we use every day (think computers, lasers, and LED lights). In this course, we'll examine the experimental evidence that led to the development of quantum mechanics, including the photoelectric effect, blackbody radiation and electron diffraction. We'll then introduce the Heisenberg uncertainty principle and the Schrödinger equation to describe simple harmonic oscillators, quantum tunneling, atomic spectra, and the hydrogen atom. The course's laboratory component puts us in the role of early 20th century physicists gathering evidence to demystify the strangeness of these phenomena!
Prerequisites: Minimum grades of C- in MATH 114 and one of PHYS 126 or PHYS 146.

PHYS 224
Fluids and Heat
3 Credits Total (45-18-0)
Why can we see our breath when we exhale outside on a cold winter day? In this course, we'll learn about the properties of fluids and the thermal properties of matter. We'll cover topics including buoyancy and hydrostatic pressure, temperature, thermal expansion, heat and energy transfer, the kinetic theory of gases, and the ideal gas law. The course's laboratory component lets us warm up to these topics further as we investigate the behaviour of fluids and the thermal properties of solids, liquids, and gases. Note: Students considering future enrolment in 300-level or higher PHYS (https://calendar.macewan.ca/course-descriptions/phys/) courses are strongly encouraged to take MATH 114 (or both MATH 114 and one of MATH 120 or MATH 125) to satisfy the mathematics requirement.
Prerequisites: A minimum grade of C- in one of PHYS 126 or PHYS 146 and in one of MATH 114, MATH 120, or MATH 125.

PHYS 226
Optics and Sound Waves
3 Credits Total (45-18-0)
Ever wonder why putting on a pair of glasses can bring the world into focus? Interested in learning how flutes and other wind instruments work? In this course, we'll learn how wave mechanics governs these behaviours. We'll study mechanical and sound waves, simple harmonic motion, and geometric optics, including applications like microscopes, telescopes, Doppler radar, spectrometers, holograms, seismic waves, and molecular vibrations. The course's laboratory component will let us see and hear how waves behave as they propagate and interact with their environment. Note: Students considering future enrolment in 300-level or higher PHYS (https://calendar.macewan.ca/course-descriptions/phys/) courses are strongly encouraged to take MATH 114 (or both MATH 114 and one of MATH 120 or MATH 125) to satisfy the mathematics requirement.
Prerequisites: A minimum grade of C- in PHYS 126 or PHYS 146, and in one of MATH 114, MATH 120, or MATH 125.

PHYS 242
Physics of Planetary Exploration
3 Credits Weekly (3-0-0)
What would it take to travel to Mars? In this course, we'll study the physical principles that govern the design of interplanetary missions within the solar system, using Newton's universal law of gravity and Kepler's laws of planetary motion to understand transfer orbits between planets and to their satellites (natural and human-made!). We'll also discuss past, present, and future space missions, and the operating principles of spacecraft instrumentation and sensors. Note: Students considering future enrolment in 300-level or higher PHYS (https://calendar.macewan.ca/course-descriptions/phys/) courses are strongly encouraged to take MATH 114 (or both MATH 114 and one of MATH 120 or MATH 125) to satisfy the mathematics requirement.
Prerequisites: A minimum grade of C- in one of PHYS 126 or PHYS 146, and one of MATH 114, MATH 120, or MATH 125.

PHYS 244
Mechanics
3 Credits Weekly (3-0-0)
This course expands on first-year mechanics, examining oscillating systems, normal modes, conservative forces, and energy. Lagrangian and Hamiltonian dynamics are introduced, including variational calculus, Hamilton's Principle, generalized coordinates, constraints, Lagrange multipliers, the Hamiltonian, conservation laws, and Hamiltonian dynamics. Further topics include central forces, orbital motion, and scattering. Note: It is recommended that MATH 115 be taken concurrently with, or prior to taking this course.
Prerequisites: Minimum grades of C- in one of PHYS 126 or PHYS 146, and MATH 114, and MATH 120 or MATH 125.

PHYS 250
Introduction to Biophysics
3 Credits Weekly (3-0-0)
Why can't chickens fly? How does a 3-metre long strand of DNA fit into a 100-micrometre wide cell? In this course, students apply physical principles learned in first-year physics to study life, from the atomic level to cellular and organism scales. Topics include biomechanics with an introduction to kinesiology, transport of energy and materials in biological systems with an introduction to diffusion and motion in dissipative media, bio-fluid with an introduction to the cardiovascular system, the elastic properties of biological material and biopolymers like DNA, and the electric properties of biomaterial with an introduction to the nervous systems. Note: Students considering future enrolment in 300-level or higher PHYS (https://calendar.macewan.ca/course-descriptions/phys/) courses are strongly encouraged to take MATH 114 (or both MATH 114 and one of MATH 120 or MATH 125) to satisfy the mathematics requirement.
Prerequisites: A minimum grade of C- in one of PHYS 126, PHYS 146, or CHEM 102, and one of MATH 114, MATH 120, or MATH 125; BIOL 107 is recommended.

PHYS 252
Physics of the Earth
3 Credits Weekly (3-0-0)
What can we learn about our planet from an earthquake, a meteorite impact, or an explosion? How can we use the basic concepts of physics to explain complicated planetary processes that shape the earth? In this course, we'll learn how to apply basic mechanics, electricity and magnetism, waves, and/or thermodynamics principles to the physical processes that guide more complex studies in geophysics, geomagnetism, atmospheric physics, and oceanography. Note: Students considering future enrolment in 300-level or higher PHYS (https://calendar.macewan.ca/course-descriptions/phys/) courses are strongly encouraged to take MATH 114 (or both MATH 114 and one of MATH 120 or MATH 125) to satisfy the mathematics requirement.
Prerequisites: A minimum grade of C- in PHYS 126 or PHYS 146, and in EASC 101, and one of MATH 114, MATH 120, or MATH 125.

PHYS 261
Physics of Energy
3 Credits Weekly (3-0-0)
This course first identifies the various forms of energy consumed by modern society. The conversion of energy is traced from natural resources to usable forms considering both the fundamental laws of thermodynamics and the practical concerns of cost and environmental consequences. Next, the benefits and drawbacks of non-renewable energy sources such as fossil fuels and nuclear power are discussed and compared to renewable sources such as hydroelectric and solar power. Finally, the development of alternative energy resources is discussed.
Prerequisites: Minimum grade of C- in one of PHYS 109, PHYS 126 or PHYS 146.

PHYS 301
Nuclear Physics
3 Credits Weekly (3-0-0)
This course is a study of the fundamental nuclear properties, the shell model, the collective model, stability of nuclei, isotopes, radioactive decay, nuclear reactions, kinematics, conservation laws, nuclear fission and fusion, nuclear reactors, particle accelerators, detectors, a brief introduction to particle physics and the Standard Model. The course also includes applications such as carbon dating, tracer techniques, cancer therapy and connections to astrophysics.
Prerequisites: Minimum grade of C- in PHYS 208 and MATH 115.

PHYS 302
An Introduction to Particle Physics
3 Credits Weekly (3-0-0)
What is the Universe made of at its smallest scale? From the humble electron to the massive Higgs boson, we follow the progress of the Standard Model as it classifies the myriad subatomic particles by their interactions and symmetries. Students apply the techniques of quantum mechanics and Feynman diagrams to calculate the properties of matter.
Prerequisites: A minimum grade of C- in PHYS 200, PHYS 208, and MATH 115.

PHYS 308
An Introduction to Semiconductors and Superconductors
3 Credits Weekly (3-0-0)
This course builds on PHYS 208 to provide students with a detailed understanding of the behaviour of condensed matter arising from the quantum nature of many particle systems at the microscopic level. Starting with probability distribution functions for classical thermodynamic systems, the theory is extended to quantum mechanical systems leading to a description of lasers. These tools allow the construction of models that explain the features of inter-atomic bonds, molecular spectra and the emergent properties of solids such as electrical conductivity, semiconductivity and superconductivity.
Prerequisites: Minimum grades of C- in PHYS 208 and MATH 115.

PHYS 320
Origin of the Elements
3 Credits Weekly (3-0-0)
Biology, chemistry, and earth sciences all study processes involving chemical reactions. But where do we get the elements in atoms, molecules, and compounds? This course studies the origin and evolution of the matter in the universe. Based on the current theories, the universe started with the Big Bang, created lighter elements such as hydrogen, helium, and lithium at early stages. The transmutation of these elements into heavier forms is then traced by examining the gravitational collapse of interstellar clouds that leads to stellar formation. The endpoint of this sequence, namely the production of new elements (nucleosynthesis) at the cores of stars and as a result of supernova events is discussed. During the course we also examine the suitable environments where the interaction of atomic material leads to the formation of complex compounds, molecules, and even the fundamental building blocks of life. Note: ASTR 122 is recommended.
Prerequisites: Minimum grade of C- in any one of PHYS 208, 224, 244, and in MATH 115 and CHEM 102.

PHYS 324
Origins of Planetary Systems
3 Credits Weekly (3-0-0)
Are we alone in the universe? If not, how would we know? This course focuses on discovery methods for extrasolar planets, how the Earth and the other planetary bodies in our solar system were formed, and compares the planets in our solar system with those planets found around other stars in the Milky Way galaxy. During this course, three compelling questions will be addressed: "How common are Earth-like planets, are other planetary systems similar to ours, and what types of extrasolar planets would be suitable for life ?"
Prerequisites: A minimum grade of C- in PHYS 224 or PHYS 244, or in both EASC 206 and MATH 114.

PHYS 330
Statistical Mechanics and Thermodynamics
3 Credits Weekly (3-0-0)
This course develops the laws of thermodynamics from a statistical perspective. Assuming a simple model for small-scale interactions between individual particles, the statistical representation of systems with a large number of such particles is constructed using simple probability theory. The rules governing how such systems evolve with time are discussed in terms of how they lead to the laws of thermodynamics. Additional applications of these tools is also discussed. Note: completion of PHYS 244 is recommended before taking this course.
Prerequisites: A minimum grade of C- in MATH 115, PHYS 208, and PHYS 224.

PHYS 332
Computational Physics
3 Credits Weekly (3-3-0)
This course introduces students to computational techniques used in physics. Topics include basic computational principles, differentiation and integration, ordinary and partial differential equations, matrix manipulation, variational techniques and stochastic methods, with application to physical systems in mechanics, heat and thermodynamics, waves, electromagnetism, quantum mechanics, condensed matter, geophysics, and biophysics.
Prerequisites: Minimum grades of C- in MATH 115 and any two of PHYS 208, PHYS 224, PHYS 226, PHYS 244, PHYS 250, or PHYS 252.

PHYS 372
Quantum Mechanics
3 Credits Weekly (3-0-0)
How do the foundational ideas of quantum mechanics blossom into the formal equations that physicists use to describe atomic systems? This course begins with the wave function and its physical interpretation. The Schrödinger equation is solved for free particles and one-dimensional potentials. Once the model becomes highly developed, solutions are extended to three-dimensional systems with orbital angular momentum. Practical applications of quantum mechanics are discussed. Course changed from PHYS 472.
Prerequisites: Minimum grades of C- in MATH 115 and one of PHYS 208, PHYS 224, or PHYS 244.

PHYS 390
Advanced Physics Laboratory
3 Credits Weekly (0-4-0)
This laboratory course introduces students to advanced experiments and analytical methods in physics. Methods of experimental design, experimental techniques, and error analysis are discussed. Students apply these methods to experiments selected from classical and modern physics.
Prerequisites: Minimum grades of C- in PHYS 208 and in one of PHYS 200, PHYS 224, PHYS 226, PHYS 244, PHYS 250, or PHYS 252.

PHYS 398
Independent Study
3 Credits Total (0-0-72)
This course permits an intermediate-level student to work with a faculty member to explore a specific topic in depth through research or through directed reading in primary and secondary sources. The student plans, executes and reports the results of their research or study project under the direction of a faculty supervisor. To be granted enrollment in the course, the student must have made prior arrangements with a faculty member willing to supervise his or her project. This course can be taken twice for credit.

PHYS 495
Special Topics in Physics and Astrophysics
3 Credits Weekly (3-0-0)
In this course, students examine one or two topics of specialization in physics and/or astrophysics in-depth. Topics can vary with the interests of students and the instructor. Consultation with the department is required prior to registration.
Prerequisites: Consent of the department.

PHYS 498
Advanced Independent Study
3 Credits Total (0-0-72)
This course permits a senior-level student to work with a faculty member to explore a specific topic in depth through research or through directed reading in primary and secondary sources. The student plans, executes and reports the results of their research or study project under the direction of a faculty supervisor. To be granted enrollment in the course, the student must have made prior arrangements with a faculty member willing to supervise his or her project. This course can be taken twice for credit. Consent of Department required.