GREETINGS FROM THE DEAN

Welcome and congratulations on joining the Engineering class of 2Y6! In Fall 2001, the Faculty of Pure and Applied Science introduced Engineering streams that build on our strengths in basic and applied sciences. These new programs are designed to meet the needs of the engineering profession as it evolves. Computer Engineering is a specialization that responds to existing needs of society in information and advanced technologies. Geomatics Engineering and Space Engineering are unique in Ontario and address the future need for professionals to be able to apply our expanding knowledge of Earth and Space for the betterment of society. These are exciting times in all the applied sciences! You will have a challenging, intense four years on your way to graduating with an Engineering degree.

With best wishes,

Gillian E. Wu, PhD.

Gillian E. Wu, PhD., Dean
Faculty of Pure and Applied Science
Tel: 416-736-5051 Fax: 416-736-5950 Email: gillwu@yorku.ca

Welcome to Engineering at York!

The Faculty of Pure and Applied Science at York University welcomes you to our Engineering Program, leading to an Honours Bachelor of Applied Science BASc (Hons) degree. We are currently admitting students into the following streams: Computer Engineering, Geomatics Engineering and Space Engineering.

These new programs respond to demonstrated need in applied science in the 21st Century and build upon existing York strengths in computer science, earth sciences, physics and space science. These are cutting edge areas in high demand.

Students in all streams share common first year courses. These courses provide a foundation to be built upon in each program. In second year and beyond, the courses become more specific to each program.

A common first year has a number of advantages. It will give students a year in which to decide (through the Engineering Design I course) whether engineering is the field they wish to pursue. If they decide not to continue in Engineering, the courses taken will prepare them well to continue in a variety of other Faculty of Pure and Applied Science areas. The common first year also means that students do not have to commit to a particular engineering stream until the end of the first year. They will be assisted in that choice through an introduction to all streams offered in the Engineering Design I course.

Students in the Engineering program will take six courses each term. This work load is heavy, but not excessively so. It is comparable to that expected of students in almost any applied science or engineering program. Students should expect to spend at least as many hours in independent study as in the classroom or laboratory.

Fourth-year students engage in a full year capstone project course. In this project, students develop complex engineering solutions to real-world problems under the guidance of a faculty member.

Since Engineering is a new program to York, some of the details are still evolving and may change over the course of time. You may notice that some of the upper year courses listed in this mini-calendar do not have the details listed. These courses will be developed as the program advances to best suit the needs presented, and are examples of how the program will evolve over the next few years. Please ensure you keep up to date on the latest information regarding the program to be aware of any changes or developments.

Advising @ FPAS

This is your first step to enrolling in classes at York. Your advising appointment is an important aspect of your academic career. It is one that will continue throughout your studies at the University. Advising occurs with the Office of Science Academic Services. We recommend you read the following information in order to be prepared for your enrolment appointment. Please also bring a pen or pencil to the appointment. We look forward to seeing you.

In order to be fully prepared, please read the information in your advising kit and arrive on time. There will be an opportunity for you to ask questions.

Office of Science Academic Services (SAS)
1012F Computer Science Building
Office Hours: Monday-Friday 8:30am-1:00pm
(416) 736-5085

We are here to help you and we take your academic career at York seriously. If you are uncertain about a procedure, regulation, or policy, Science Academic Services is the first place you should visit. SAS has advisors available during regular office hours.

The Office of Science Academic Services believes in an open door policy and provides advising for all Science students.

We believe that good academic advising ensures students in the Faculty of Pure and Applied Science make proper course selections and understand all aspects of academic life at York.

Earning your Applied Science degree @ York

The Credit System

At York, each course is worth a prescribed number of credits. These credits are intended to reflect the total workload. Normally, one lecture hour per week per term is defined as one academic credit, as is one laboratory session per week per term.

A full year course runs from September to April and is normally worth 5-8 credits. A one-semester course runs from September to December or January to April and is normally worth 1-4 credits.

Note: the number of credits each course is worth is indicated by the second last digit in each course number (e.g., BIOL 1010 **6.0**)
When determining what year you are in, it is necessary to equate credits passed with the year level.

Credits Passed	Year Level
0-23	1st year
24-53	2nd year
54-83	3rd year
84+	4th year

General Education Courses/Complementary Studies

All BASc students must complete a minimum of 12 non-science credits from at least two different areas of study outside the Faculty of Pure and Applied Science. General education credits may be taken at any year level, but students are strongly encouraged to take their initial Gen. Ed. Courses at the 1000 or 2000 level. Part of the requirement is met by courses taken from the Complementary Studies area required for professional accreditation.
More information about these courses will be available at your advising appointment.

GPA Requirements

To proceed in each year of the BASc (Hons.) program requires a minimum cumulative credit-weighted grade-point average of 5.0 (C+) over all courses completed. (Pending Senate approval)

Graduation Requirements

To graduate in the BASc (Hons.) program requires successful completion of all Faculty requirements and a minimum cumulative credit-weighted grade-point average of 5.0 (C+) over all courses completed. (pending Senate approval)

Exit Strategies

Students who do not maintain the minimum GPA needed to proceed or who decide they would prefer to be in another program have the option to transfer from Engineering to BSc or BSc Honours programs depending on GPA.

Course Descriptions

The following is a sample of a course description you would find in the lecture schedule or the Undergraduate Programs Calendar. We have broken it down to define each section.

> **SC/PHYS1010 6.0 Physics**. Topics include linear, rotational and oscillatory motion; Newtonian mechanics; electrostatics; magnetostatics; electric current and induction; heat; geometrical and physical optics and sound. Differential and integral calculus and vector algebra are used. This course covers fewer topics than SC/PHYS1410 6.0, but covers them in greater depth. It should be taken by all those likely to enroll in 2000-level PHYS courses. Three lecture hours per week in the first term, two lecture hours per week in the second term; three laboratory hours in alternate weeks in both terms; one tutorial hour each week in both terms.
> Prerequisite: OAC Physics or SC/PHYS1510 4.0
> Co-requisite(s): AS/SC/MATH1013 3.0 and AS/SC/MATH1014 3.0 and AS/SC/MATH1025 3.0, or AS/SC/MATH1505 6.0, or equivalents.
> Degree credit exclusions: SC/PHYS1410 6.0, AK/PHS1200 6.0

SC/.... This is the prefix that tells you what Faculty offers the course (SC=Science, AS=Arts, etc). It also tells you what sort of credit you will receive for the course. Faculty requirements require a certain number of SC credits.

Note: Geography, Math, Computer Science, Kinesiology, Psychology and Statistics are offered as Science and Arts courses. You must ensure that you register for the SC credits.

PHYS... The four-letter code represents the department that offers the course. In this case, Physics and Astronomy.

1010: Determines the year level of the course. All course numbers at the 1000 level are first year courses, 2000 are for second year courses, etc.

6.0: How many credits the course is worth.

Prerequisite: Courses that have to be successfully completed before taking this one.

Co-requisite: Any courses that must be taken at the same time as this one. For example, when you take PHYS1010 6.0, you must also enroll in MATH1013 3.0, MATH1014 3.0 and MATH1025 3.0.

Degree Credit Exclusion: Courses that are similar to each other, but not considered equal. You should not enroll in a course if you have already successfully completed the exclusion. If you take both courses, you will only receive credit for one. Check with your advisor if you are thinking of substituting one course for another.

Calculating your Grade Point Average (GPA)

Averages are calculated on the basis of the point value assigned to each letter grade.

A+ = 9.0	C = 4.0
A = 8.0	D+ = 3.0
B+ = 7.0	D = 2.0
B = 6.0	E = 1.0
C+ = 5.0	F = 0.0

Calculating your GPA

1. Multiply total credits of each course by the grade point value.
2. Add up the total number of credits.
3. Add up the total grade points.
4. Divide the total grade points by the total credits.

Example:

courses	Grade earned	Grade point value	credits	x	grade point value	= Grade points
xxxx 6.0	C+	5.0	6		5.0	30
xxxx 3.0	F	0.0	3		0.0	0
xxxx 5.0	B	6.0	5		6.0	30
xxxx 4.0	B	7.0	4		7.0	28
xxxx 3.0	A	8.0	3		8.0	24
Total			21			112
			112) 21 = 5.33 GPA			

Academic Deadlines

Please mark the following dates on your calendar.

First day of classes September 9, 2002

Last day to **add** a course without permission of the course director

Fall Term	September 20
Full Year	September 20
Winter Term	January 17

Last day to **add** a course with permission of the course director

Fall Term	October 4
Full Year	October 18
Winter Term	January 31

Last day to **drop** a course without receiving a grade

Fall Term	November 8
Full Year	February 7
Winter Term	March 7

Financial Deadlines

See "The Fees and Registration" section of the FW02 Lecture schedule for more details.

Policies and Procedures

As a student, it is your responsibility to become familiar with the rules and regulations at the university, in your Faculty and in your Department. Reliable sources to consult are the Undergraduate Calendar and the Lecture schedule. As well, you can contact the advisors at SAS.

University rules include deadlines to enroll in courses, payment of fees, drop/change courses and academic conduct.

Academic Honesty

The Senate of the University has a comprehensive policy on this subject. You should read and understand its implications. Details on the policy can be found in the Undergraduate calendar.

Offices of Support Services

University life is filled with challenges. York provides a wide variety of services to help you deal with these challenges. The following is a list of services available to science students.

Office or Contact	**Type of Assistance or Service**
Office of Science Academic Services, 1012F Computer Science Bldg. 416 736-5085	General advising, course selection/changes, Faculty policies and procedures, good place to start
Director of Engineering 1012T Computer Science Bldg. 416 736-5051	Engineering specific questions, advice on dropping courses
Bethune College Advisor, 416 736-2100 ext. 33940	General advising, study skills, college activities, upcoming events
SOS: 214B Bethune College 416 736-5383	Students' perspective on university life
Professors	Academic difficulties
Bethune Writing Centre 253 Bethune College 416 736-5164 ext 22035	Writing difficulties
Office of the Registrar, West Office Building 416 736-5440 http://www.registrar.yorku.ca	Petitions, permission to take a course at another university, transcripts and most forms
Counselling & Development Centre 145 Behavioural Science Building 416 736-5297 www.yorku.ca/cdc	Personal problems, depression, grief counselling, stress management workshops, exam anxiety, etc.
Student Financial Services West Office Building 416 872-9675 www.yorku.ca/osfs	Scholarships, financial problems, OSAP information
Career Services 108 North Ross Building www.yorku.ca/careers	Career counselling

Departmental Offices

Computer Science (Computer Engineering)
1003 Computer Science Building
416 736-5334
Dr. P. Cribb, Chair
Professor G. Gotshalks, Undergraduate Director

Earth & Atmospheric Science (Geomatics and Space Engineering)
102 Petrie Science Building
416 736-5245
Dr. G. Jarvis, Chair

First Year

Introduction

Students in all streams share common first year courses. These courses provide a foundation to be built upon in each program. In second year the Geomatics Engineering and Space Engineering streams will continue to share common courses. Beyond second year, courses are specific to each stream.

A common first year has a number of advantages. It gives students a year in which to decide (through the Engineering Design I course) whether engineering is the field they wish to pursue. If they decide not to continue in Engineering, the courses taken will prepare them well to continue in a variety of other Faculty of Science areas. The common first year also means that students do not have to commit to a particular engineering stream until the end of the first or second year. They will be assisted in that choice through an introduction to all areas offered in the Engineering Design I course. Towards the end of first year, students will choose their engineering stream. As Geomatics and Space Engineering share a common second year, this choice can effectively be delayed until the end of second year.

First Year Course Requirements

ENG 1000 6.0	Engineering Design I
CHEM 1000 3.0	Chemical Structure
COSC 1020 3.0	Introduction to Computer Science I
COSC 1030 3.0	Introduction to Computer Science II
EATS 1010 3.0	The Dynamic Earth & Space Geodesy
MATH 1013 3.0	Applied Calculus I
MATH 1014 3.0	Applied Calculus II
MATH 1025 3.0	Applied Linear Algebra
MATH 1090 3.0	Introduction to Logic for Computer Science
PHYS 1010 6.0	Physics

Computer Engineering

Introduction

The York University Computer Engineering Program combines theoretical and practical aspects of Computer Science with hardware related aspects of Engineering into a comprehensive course of study. Computer Engineering students participate in a cooperative education program in which an industrial internship between 3rd and 4th year of up to 16 months duration is required as part of the program. In addition, all students are required to complete a Senior Project for their degree.

The Computer Engineering program consists of both software development, which concentrates on the application of Engineering Design principles to the development of effective, efficient and correct computer software, and hardware development, which concentrates on the development of hardware structures to support computer-controlled processes.

Computer Engineering questions should be directed to the Undergraduate Computer Science Office in the Computer Science Building , room 1003, which is open for enquiries Monday-Friday, 10 am-12 noon, 2-4 pm.

Telephone: (416) 736-5334
E-mail: enquiries@cs.yorku.ca

Internship Program

A non-credit industrial internship is required between third and fourth year in the Computer Engineering Stream. The model will follow that of already existing internships for York students in Computer Science and the Space and Communication Sciences streams. The internship will normally last 16 months, but students must spend a minimum of 4 months at an employer's work location. There will be considerable flexibility in the duration of individual internships within that range. For a 16-month placement, a York University engineering student can expect to earn an average of $45,000. Students who participate in the 16-month placement can expect to retire a significant fraction of their student debt before graduating.

In addition to providing essential work experience to Computer Engineering graduates, suitable work placements are expected to count towards the work term required by Engineering graduates who plan to seek certification as a Professional Engineer.

The Department of Computer Science maintains an Internship Office to assist students seeking internship employment and to assist employers wishing to hire York University internship students. The Internship Office coordinates recruitment activity on campus. Internship students receive assistance in identifying relevant and interesting internship opportunities, formulating the employer application package and sharpening interview skills. Computer Science students are currently placed at a wide range of companies including IBM Canada Ltd., Nortel Networks and Microforum.

Program Course Requirements

First year, Computer Engineering, See page 8

Second year, Computer Engineering

COSC 2001 3.0	Introduction to Theory of Computation
COSC 2011 3.0	Fundamentals of Data Structures
COSC 2021 3.0	Computer Organization
COSC 2031 3.0	Software Tools
ENG 2000 6.0	Engineering Design II
MATH 2015 3.0	Applied Multivariate and Vector Calculus
MATH 2030 3.0	Elementary Probability
MATH 2090 3.0	Applications of Logic to Discrete Mathematics
PHYS 2020 3.0	Electricity and Magnetism
PHYS 3050 3.0	Electronics I
PHYS 3150 3.0	Electronics II

Third Year, Computer Engineering

ENG 3000 3.0	Organization and Management Seminar (both terms)		
COSC 3213 3.0	Computer Networks I		
COSC 3215 3.0	Microcomputers and Embedded Systems		
COSC 3221 3.0	Operating System Fundamentals		
COSC 3311 3.0	Software Design		
COSC 34xx 3.0	applications course		
6 credit	complementary studies*		
plus for the Software Development Stream:		COSC 3101 3.0	Design and Analysis of Algorithms
		COSC 33xx 3.0	software development course
or for the Hardware Development Stream:		COSC 3201 3.0	Digital Logic
		3 credits any course	
6 credits Science electives			

plus at least 6 credits from the following courses:

BIOL 1010 6.0	Biological Science
BIOL 1410 6.0	Principles and Processes in Biology
CHEM 1001 3.0	Chemical Dynamics
CHEM 2011 3.0	Introduction to Thermodynamics
EATS 1011 3.0	Introduction to Atmospheric Science
PHYS 1070 3.0	Astronomy
PHYS 2010 3.0	Classical Mechanics
PHYS 2040 3.0	Special Relativity and Modern Physics
PHYS 2060 3.0	Optics and Spectra

Between third and fourth year - a required, but non-credit, 4-16 month internship program where students will gain professional experience

Fourth Year, Computer Engineering

ENG 4000 6.0	Engineering Project		
COSC xxxx 3.0	any other 3000- or 4000-level COSC course		
6 credit	complementary studies*		
plus for the Software Development Stream:		COSC 42xx 3.0	systems course
		COSC 43xx 3.0 x 3	software design courses
		COSC 44xx 3.0 x 2	applications courses
or for the Hardware Development Stream:		COSC 42xx 3.0 x 3	systems courses
		COSC 43xx 3.0	software design course
		COSC 44xx 3.0 x 2	applications courses
3 credit elective			

***Complementary Studies Courses**

To be chosen from the following:

ECON 1000 3.0	Introduction to Microeconomics
ECON 1010 3.0	Introduction to Macroeconomics
ECON 1900 3.0	Introduction to Economics for Non-Majors
HIST 3870 3.0	The Historical Development of Technology Since 1800 and its Impact
HUMA 3920 3.0	Technology and Communication
PHIL 2070 3.0	Introductory Ethics
PHIL 2075 3.0	Introduction to Practical Ethics
SOSC 2860 3.0	Interactive Media
SOSC 3310 6.0	Communications for Tomorrow

Geomatics Engineering

Introduction

Geomatics engineering is founded on the scientific framework of Geodesy, the science concerned with the determination of size, shape, physical surface and gravity field of the Earth, in three-dimensional, time-varying space. Geomatics engineering uses terrestrial, marine, airborne and space sensors that are referenced to a national, highly accurate and globally consistent, four-dimensional spatial reference frame to acquire data for a wide range of applications.

Geomatics is the combination of several disciplines dealing with geospatial information (i.e., information tied to geographic or other spatial coordinates). It includes global positioning systems (GPS, GLONASS, other), satellite imaging and photogrammetry, remote sensing, computer vision and image processing, geographic information systems (GIS), surveying engineering, land management, computer mapping, digital terrain modelling and the wireless and web-based dissemination of geospatial data.

Geomatics Engineering facilitates the economic growth, well-being and safety of the citizens of the country. Geomatics technology and techniques are used in a wide variety of fields such as forestry, agriculture, geology, mining, oceanography, hydrography, environmental management, urban planning, public utilities, transport, navigation, defence, medical epidemiology, disaster management, geomarketing, health emergency responses, and business and commerce. It is currently the most rapidly expanding high technology sector.

Areas of study may include geodesy, global positioning systems, geodetic surveys, land surveying, remote sensing, computer aided cartography, aerial photography, data mining, photogrammetry and digital terrain modelling/analysis, spatial analysis, resource modelling, spatial data storage, high-resolution satellite imagery, web-based mapping, geographical information systems, Internet data dissemination, data integration, mobile computing data visualization, image processing and high speed data transmission.

A graduate of the York University Geomatics Engineering stream may also be qualified for certification by the Association of Ontario Land Surveyors (AOLS), as an Ontario Land Surveyor (OLS) and (equivalently) an Ontario Land Information Professional (OLIP).

Program Course Requirements

First year, Geomatics Engineering, See page 8

Second Year, Geomatics Engineering

COSC 2011 3.0	Fundamentals of Data Structures
COSC 2031 3.0	Software Tools
COSC 2501 1.0	Fortran and Scientific Computing
EATS 2030 3.0	Geophysics and Space Science
EATS 2470 3.0	Introduction to Mechanics of Fluids and Solids
EATS 2610 2.0	Geomatics and Space Engineering
EATS 2620 4.0	Fundamentals of Surveying
ENG 2000 6.0	Engineering Design II
MATH 2015 3.0	Applied Multivariate and Vector Calculus
MATH 2270 3.0	Differential Equations
PHYS 2020 3.0	Electricity and Magnetism
3 credits	complementary studies

Between Second and Third Year

SENECA 3.0	Field Surveys (two-week field school)

Third Year, Geomatics Engineering

COSC 3121 3.0	Introduction to Numerical Computations I
EATS 3020 3.0	Global Geophysics and Geodesy
EATS 3300 3.0	GIS and Spatial Analysis of the Physical Environment
EATS 3610 3.0	Geodetic Concepts
EATS 3620 3.0	Geomatics Networks
EATS 3630 3.0	Geomatics Modelling Methods
EATS 3640 3.0	Hydrography
EATS 3650 3.0	Analytical Photogrammetry
EATS 3660 3.0	Cadastral Surveys and Land Registration Systems
ENG 3000 3.0	Organization and Management Seminar
GEOG 2420 3.0	Introductory Statistical Analysis in Geography
PHYS 3050 3.0	Electronics I
SENECA 3.0	Land Use Planning
XXXXxxxx 3.0	Principles of Law (in process of development)

Between Third and Fourth Year

SENECA 3.0	Advanced Surveying Field Camp (2 weeks)

Between third and fourth year - an optional, but non-credit, 4-16 month internship program where students will gain professional experience

Fourth Year, Geomatics Engineering

EATS 4020 3.0	Time Series and Spectral Analysis
EATS 4220 3.0	Remote Sensing of the Earth's Surface
EATS 4400 3.0	Geographical Information Systems
EATS 4610 3.0	Satellite Positioning
EATS 4620 3.0	Geodetic Positioning
EATS 4630 3.0	High Precision Surveys
EATS 4640 3.0	Digital Terrain Models and their Applications
EATS 4650 3.0	Digital Imaging and Applications
ENG 4000 6.0	Engineering Project
SENECA 3.0	Environmental Modelling
SENECA 3.0	Survey Law I/Real Property (new course)
SENECA 3.0	Survey Law II/Parcels, Records and Boundaries
XXXX 3.0	Complementary studies

Space Engineering

Introduction

Space engineering, based on the framework of applied mathematics, physics and astronomy and computer science, involves system design, fabrication, and the integration of satellite communication systems, remote sensing technology and scientific payloads. It also involves the design and management of complex hardware and data systems.

Space engineering has links to many other disciplines including geomatics engineering, computer engineering, space and communication science all of which are offered at York University. Space engineering is concerned with the development of space technology that will improve our knowledge of the solid Earth, oceans and atmosphere and of the evolution of our planetary system and universe. Probing the Earth and its atmosphere from space provides an efficient, cost-effective and rapid approach to discovering natural resources, understanding climate system history and dynamics and ocean circulation.

Space engineering in combination with geomatics engineering and computer engineering enables the development of new technologies and applications that accelerate economic growth and improve the standard of living. Spaceborne sensors provide useful, and in many cases real-time data that have a wide variety of applications in resource exploration, environmental management, navigation, health and safety and many others.

Areas of study may include, satellite missions, space stations and deep space probes, propulsion systems, space exploration and communication, space vehicles and orbit determination, sensors, data acquisition, evaluation, processing and analysis.

York University is currently involved in a number of international satellite missions dedicated to studies of the atmosphere from space. These missions include the Canadian WINDII instrument (the WIND Imaging Interferometer) on NASA's Upper Atmosphere Research Satellite and the Canadian OSIRIS instrument (the Optical Spectrograph and IR Imager System) on Sweden's Odin satellite.

Program Course Requirements

First year, Space Engineering, See page 8

Second Year, Space Engineering

COSC 2011 3.0	Fundamentals of Data Structures
COSC 2031 3.0	Software Tools
COSC 2501 1.0	Fortran and Scientific Computing
EATS 2030 3.0	Geophysics & Space Science
EATS 2470 3.0	Introduction to the Mechanics of Fluids and Solids
EATS 2610 2.0	Geomatics and Space Engineering
EATS 2620 4.0	Fundamentals of Surveying
ENG 2000 6.0	Engineering Design II
MATH 2015 3.0	Applied Multivariate and Vector Calculus
MATH 2270 3.0	Differential Equations
PHYS 2020 3.0	Electricity and Magnetism
3 credit	Complementary studies

Third Year, Space Engineering

COSC 2021 3.0	Computer Organization
COSC 3121 3.0	Introduction to Numerical Computations I
COSC 3211 3.0	Data Communications
ENG 3000 3.0	Organization and Management Seminar
MATH 3410 3.0	Complex Variables
PHYS 3050 3.0	Electronics I
PHYS 3150 3.0	Electronics II
PHYS 3250 3.0	Introduction to Space Communication
PHYS 3280 3.0	Physics of the Space Environment
3 credit	Science or Engineering elective
6 credit	complementary studies

Between third and fourth year - an optional, but non-credit, 4-16 month internship program where students will gain professional experience

Fourth Year, Space Engineering

EATS 4610 3.0	Satellite Positioning
ENG 4000 6.0	Engineering Project
PHYS 4110 3.0	Dynamics of Space Vehicles
PHYS 4250 3.0	Signal and Communications Theory
PHYS 4350 3.0	Hardware for Space Communications
PHYS 4450 3.0	Spacecraft Systems
PHYS 4550 3.0	Introduction to Control Systems
3 credit	Space Engineering elective
6 credit	engineering elective
3 credits	complementary studies

Engineering Physics

Engineering Physics is currently not admitting new students.

Introduction

Engineering Physics at York builds on existing strengths in the Department of Physics and Astronomy which links the interests of experimentalists in laser-based atomic physics to the applied area of photonics. These scientists who deliver the physics-related aspects of the program will be complemented by engineering physicists who will deliver the upper-year components which will prepare graduates for the industry sector which drives the internet and telecommunication revolution, namely fibre optics. There is a demand in industry laboratories for physicists who are trained in theoretical and experimental aspects of wave optics and laser physics.

At the same time this program will train students to become strong scientists with not only the knowledge and thinking skills of a physicist, but with important modern computing skills as well. The latter aspect is missing to some extent in the more traditional physics or astronomy program. Students who will choose to opt out of the engineering parts will have the option to directly go into an honours program of physics, or a combined program with computer science. In the first two years the program is similar to Space Engineering, however, it does build less towards any computer science courses in third year. In contrast it puts more emphasis on physics-related and engineering-physics-related activities to be developed for the third and fourth year of the program.

Program Course Requirements

First year, Engineering Physics, See page 8

Second Year, Engineering Physics

COSC 2011 3.0	Fundamentals of Data Structures
COSC 2021 3.0	Computer Organization
EATS 2470 3.0	Introduction to the Mechanics of Fluids and Solids
ENG 2000 6.0	Engineering Design II
MATH 2015 3.0	Applied Multivariate and Vector Calculus
MATH 2270 3.0	Differential Equations
PHYS 2020 3.0	Electricity and Magnetism
PHYS 2040 3.0	Special Relativity and Modern Physics
PHYS 2211 1.0	Experimental Physics (laboratory course)
3 credit x 2	engineering elective

Third Year, Engineering Physics

ENG 3000 3.0	Organization and Management Seminar
MATH 3271 3.0	Partial Differential Equations
PHYS 3010 3.0	Classical Mechanics
PHYS 3020 3.0	Electromagnetics I
PHYS 3040 6.0	Modern Physics
PHYS 3050 3.0	Electronics I
PHYS 3150 3.0	Electronics II
PHYS 3210 6.0	Experimental Physics (laboratory course)
3 credit	engineering elective
3 credit	complementary studies

Between third and fourth year - an optional, but non-credit, 4-16 month internship program where students will gain professional experience

Fourth Year, Engineering Physics

ENG 4000 6.0	Engineering Project
PHYS 3030 3.0	Statistical and Thermal Physics
PHYS 4010. 30	Quantum Mechanics
PHYS 4020 3.0	Electromagnetics II
PHYS 4050 3.0	Solid State Physics
PHYS 4060.30	Time Series and Spectral Analysis
PHYS 4211 3.0	Experimental Physics (laboratory course)
3 credit	engineering elective
9 credits	complementary studies

Course Descriptions

First Year Courses

ENG 1000 6.0
ENGINEERING DESIGN I
An introduction to design using case studies to illustrate the use of resources to meet stated objectives within constraints imposed by economic, health, safety, environmental, social and other factors. Emphasis is placed on written and oral presentation and critical analysis.

Format
Three lecture hours per week

CHEM 1000 3.0
CHEMICAL STRUCTURE
Introduction to chemistry with emphasis on physical and electronic structure of matter, including gases, liquids and solids. Topics include behaviour of gases; thermochemistry; atomic structure and periodic table; chemical bonding and architecture; structure of liquids and solids; frontiers of chemistry.

Prerequisites
OAC Chemistry or SC/CHEM 1500 4.0 or equivalent; OAC Physics or SC/PHYS 1510 4.0 or equivalent normally required.

Degree credit exclusions
SC/CHEM 1000 6.0, SC/CHEM 1010 6.0, AK/CHEM 2000 6.0.

Format
Two and one-half lecture hours per week, one tutorial hour per week, six three-hour laboratory sessions

COSC 1020 3.0
INTRODUCTION TO COMPUTER SCIENCE I
Introduction to computation, computing machinery, algorithms and programming via theoretical concepts and practical skills. Problem solving via the structure, design and analysis of algorithms and their implementation as effective, correct and efficient programs. Control and data structures of a structured programming language (Java).

This course is introductory to the discipline in that it is the first in a hierarchy of courses; it is not a survey course. The emphasis is on the development of a theoretical conceptual basis and the acquisition of the intellectual and practical skills required for further study. The course is intended for prospective computer science majors, i.e. those with a well-developed interest in computing as an academic field of study and with strong mathematical, analytical and language abilities; it is not intended for those whose interest is casual, nor for those who require remedial work in the necessary background.

Format
3 lecture hours per week, weekly labs

COSC 1030 3.0
INTRODUCTION TO COMPUTER SCIENCE II
This course is a continuation of COSC1020 and covers some of the fundamentals of software development, various data structures (arrays, queues, stacks, trees, lists), and algorithms that use these structures (sorting, searching). An object oriented approach will be introduced. Students will use the Unix operating system with the X Window System.

Prerequisites
COSC1020 3.0

Degree Credit Exclusion
AK/COSC2410 6.0, AK/COSC2412 3.0

Format
3 lecture hours per week

EATS 1010 3.0

THE DYNAMIC EARTH AND SPACE GEODESY

An overview of modern geophysics: origin of the Earth, impact cratering, internal structure and rheology, earthquakes, plate tectonics, geomagnetism, Space geodetic positioning techniques such as VLBI, SLR and GPS are introduced as means of detecting and monitoring tectonic movements.

Prerequisites
OAC Calculus or AS/SC/MATH 1515 3.0 or OAC Algebra and Geometry; OAC Physics or SC/PHYS 1510 4.0.

Degree credit exclusion
SC/EATS 1010 6.0

Format
Three lecture hours per week. Five three hour laboratory sessions. Lecture and laboratory schedule will be handed out at beginning of session.

MATH 1013 3.0

APPLIED CALCULUS I

The first half of this course deals with differentiation and the second half with integration. Topics include derivatives of algebraic and transcendental functions, indefinite integrals, techniques of integration, the definite integral and its interpretation as an area.

Format
Three lecture hours per week

MATH 1014 3.0

APPLIED CALCULUS II

Applications of differential and integral calculus (e.g., maxima and minima, areas, volumes of revolution, moments and centroids, etc.), indeterminate forms, improper integrals, Taylor series, simple ordinary differential equations and an introduction to multivariate calculus.

Prerequisites
AS/SC/ MATH 1013 3.0

Format
Three lecture hours per week

MATH 1025 3.0

APPLIED LINEAR ALGEBRA

Topics include spherical and cylindrical coordinates in Euclidean 3-space, general matrix algebra, determinants, vector space concepts for Euclidean n-space (e.g., linear dependence and independence, basis, dimension, linear transformations, etc.), an introduction to eigenvalues and eigenvectors.

Format
Three lecture hours per week

MATH 1090 3.0

INTRODUCTION TO LOGIC FOR COMPUTER SCIENCE

The syntax and semantics of propositional and predicate logic. Applications to program specification and verification. Optional topics include set theory and induction using the formal logical language of the first part of the course.

By taking this course, students will master the syntax and manipulations of propositional and predicate logic, as well their informal semantics. The proper understanding of propositional logic is fundamental to the most basic levels of computer programming, while the ability to correctly use variables, scope and quantifiers is crucial in the use of loops, subroutines, and modules, and in software design. Logic is used in many diverse areas of computer science including digital design, program verification, databases, artificial intelligence, algorithm analysis, and software specification. We will not follow a classical treatment of logic. Instead we will use an "equational" treatment.

PHYS 1010 6.0

PHYSICS

Topics include linear, rotational and oscillatory motion; Newtonian mechanics; electrostatics; magnetostatics; electric current and induction; heat; geometric and physical optics and sound. Differential and integral calculus and vector algebra are used. In addition, some concepts of modern physics are introduced interspersed throughout.
Content

- Unit system, dimensions, accuracy, graphs, functions, vectors
- Motion in one, two and three dimensions
- Newton's Laws - work, energy, power
- Gravitation
- Conservation of energy and momentum, collisions
- Rotational motion and dynamics, equilibria
- Oscillations, waves and sound
- Temperature, heat, thermodynamics, entropy
- Reflection, refraction, diffraction, image formation
- Electric charge, electric fields, potential, current, magnetic fields, electromagnetic inductance, radiation

Co-requisites
MATH 1013 3.0 and MATH 1014 3.0 and MATH 1025 3.0, or MATH 1505 6.0, or equivalent(s).

Format
Three lecture hours per week first term, two lecture hours per week second term; one tutorial hour per week each term; three laboratory hours in alternate weeks each term.

Second Year Courses

COSC 2001 3.0

INTRODUCTION TO THEORY OF COMPUTATION

The course introduces different theoretical models of computers. Topics covered may include the following:

- Finite automata and regular expressions. Practical applications ie. text editors.
- Push-down automata and context-free grammars. Practical applications e.g. parsing and compilers.
- Turing machines. Turing machines as a general model of computers.
- Introduction to the halting problem and NP completeness.

Prerequisites
COSC 1030 3.0, MATH 1090 3.0

Degree Credit Exclusion
AK/COSC 3431 3.0

Format
Three lecture hours per week

COSC 2011 3.0

FUNDAMENTALS OF DATA STRUCTURES

This course discusses the fundamental data structures commonly used in the design of algorithms. At the end of this course, students will know the classical data structures, and master the use of abstraction, specification and program construction using modules. Furthermore, students will be able to apply these skills effectively in the design and implementation of algorithms.

Topics covered may include the following:

- Review of primitive data types and abstract data type - arrays, stacks, queues and lists.
- Searching and sorting. A mixture of review and new algorithms.
- Priority queues.
- Trees: threaded, balanced (AVL-, 2-3-, and/or B-trees), tries
- Graphs: representations; transitive closure; graph traversals; spanning trees; minimum path; flow problems

Prerequisites
COSC 1030 3.0, MATH 1090 3.0

Degree Credit Exclusion
AK/COSC 3501 3.0, AS/AK/ITEC 2011 3.0

COSC 2021 3.0

COMPUTER ORGANIZATION

Computers can be usefully viewed as having a structure organized into several levels, ranging from high-level programming languages such as Java to digital logic circuits. Each level provides specific resources and abstractions for the programmer which are created by the level beneath it. This course provides students with basic understanding of computers at the low-lying levels of this structure. This includes programming in assembly / machine language, computer organization (CPU, DRAM, I/O, and busses), CPU structure (Datapath and Control), and Digital Logic. The presentation is centered around performance and covers topics like caching, pipelining, and parallel processing. The course presents theoretical concepts as well as concrete implementations on a modern, RISC processor.

Prerequisites
COSC 1030 3.0, MATH 1090 3.0

Degree Credit Exclusion
AK/COSC 3411 3.0, AK/COSC 3412 3.0, AK/COSC 3460 3.0, AS/AK/ITEC 2021 3.0

COSC 2031 3.0

SOFTWARE TOOLS

This course introduces software tools that are used for building applications and in the software development process. It covers the following topics:

- Ansi-C (stdio, pointers, memory management, overview of Ansi-C libraries)
- Shell programming
- Filters and pipes (shell redirection, grep, sort & uniq, tr, sed, awk, pipes in C)
- Version control systems and the "make" mechanism
- Debugging and testing

All the above tools will be applied in practical programming assignments and/or small-group projects.

Prerequisites
COSC 1030 3.0, MATH 1090 3.0

COSC 2501 1.0

FORTRAN AND SCIENTIFIC COMPUTING

Covers computer-based problem solving in a variety of scientific and engineering settings. Introduces the FORTRAN programming language and its interface with scientific libraries. Applications are drawn mainly from scientific areas such as numerical methods, processing experimental data, simulation and data visualization.

Prerequisite
COSC 1020 3.0 or COSC 1530 3.0

Degree Credit Exclusion
COSC 1540 3.0

Format
Three lecture hours per week

EATS 2030 3.0

GEOPHYSICS AND SPACE SCIENCE

Seismic waves, earthquake fault plane solutions, tectonics on a sphere, geochronology, paleomagnetism, Earth's magnetic field, its origin and deformation by solar winds. VLBI measurements of fluctuations of Earth rotation, gravitational perturbations of satellite orbits, planetary exploration and communications issues.

Prerequisites
AS/SC MATH 1014 3.0; SC/PHYS 1010 6.0 or a minimum grade of C in SC/PHYS 1410 6.0.

Format
Three lecture hours per week and a one hour computer laboratory.

EATS 2470 3.0

INTRODUCTION TO THE MECHANICS OF FLUIDS AND SOLIDS

Introductory Cartesian tensor algebra and calculus. Stress and strain analysis. Symmetry of stress tensor, equilibrium conditions. Lagrangian and Eulerian descriptions of strain. Physical interpretation of stress, strain and strain rate tensors. Conservation laws in continua. Consistency and compatibility considerations. Constitutive relations. Navier-Cauchy equation of elasticity. Navier-Stokes equation for fluids.
Content

- Mathematical background - Cartesian Tensors
- Stress analysis
- Strain
- Laws of continuum mechanics
- Elasticity
- Fluid mechanics

Prerequisites
MATH 2015 3.0; MATH 1025.03; COSC 1540 3.0; PHYS 1010 6.0,

Format
Two lecture hours, plus one lecture or laboratory session per week

EATS 2610 2.0

GEOMATICS AND SPACE ENGINEERING

Introduction to Geodesy and Geomatics Engineering: surveying, geodesy, hydrography, space geodesy and geodynamics, photogrammetry and digital mapping. A survey of communications, remote sensing and geodetic satellites, their engineering Characteristics, payloads, and use; features of low Earth Orbiter (LEO) missions.

Prerequisites
EATS 1010 3.0; PHYS 1010 6.0, or permission of the course instructor.

Format
One and a half lecture hours and one and a half laboratory hours per week.

EATS 2620 4.0

FUNDAMENTALS OF SURVEYING

Coordinate systems, conventions and transformations. First and second geodetic problem: Trig sections, traverses, eccentricities, areas. Distance measurements, angular measurements, heights. Topographic mapping and property surveys. Route Surveying. Introduction to other surveys: alignment, deformation surveys for buildings, bridges, dams, tunnels, pipelines.

Prerequisites
EATS 1010 3.0;MATH 1014 3.0;MATH 1025 3.0;EATS 2610 2.0 or permission of the course instructor.

Format
Three lecture hours and three laboratory hours per week. One term.

ENG 2000 6.0

ENGINEERING DESIGN II

An extension of ENG 1000 6.0 to include more advanced engineering concepts, such as strength of materials, basic structural mechanics, and the fundamentals of the electronic properties of materials. Students will execute an engineering design from concept to working prototype within a variety of realistic constraints, such as economic factors, safety, reliability, human factors, ethics, and others.

Prerequisites
First year engineering courses: ENG 1000 6.0, CHEM 1000 3.0, PHYS 1010 6.0, COSC 1020 3.0, COSC 1030 3.0, EATS 1010 3.0, MATH 1013 3.0, MATH 1014 3.0, MATH 1025 3.0, MATH 1090 3.0.

Format
Three lecture hours per week

GEOG 2420 3.0

INTRODUCTORY STATISTICAL ANALYSIS IN GEOGRAPHY

This introductory course aims to provide a working knowledge of several statistical techniques which are widely used in many branches of geography. Some attention is also given to broader questions concerning the nature of the scientific method.

Prerequisites: 24 credits successfully completed. This course is intended primarily for students majoring in Geography and is normally taken during the second year of study.

Format
Two lecture hours per week, nine two-hour laboratory sessions. One term.

MATH 2015 3.0

APPLIED MULTIVARIATE AND VECTOR CALCULUS

Topics covered include grad, div, curl and Laplacian in polar coordinates; line and surface integrals; theorems of Gauss and Stokes; double and triple integrals in various coordinate systems; extrema and Taylor series for multivariate functions; differential geometry in Euclidean 3-space. Other topics covered include partial derivatives; curves and surfaces in Cartesian, cylindrical, and spherical polar coordinates; differential vector identities; Green's theorem.

Prerequisite
One of MATH 1010 3.0, MATH 1014 3.0, MATH 1310 3.0, or MATH 1505 6.0 plus permission of the Course Coordinator.

Degree Credit Exclusion
AS/SC/MATH 2010 3.0, AS/SC/AK/MATH 2310 3.0.

Format
Three lecture hours per week

MATH 2030 3.0

ELEMENTARY PROBABILITY

Introduction to the theory of probability as preparation for further study in either mathematical or applied probability and statistics. Topics include probability spaces, conditional probability, independence, random variables, distribution functions, expectation, Chebyshev's inequality, common distributions, moment-generating functions and limit theorems.

Prerequisite
One of MATH 1010 3.0, MATH 1014 3.0, MATH 1310 3.0.

Degree Credit Exclusion
MATH 2030 6.0

Format
Three lecture hours per week

MATH 2090 3.0

APPLICATIONS OF LOGIC TO DISCRETE MATHEMATICS

A continuation of MATH 1090 3.0, this course uses formal logic to study topics in discrete mathematics, including sets, relations, functions, induction, the integers. Optional topics include program specification, sequences, recurrence relations.

Prerequisite
MATH 1090 3.0

Format
Three lecture hours per week

MATH 2270 3.0
DIFFERENTIAL EQUATIONS

Introduction to differential equations, including a discussion of the formation of mathematical models for real phenomena; solution by special techniques; applications; linear equations; solutions in series; other topics if time permits.

Differential equations have played a central role in mathematics and its applications for the past three hundred years. Their importance in applications stems from the interpretation of the derivative as a rate of change, a familiar example being velocity. Many of the fundamental laws of physical science are best formulated as differential equations. In other areas, too, such as biology and economics, which involve the study of growth and change, such equations are of fundamental importance.

In this course we will study some important types of linear differential equations and their solutions. Topics will include first-order (differential) equations; homogeneous second and higher order equations with constant coefficients; the particular solution of inhomogeneous second-order equations; series-form solutions of equations with variable coefficients; solutions by use of Laplace transforms.

Students will use the symbolic computational computer language MAPLE to study the behaviour of differential equations. No prior experience with this language is necessary.

Prerequisites
One of MATH 2010 3.0, MATH 2015 3.0, or MATH 2310 3.0; one of MATH 1025 3.0, MATH 2021 3.0, or MATH 2221 3.0.

Format
Three lecture hours per week

PHYS 2020 3.0
ELECTRICITY AND MAGNETISM

The elements of electric and magnetic fields are developed, together with dc and ac circuit theory and an introduction to electromagnetic waves.
Content

- Review of vector calculus
- Coulomb's Law
- Electric field
- Gauss' Law
- Electric potential
- Electrostatic energy
- Capacitance
- Current - Continuity equation, Ohm's Law
- Magnetic fields - Ampere's Law, Biot-Savart Law
- Magnetostatic energy
- Faraday's Law
- Inductance
- Displacement current
- Time Dependent Maxwell Equations
- AC circuits, RMS relations, impedance, Q factor

Prerequisites
PHYS 1010 6.0, MATH 1025 3.0, MATH 2015 3.0

Format
Three lectures hours per week.

PHYS 2040 3.0

SPECIAL RELATIVITY AND MODERN PHYSICS

This course discusses moving frames of reference, Galilean and Lorentz transformations, relativistic dynamics, relativity and electromagnetism, and introduces the quantum theory of the atom.

Content

- Einstein's postulates, time dilation, and space contraction
- Relativistic kinematics
- Relativistic dynamics
- Quantization of matter and radiation
- The Bohr atom
- Matter waves and the Uncertainty Principle

Prerequisites

PHYS 1010 6.0; MATH 1025 3.0 or equivalent; MATH 2015 3.0,

Format

Three lecture hours per week.

PHYS 2211 1.0

EXPERIMENTAL PHYSICS

A second-year experimental laboratory for students of physical science, in mechanics, electric and magnetic interactions including both ac and dc circuits, geometrical and physical optics.

Prerequisite

PHYS 1010 6.0

Co-requisites

At least one of PHYS 2010 3.0, PHYS 2020 3.0 or PHYS 2060 3.0

Degree Credit Exclusion

PHYS 2210.02, PHYS 2210.01 PHYS 2210A.01

Format

Normally three laboratory hours per week.

Third Year Courses

COSC 3101 3.0

DESIGN AND ANALYSIS OF ALGORITHMS

Review of fundamental data structures. Analysis of algorithms: time and space complexity. Algorithm design paradigms: divide-and-conquer, exploring graphs, greedy methods, local search, dynamic programming, probabilistic algorithms, computational geometry. NP-complete problems.

Prerequisites
General prerequisites, including AS/SC/AK/MATH 2090 3.0 or AS/SC/AK/MATH 2320 3.0 or AK/MATH 2442 3.0.

Degree credit exclusion
AK/COSC 3432 3.0

Format
Three lecture hours per week

COSC 3121 3.0

INTRODUCTION TO NUMERICAL COMPUTATIONS I

AN introductory course in computational linear algebra. Topics include simple error analysis, linear systems of equations, non-linear equations, linear least squares and interpolation.

Cross-listed to
AS/SC/MATH 3241 3.0.

Prerequisites
One of AK/AS/SC/COSC 1540 3.0, AK/AS/SC/COSC 2031 3.0, AK/COSC 3501 3.0; one of AS/SC/MATH 1010 3.0, AS/SC/MATH 1014 3.0, AS/SC/AK/MATH 1310 3.0; one of AS/SC/AK/MATH 1021 3.0, AS/SC/MATH 1025 3.0, AS/SC/MATH 2021 3.0, AS/SC/AK/MATH 2221 3.0.

Degree credit exclusions
AK/COSC 3511 3.0, AS/SC/MATH 3241 3.0.

COSC 3201 3.0

DIGITAL LOGIC DESIGN

Introduction to logic design. Analysis and design of combinatorial and sequential circuits. Standard MSI and LSI circuits, programmable logic device (PLD) and their use in the design of digital systems. Reliable design and fault detection. Laboratory experiments.

Prerequisites
General prerequisites, including AK/AS/SC/COSC 2021 3.0 or AK/COSC 3411 3.0 AS/AK/ITEC 2021 3.0.

Format
Three lecture hours per week

COSC 3211 3.0

DATA COMMUNICATION

This course covers, in some detail, the first three layers in the OSI computer communication model. It concentrates on the data link and network layers. Examples of local area networks and wide area networks are presented in detail.

Prerequisites
General prerequisites; including AS/SC/AK/MATH 2090 3.0, and AK/AS/SC/COSC 2021 3.0 or AK/COSC 3411 3.0 or AS/AK/ITEC 2021 3.0.

Degree credit exclusions
AK/AS/SC/COSC 3213 3.0, AK/COSC 3409A 3.0.

COSC 3213 3.0
COMPUTER NETWORKS I
This course is an introduction to communications and networking.

Prerequisites
COSC 2011; one of COSC 2001, COSC 2021, or COSC 2031; MATH 1013/1014; MATH 2090

Degree Credit Exclusions
COSC 3211 3.0, COSC 3212 3.0

Format
Three lecture hours per week

COSC 3215 3.0
MICROCOMPUTERS AND EMBEDDED SYSTEMS
Instruction sets, assembly language, implementation of simple controllers, bus signals and timing parameters, ROM and RAM memory system timing, I/O port address mapping techniques, handshake protocols, Interrupt system design, parallel and seriel interface. A/D and D/A converters.

Prerequisites
COSC 2011, COSC 2021, MATH 2090

Format
Three lecture hours and two laboratory hours per week

COSC 3221 3.0
OPERATING SYSTEM FUNDAMENTALS
Concurrent processes, CPU scheduling, deadlocks, memory management, file systems, protection and security, and case studies.

Prerequisites
COSC 2011; COSC 2021 or AK/COSC 3411 3.0 or AS/AK/ITEC 2021 3.0; AK/AS/SC/COSC 2031 3.0; MATH 1013/1014; MATH 2090

Degree credit exclusions
COSC 3321 3.0, AK/COSC 3470 3.0

Format
Three lecture hours per week

COSC 3311 3.0

SOFTWARE DESIGN

A study of design methods and their use in the correct implementation, maintenance and evolution of software systems. Topics include design, implementation, testing, documentation needs and standards, support tools. Students design and implement components of a software system.

Prerequisites
COSC 2011; MATH 2090; COSC 2001 or AK/COSC 3431 3.0; COSC 2031 3.0

Format
Three lecture hours per week

EATS 3020 3.0

GLOBAL GEOPHYSICS AND GEODESY

Global studies of the planet Earth: isostasy, seismic tomography, rotation, precession, nutation and wobble, the figure of the Earth, potential theory and the satellite geoid, normal gravity, tides in the solid Earth and oceans, geothermal heat flow and dynamics of the deep interior.
Content

- Earth structure overview.
- Isostasy and glacial rebound.
- Seismic tomography overview.
- Fourier series expansions - 1D and 2D.
- Laplace's equation in spherical coordinates.
- Spherical harmonics.
- Gravitational potential and reference geoid.
- Gravity anomalies and geoid height.
- Earth rotation, precession, nutation and wobble.
- Moments of inertia.
- Geothermal heat flow.

Prerequisites
EATS 2030.03; EATS 2470.04 or PHYS 2010.03; MATH 2015.03; MATH 2270.03; PHYS 2020.03.

Format
Three lecture hours per week.

EATS 3300 3.0

GEOGRAPHIC INFORMATION SYSTEMS (GIS) AND SPATIAL ANALYSIS OF THE PHYSICAL ENVIRONMENT

The fundamental concepts and techniques of GIS are presented along with a detailed discussion of computer implementation. The emphases include database management with SQL programming and map analysis/spatial modelling combined with 4GL programming. PC ArcView with Spatial Analyst, 3-D Analyst and Wofe extension GIS programs will be used for hands-on exercises.
Content

- Spatial and non-spatial data, data structure, data compression.
- Database management with SQL programming.
- Map projection and georeferencing.
- Basic concepts of image processing.
- Spatial analysis of maps with 4GL programming.
- Macro programming.
- Network applications and hydrological modelling.
- Weights of evidence modelling for mineral potential mapping.

Prerequisites
COSC 1540 3.0 or COSC 1030 3.0 or COSC 1520 3.0; MATH 2560 3.0 or GEOG 2420 3.0 or MATH 1131 3.0;

MATH 1025 3.0 or MATH 1013 3.0; one of EATS 1010 6.0, EATS 2030 3.0, AS/GEOG 1400 6.0, AK/GEOG 2510 6.0 or permission of the course instructor

Format
Two lecture hours and three laboratory hours per week.

EATS 3610 3.0

GEODETIC CONCEPTS

Microcomputer laboratory exercises including use of software for report preparation, spreadsheets for engineering computations, engineering calculation software, and data handling in C++.

EATS 3620 3.0

GEOMATICS NETWORKS

Uses of geomatics networks. Observational models. The datum for geomatics networks. Measures of precision of coordinates. Reliability, data snooping, variance component estimation. Global and local coordinate systems.

EATS 3630 3.0

GEOMATICS MODELLING METHODS

Geomatics engineering methodology and estimation. Classes of mathematical models. Least squares method: parametric, condition and combined cases. Problem formulation and solution: adjustment of observations; analysis of trend; problems with two random components; combination of mathematical models; problems with a prior knowledge of parameters; step-by-step methods. Univariate and multivariate statistical testing applied to geomatics engineering.

EATS 3640 3.0

HYDROGRAPHY

Elements of oceanography, tides and water levels, principle of underwater acoustics. Fundamental of RF and acoustic propagation. Marine positioning; shore-based and satellite-based radionavigation systems; optical methods, dead reckoning systems, underwater positioning, integrated positioning systems. Depth determination: shipborne echo-sounding and mechanical methods, airborne laser and electromagnetic methods, related corrections.

EATS 3650 3.0

ANALYTICAL PHOTOGRAMMETRY

Mathematical relationships between image and object space. Direct and inverse problems of projective and similarity coordinate transformation. Conditions of collinearity and coplanarity. Orientation procedures (Interior, Exterior, Relative and Absolute). Measurement and correction of image coordinates. Stereomodel formation and error analysis. Various mathematical models for analog, analytical, independent model, strip and block adjustments. Project planning.

EATS 3660 3.0

CADASTRAL SURVEYS AND LAND REGISTRATION SYSTEMS

The role of the professional land surveyor. The Dominion Lands Survey System and Land Surveys Acts and Regulations. Cadastral surveys, including surveys of Canada Lands for aboriginal land claims and coastal boundaries. Land registration systems in Eastern Canada.

ENG 3000 3.0
ORGANIZATION AND MANAGEMENT SEMINAR
A seminar course taught by guest speakers from industry, government and the university. Topics include: role and responsibility of professions from the historical, ethical, legal, organizational and economical perspectives, exploration of fundamentals of professional judgement and conduct, practice creation and management.

Degree Credit Exclusions
COSC 3001 1.0; COSC 3002 1.0; EATS 3001 1.0, PHYS 3001 1.0

Format
Two terms. One lecture hour per week.

MATH 3271 3.0
PARTIAL DIFFERENTIAL EQUATIONS
Partial differential equations of mathematical physics and their solutions in various coordinates, separation of variables in Cartesian coordinates, application of boundary conditions; Fourier series and eigenfunction expansions; generalized curvilinear coordinates; separation of variables in spherical and polar coordinates.

Other topics include orthogonal curvilinear coordinates and the grad, div, curl, and laplacian operators in these systems; the gamma function; and the cylindrical and spherical Bessel, Legendre, Laguerre, Hermite, Chebyshev, hypergeometric and confluent hypergeometric equations and functions and their properties. The final grade will be based on assignments, two tests, and a final examination.

Prerequisites
MATH 2270 3.0; one of MATH 2010 3.0, MATH 2015 3.0, MATH 2310 3.0; MATH 3010 3.0 is also desirable, though not essential, as prerequisite for students presenting AS/SC/MATH 2010 3.0 or AS/SC/AK/MATH 2310 3.0.

Format
Three lecture hours per week.

MATH 3410 3.0
COMPLEX VARIABLES
Analytic functions, the Cauchy-Riemann equations, complex integrals, the Cauchy integral theorem, maximum modulus theorem. Calculations of residues and applications to definite integrals, two-dimensional potential problems and conformal mappings.

Prerequisites
AS/SC/MATH 2010 3.0 or AS/SC/MATH 2015 3.0 or AS/SC/AK/MATH 2310 3.0. (AS/SC/AK/MATH 3010 3.0 is also recommended as a prerequisite for students who have taken AS/SC/MATH 2010 3.0.)

PHYS 3010 3.0
CLASSICAL MECHANICS
Intermediate classical mechanics, including dynamics of particles and systems of particles, Lagrange's equations and Hamilton's equations.

Prerequisites
EATS 2470 3.0; MATH 2015 3.0; MATH 2270 3.0

Format
Three lecture hours per week.

PHYS 3020 3.0

ELECTROMAGNETICS I

Vector calculus; electrostatic and magnetostatic fields, derived from charge and current distributions studied in vacuum and in material media.

Content

– Vector calculus in Cartesian, cylindrical and spherical co-ordinate systems
– Electrostatic fields from discrete and continuous charge distributions in vacuo
– Laplace's equation and selected techniques for calculating the electrostatic vector potential in vacuo and in linear dielectric materials
– Magnetostatic fields from line and distributed currents in vacuo
– Use of symmetry with Ampere's Law and Gauss' Law
– Electrostatic and magnetostatic fields in material media which are linear, isotropic, and homogeneous
– Interaction of matter with electrostatic and magnetostatic fields; electrostatic and magnetostatic dipole moments per unit volume and their effects on fields; ferromagnetism

Prerequisites
PHYS 2020 3.0; MATH 2015 3.0; MATH 2270 3.0

Prerequisite or Co-requisite
MATH 3271 3.0

Format
Three lecture hours per week.

PHYS 3030 3.0

STATISTICAL AND THERMAL PHYSICS

Statistical mechanics of systems of large numbers of elements; probability, ensembles, fluctuations; applications: spin magnetism, electrons in metals, radiation, specific heats of solids; transport theory.

Content

– Review of classical thermodynamics: three laws, specific heats, adiabatic processes, heat engines
– Quantum states of weakly interacting particles, Pauli exclusion principle
– Entropy and probability, Boltzmann's relation, two-level systems, Boltzmann distribution
– Distribution of quantum sates, subsystems and reservoirs, partition function, free energies, entropy of a two-level system, systems of harmonic oscillators, classical perfect gas, diatomic molecules
– Equipartition theorem, kinetic theory of gases, transport properties
– Planck radiation law, Bose and Fermi gases

Prerequisite
PHYS 2010 3.0; PHYS 2020 3.0

Degree Credit Exclusions
CHEM 4012 3.0, CHEM 4090 3.0

Format
Three lecture hours per week.

PHYS 3040 6.0

MODERN PHYSICS

Survey of the basis of contemporary physics: introduction to quantum theory of light, atoms, molecules, solids, nuclei, elementary wave mechanics and elementary particles.

Content

– Schrödinger equation; probability interpretation; stationary states; the 1D box; harmonic oscillator; eigenfunctions and eigenvalues; expectation values; barrier penetration; three-dimensional box

– 3D Schrödinger equation with central forces; angular momentum; hydrogen atom; dipole transitions; Stern-Gerlach experiment-Spin; spin-orbit interaction; many-electron atoms; exclusion principle; molecules; ionic bonding; Ro-Vib molecular spectra

– Selected topics from the following: Quantum statistics (Bose-Einstein+Fermi-Dirac); condensed matter physics; nuclear physics; particle physics

Prerequisites

PHYS 2010 3.0; PHYS 2020 3.0; PHYS 2040 3.0; PHYS 2211 1.0; MATH 2270 3.0

Co-requisite

Registration in MATH 3271 3.0 is suggested.

Format

Three lecture hours per week.

PHYS 3050 3.0

ELECTRONICS I

Introduction to physical electronics including DC and AC circuit theory and network analysis; circuit models/analysis for selected transformers; electron and semiconductor devices; introduction to DC power supplies (including CV/CC); analysis/design of basic amplifiers and oscillators; computer simulation/analysis of circuits. Laboratory exercises will allow experimental examination and verification of many aspects of the lecture material.

Content

– Electronic instruments and measurements
– DC and AC circuit analysis, filters
– Bandpass filters
– The p-n junction and diodes
– DC power supplies
– Transistors and basic amplifier circuits
– Introduction to operational amplifiers

Prerequisites

PHYS 2020 3.0; PHYS 2211 1.0

Format

Two lecture hours per week. Three laboratory hours per week.

PHYS 3150 3.0

ELECTRONICS II

Advanced circuit theory and analysis/design for semiconductor circuits, operational amplifier circuits, analogue and digital computation circuits, pulse circuits and circuits employing electronic devices of current interest; general feedback and noise theory; electronic circuit analysis/design using computer simulation.

Assigned laboratory exercises will be completed during the first part of the course. A laboratory project will be selected, in consultation with the course director, for the second part of the course. Typical project topics include analogue computers, op amp circuits, digital logic circuits, and microcomputer circuits.

Content

– Feedback principles

- Characteristics of operational amplifiers
- Operational amplifier circuits employing negative feedback
- Operational amplifier circuits employing positive feedback
- Basic digital concepts
- Basic digital logic circuits
- Analogue/Digital conversion
- Microcomputer fundamentals

Prerequisite
PHYS 3050 3.0

Format
Two lecture hours per week. Three laboratory hours per week.

PHYS 3210 6.0

EXPERIMENTAL PHYSICS

Experiments are performed in fluid mechanics, electromagnetism, optics, atomic and nuclear physics. Error analysis of the data and detailed write-ups of at least nine experiments are required. Students are required to present a seminar on a research topic to the class.

Prerequisites
PHYS 2211 1.0, PHYS 2212 1.0

Co-requisite
PHYS 3040 6.0

Degree Credit Exclusions
PHYS 3210 4.0, PHYS 3220 3.0

Format
One scheduled lecture/seminar hour per week and open laboratory hours.

PHYS 3250 3.0

INTRODUCTION TO SPACE COMMUNICATION

The course covers all fundamental aspects of communications between spacecraft and ground stations. Topics include orbits, perturbations and launching methods, the essential characteristics and components of satellites, interplanetary spacecraft and ground stations, transmission, reception and link equation and access to a satellite.
Content

- History and overview of present status
- Orbital aspects of satellite communications
- Spacecraft
- Earth station
- Communications link
- Modulation and multiplexing techniques
- Multiple access to a satellite

Prerequisite
PHYS 2020 3.0

Prerequisite or Co-requisite
PHYS 3050 3.0

Format
Three lecture hours per week.

PHYS 3280 3.0

PHYSICS OF THE SPACE ENVIRONMENT

(same as EATS 3280 3.0)
An introduction to the physical processes of the upper atmosphere, the ionosphere, the magnetosphere and the heliosphere, and the interactions that occur with space vehicles that traverse these regions of space.
Content
- Atmospheric structure and constitution particularly at spacecraft altitudes in the ionosphere, thermosphere and exosphere
- Essentials of solar physics
- Solar electromagnetic radiation
- Solar wind and its interactions with the terrestrial atmosphere
- Terrestrial magnetism
- Solar-terrestrial phenomena
- Magnetosphere

Prerequisites
PHYS 2020 3.0; PHYS 2040 3.0

Degree Credit Exclusion
EATS 3280 3.0

Format
Three lecture hours per week.

SENECA
FIELD SURVEYS

A two-week field camp will be held prior to the start of the Fall Session lectures. Field exercises include instrument familiarization, highway design and construction survey, boundary survey problems, astronomic azimuth, precise engineering survey, geodetic control survey, satellite survey. Emphasis is place on practical and professional experience and students participate in organizational, planning, scheduling and logistical aspects of field operations. In addition to group field reports on each exercises, each student is required to prepare a complete report on one selected major exercise.

Format
Two-weeks before fall term.

SENECA
PRINCIPLES OF LAW

Overview of the role and purpose of the Canadian legal system; the Canadian constitution; structure and operation of our civil courts; the establishment of law, including statutes and common law; impact of laws on individuals and business entities.

SENECA
LAND USE PLANNING

Subdivision planning. Land ethics. Sustainable development. Provincial and municipal requirements. Pattern usage design. Site assessments. Impact assessments.

Fourth Year Courses

EATS 4020 3.0

TIME SERIES AND SPECTRAL ANALYSIS

Treatment of discrete sampled data by linear optimum Wiener filtering, minimum error energy deconvolution, autocorrelation and spectral density estimation, discrete Fourier transforms and frequency domain filtering and the Fast Fourier Transform algorithm. Three lecture hours. One term. Three credits.

Cross-listed to
AS/SC/MATH 4830 3.0, SC/PHYS 4060 3.0.

Prerequisites
AK/AS/SC/COSC 1540 3.0 or equivalent FORTRAN programming experience; AS/SC/MATH 2015 3.0; AS/SC/AK/MATH 2270 3.0.

Degree credit exclusions
AK/AS/SC/COSC 4242 3.0, AK/AS/SC/COSC 4451 3.0, AS/SC/MATH 4130B 3.0, AS/SC/MATH 4830 3.0, AS/SC/MATH 4930C 3.0, SC/PHYS 4060 3.0.

Format
Three lecture hours per week.

EATS 4220 3.0

REMOTE SENSING OF THE EARTH'S SURFACE

The physical principles of remote sensing are presented along with detailed discussion of Earth-observing sensors which detect e.m. energy in the ultraviolet to microwave spectral regions. Both passive and active techniques are examined with application examples drawn from many of the disciplines associated with remote sensing of Earth resources. Laboratory experiments involve spectral reflectance measurements of typical natural surfaces, as well as digital image processing.
Content
– Physical Basis of Remote Sensing: Topics include the sun as a source, scattering and absorption effect of the atmosphere, spectral reflectance and emittance properties of natural surfaces, estimation of radiant flux received by a satellite sensor.
– Sensors: Topics include radiometric sensitivity, spectral sensitivity, noise considerations, image production by camera systems, line scanners, pushbroom imagers, imaging spectrometers.
– Image Processing: Topics include correction techniques, enhancement techniques and information extraction techniques.
– Interpretation: The basis whereby physical parameters of interest to Earth resources management can be measured directly or inferred from remote sensing data are discussed.
– Application Areas: Meteorology. Hydrology and water resources. Oceanography and marine resources. Vegetation and soil resources. Geology and mineral resources.

Prerequisite
PHYS 2020.03, or PHYS 2060.03, or both PHYS 2211.01 and PHYS 2212.01 or permission of the course director.

Format
Two lecture hours and three laboratory hours per week.

EATS 4400 3.0

GEOGRAPHICAL INFORMATION SYSTEMS (GIS) AND DATA INTEGRATION

Project-oriented Geomatics course using GIS systems and various techniques (map algebraic, statistical, fuzzy logic, AI, and Fractal/multifractal) for integrating diverse dataset (geographic, geological, geophysical, geochemical, hydrological, remote sensing and GPS). It starts with the fundamental concepts and techniques of GIS along with a detailed discussion of computer implementation. The emphases include database management and map analysis/spatial modelling with Macro Language Programming. UNIX ARC/INFO GIS program is used for hands-on exercises.
Content
– Introduction to Geomatics.
– Spatial data, data structure and database management.
– Data collection, data conversion and data transformation.

– Georeferencing and GPS.
– Spatial statistical analysis for vector and raster data.
– Diverse data integration.
– Spatial modelling and prediction.
– Macro programming (AML).
– Application examples include mineral potential mapping, hydrological modelling, stream network analysis, and environmental planning.

Prerequisite
EATS 3300 3.0 or AS/GEOG 3180 3.0 or AS/GEOG 4340 3.0 or EN/ENVS 3520 3.0 or EN/ENVS 4520 3.0 or permission of the instructor.

Format
Two lecture hours and two laboratory hours per week.

EATS 4610 3.0
SATELLITE POSITIONING
Description of GPS signal structure and derivation of observables. Characteristics of instrumentation. Analysis of atmospheric, orbital and other random and non-random effects. Derivation of mathematical models used for absolute and differential static and kinematic positioning. Pre-analysis methods and applications. Software considerations. Introduction to GPS quality control. Static and kinematic survey procedures and operational aspects. Introduction to integrated GPS-INS systems.

Format
Three lecture hours per week.

EATS 4620 3.0
GEODETIC POSITIONING
Static and kinematic positioning methodology on the surface of the Earth and in space. Review of reference systems, measurement and observables, the modelling process. Static positioning on the surface of the Earth; the direct and inverse geodetic problems in three-dimensional space, on the ellipsoid and in the conformal mapping plane. Kinematic positioning using inertial techniques; the state vector model and the initial value problem. Static and kinematic positioning to extraterrestrial targets, including astronomic positioning using stars and quasar sources (VLBI), satellite ranging using Doppler, microwave ranging, laser ranging, and satellite altimetry. Static and kinematic satellite positioning using GPS; point positioning models and differential positioning models (DGPS). The future of positioning; GPS/INS integration and multi-sensor systems.

Format
Three lecture hours per week.

EATS 4630 3.0
HIGH PRECISION SURVEYS
Instrument systems and procedures for high-precision surveys; precise levels, high-precision theodolites, electronic distance measurement instruments. High-precision industrial surveys: computation of three-dimensional orientations and rotations by autoreflection and autocollimation; computation of three-dimensional coordinates and coordinate changes by theodolite intersection methods, total station methods, scale bar on target methods, digital camera methods, laser scanner methods, systematic errors and their control; geometric form fitting.

Format
Three lecture hours per week.

EATS 4640 3.0

Digital Terrain Models and Their Applications

Digital Terrain Modelling (DTM, DEM, DHM, DTEM) concepts and their implementation and applications in geomatics engineering and other disciplines. Emphasis will be on mathematical techniques used in the acquisition (e.g photogrammetric data capture, digitized cartographic data sources capturing, other methods: IFSAR and laser altimeters), processing, storage, manipulation and applications of DTM. Models of DTM (Grids, Contours, and TINS). Surface representation from point data using moving averages, linear projection and Kriging techniques. Grid resampling methods and search algorithms used in gridding and interpolation. DTM derivates (slope maps, aspect maps, viewsheds and watershed). Applications of DTM in volume computation, orthophotos and drainage networks.

Format
Three lecture hours per week.

EATS 4650 3.0

Digital Imaging and Applications

An introduction to digital imaging from remote platforms. Course includes a brief review of optical, infrared and microwave imaging systems. Introduction to digital image data. Introduction to image processing and analysis, including radiometric and geometric corrections, radiometric and geometric enhancements, multispectral transformations and classification.

Format
Three lecture hours per week.

ENG 4000 6.0

Engineering Project

Individual projects will be assigned by mutual agreement between the student and a faculty member. The work may be done under supervision by the faculty member, or under supervision of an industrial associate to that faculty member. The projects will be self-contained problems of a design nature, and will be pursued in the manner of a engineering project. Thus, the first step to define the requirements of the design, the second to carry out a review of previous work, and the third to execute the design. Following that, the design shall be tested, normally through simulation and conclusions drawn. A report of professional quality shall be written and submitted.

Format
Ten hours per week, either three half-days per week in a university setting, or one day per week in an industrial environment.

PHYS 4010 3.0
QUANTUM MECHANICS
Physical concepts and applications of non-relativistic quantum mechanics: Schrödinger, Heisenberg and Dirac formalisms; applications to nuclear, atomic, molecular and solid-state physics, elementary scattering theory and radiation theory.
Content
– A free particle in QM: in an infinite vs. finite volume (continuous vs. discrete spectra)
– The momentum space formulation of QM: Dirac notation, Fourier transform, change of representation, representation-free Schrödinger equation (SE), interpretation
– The time-dependent SE: free wavepackets, dispersion; interpretation
– Approximation methods for bound states: matrix representation of QM; Rayleigh-Ritzv variational method; Matrix diagonalization; perturbation theory
– The semiclassic limit of QM: equations of motion for observables; Ehrenfest's theorems; commutation relations and conservation laws
– Angular momentum algebra; deriving the properties of angular momentum from the Crs; raising/lowering operators; spin; the Pauli and Schrödinger-Pauli equations; spin-orbit coupling; angular momentum coupling: calculation of Clebsch-Gordon coefficients
– Relativistic QM: the Klein-Gordon and Dirac equations; free particle solutions; numerical solution of the radial equation for the Dirac-H atom (no derivation); scattering theory will be covered: partial wave expansion for potential scattering, attractive/repulsive spherical potential well; high energy approximation, application to atomic scattering

Prerequisite
PHYS 3040 6.0

Prerequisites or Co-requisites
PHYS 3020 3.0; MATH 3271 3.0

Format
Three lecture hours per week.

PHYS 4020 3.0
ELECTROMAGNETICS II
Time-dependent electric and magnetic fields, Maxwell's differential equations in linear, isotropic, homogeneous conductors and dielectrics; the radiation and transmission of electromagnetic energy; relativistic transformation; scalar diffraction theory.
Content
– Guided Waves: Rectangular wave guides; transmission lines, optical fibres
– Radiation: Retarded time; electric dipole radiation; magnetic dipole radiation; antennas; Lienard-Wiechert Potentials; Bremstrahlung
– Relativity: Review of relativistic mechanics; covariance, 4-vector, Lorentz invariant; electromagnetic field and energy momentum tensors; transformation of tensors
– Scalar Diffraction Theory: Fresnel and Frauhofer diffraction

Prerequisites
PHYS 3020 3.0, MATH 3271 3.0

Format
Three lecture hours per week.

PHYS 4050 3.0

SOLID STATE PHYSICS

The structural, mechanical, thermal, electrical and magnetic properties of crystalline solids are studied.
Content
– Molecular forces and interatomic bonding.
– Crystal structure, diffraction and the reciprocal lattice.
– Elastic constants and elastic waves: continuum approach.
– Phonon and lattice vibrations: monatomic and diatomic lattices; local phonon modes; thermal properties of insulators; lattice specific heat, thermal conductivity; thermal expansion.
– Free electron theory of metals: Fermi surface; Fermi-Dirac distribution function; specific heat of metals; electrical conductivity; thermal conductivity; band theory of solids: Kronig-Penny model; effective mass; conductors, insulators, semi-metals, and semi-conductors; holes; magnetic properties.
– Superconductivity: BCS theory (Introduction only).

Prerequisites
PHYS 3030 3.0, PHYS 4010 3.0 or PHYS 4010 6.0

Format
Three lecture hours per week.

PHYS 4060 3.0

TIME SERIES AND SPECTRAL ANALYSIS

(same as EATS 4020 3.0 and MATH 4830 3.0)
Treatment of discrete sampled data by linear optimum Wiener filtering, minimum error energy deconvolution, auto-correlation and spectral density estimation, discrete Fourier transforms and frequency domain filtering and the Fast Fourier Transform algorithm.
Content
– Discrete, Equispaced Time Series
Power and energy signals, wavelets; convolution and the z-transform; expected value, autocorrelation and cross correlation; impulse, white noise and Wold decomposition; time reversal; properties of wavelets; linear, optimum filtering; deconvolution, shaping and spiking filters.
– Fourier Methods
Finite Fourier transform; Fourier transform effects of sampling and record length; digital frequency filtering; the power spectrum; fast Fourier transform.

Prerequisites
COSC 1540 3.0 or equivalent FORTRAN programming experience; MATH 2015 3.0; MATH 2270 3.0

Degree Credit Exclusions
EATS 4020 3.0, COSC 4242 3.0, MATH 4130B 3.0, MATH 4830 3.0, MATH 4930C 3.0

Format
Three lecture hours per week.

PHYS 4110 3.0

DYNAMICS OF SPACE VEHICLES

The dynamics of spacecraft in the near Earth and deep space environments, including the classical theory of orbits, the effects of perturbations on satellite orbits, aerodynamic and electromagnetic drag effects, rocket propulsion, orbital manoeuvres, and methods of satellite stabilization.
Content
– Review of basic astronomy, the two body problem
– Geometrical expression of the orbit, barycentric orbits
– Kepler's equation and methods of solution
– Hyperbolic orbits
– Co-ordinate transformations and orbital elements

- Orbital dynamics in rotating frames of reference
- Orbital perturbation theory
- Orbital perturbations due to disturbing "third" bodies
- Spherical harmonic expansions of gravity fields
- Orbital perturbations due to complex gravity fields
- Rocket propulsion
- Launch windows and orbital insertion
- Orbital manoeuvres: rendezvous and interception
- Docking manoeuvres
- Low thrust orbital manoeuvres s
- Tethered satellite systems
- Inter-planetary missions
- Euler's equations and the dynamics of rotating bodies
- Attitude control systems
- Axis-symmetric, torque-free satellites
- Gravity gradient torques
- Stability analysis in attitude control
- The problem of mis-aligned thrust

Prerequisites
PHYS 2010 3.0 or EATS 2470 4.0, MATH 2015 3.0; MATH 2270 3.0, MATH 3271 3.0 strongly recommended.

Format
Three lecture hours per week.

PHYS 4211 3.0

EXPERIMENTAL PHYSICS

Advanced experiments in physics related to topics in solid state physics, optical and microwave spectroscopy, and nuclear physics.

Prerequisite
PHYS 3210 6.0

Format
Six open laboratory hours for one term.

PHYS 4250 3.0

SIGNAL AND COMMUNICATIONS THEORY

Signal representation using orthogonal functions; Fourier series and transforms as applied to signals; ideal and physically realizable filters; the sampling theorem; definitions and characterizations of energy, power and their spectral densities; the modulation theorem; various kinds of modulation and bandwidth requirements.
Content
- Fourier series and transforms
- Linear systems, convolution and filtering
- Modulation

Prerequisites
PHYS 3250 3.0; MATH 2015 3.0; MATH 2270 3.0

Degree Credit Exclusion
MATH 4130B 3.0

Format
Three lecture hours per week.

PHYS 4350 3.0

HARDWARE FOR SPACE COMMUNICATIONS

The fundamentals, design, implementation and performance of hardware systems used for data/voice space communications are covered in detail.

Prerequisites
PHYS 3050 3.0; PHYS 3250 3.0; COSC 3211 3.0; MATH 2015 3.0; MATH 2270 3.0

Format
Three lecture hours per week.

PHYS 4450 3.0

SPACECRAFT SYSTEMS

This course begins with a presentation of the basic principles underlying the design of spacecraft systems to meet the requirements of an orbital environment. It then develops the concepts and current approaches to spacecraft electrical, mechanical and thermal design.

Prerequisites
PHYS 3050 3.0, PHYS 3250 3.0, PHYS 3280 3.0 or EATS 3280 3.0

Format
Three lecture hours per week.

PHYS 4550 3.0

INTRODUCTION TO CONTROL SYSTEMS

An introduction to the analysis and design of automatic control systems for linear time-invariant systems.

Prerequisites
MATH 2015 3.0; MATH 2270 3.0; MATH 3410 3.0 strongly recommended.

Format
Three lecture hours per week.

SENECA
ADVANCED SURVEYING FIELD CAMP

A two-week field camp will be held prior to the start of the Fall Session lectures.

SENECA
ENVIRONMENTAL MODELLING

A technical appreciation of environmental modelling. Mathematical models for the modelling of ecosystem parameters. Numerical soil-vegetation-atmosphere transfer (SAT) models. Integration of field derived data with remotely sensed data for quantitative modelling for larger scale environmental systems. Spatial and spatial-frequency analyses.

SENECA
SURVEY LAW/REAL PROPERTY

Real property; land parcels and property rights; survey systems; Crown lands; grants and surveys.

SENECA
SURVEY LAW II/PARCELS, RECORDS AND BOUNDARIES

Creation of boundaries; principles of evidence; Estoppel Adverse possession; natural boundaries; description of lands.