Mount Allison University
Mathematics and Computer Science Society

Mathematics and Computer Science Degree Mapping

Based on the Academic Calendar of 2018-2019
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Bachelor of Science Degree Requirements

A minimum of 72 credits in Science must be earned from the Science disciplines.

A minimum of 30 credits in Science must be earned from the 3000 and/or 4000 level. At least 24 credits must be from Mount Allison courses.

The credits required for a B.Sc. include those required for a Major, plus the credits required for a Minor from any other program. **No more than 9 credits can be counted in common between the Major and Minor.** Where there are more than 9 credits of requirements in common, the credit value of the combined program will still be at least 15 credits greater than the total for the Major. The Major and Minor are recorded on the student's transcript. Although the combination of a Major and a Minor is the usual means of achieving a B.Sc., other combinations are possible, as outlined in sections 11.3.7 through 11.3.10 in the Academic Calendar.

Distribution Requirements are outlined on Slide 5.
Bachelor of Arts Degree Requirements

A minimum of 36 credits must be earned from courses at the 3000 and/or 4000 level. At least 30 credits must be from Mount Allison courses.

The credits required for a B.A. include those required for a Major, plus the credits required for a Minor from any other program. **No more than 9 credits can be counted in common between the Major and Minor.** Where there are more than 9 credits of requirements in common, the credit value of the combined program will still be at least 15 credits greater than the total for the Major. The Major and Minor are recorded on the student's transcript. Although the combination of a Major and a Minor as called for in 11.2.4 is the usual means of achieving a B.A. degree, other combinations are possible, as outlined in sections 11.2.5 through 11.2.8 in the Academic Calendar.

Distribution Requirements are outlined on Slide 5.
Distribution Requirements

Distribution requirements must be earned as follows:

1. Six credits must be earned from each of the four main distribution areas. Sub-categories and their descriptions are provided to guide choice and assist students in selecting courses. Selecting courses from different sub-categories within each of the main categories is recommended but not required. Courses that are listed in more than one sub-category under a main distribution area can only be counted once within that distribution area.

2. Only one course (3 credits) from a single discipline (subject area/course code) may be used to fulfill distribution requirements.

3. Courses that may be used to satisfy distribution requirements are identified both in the lists here and in course descriptions contained in Section 12 of this calendar (Programs and Courses of Instruction). Exceptions, including 1991 courses and non-designated 1000 level transfer credits, may be approved by a Dean in consultation with the appropriate Department.
Arts (6 credits required)

Arts and Literature. These courses involve analysis and appreciation of creative expression (literary texts, visual and performing arts, musical compositions) and the insight these give into human societies both past and present. They either emphasize critical and analytical approaches to artistic expression, or they engage students in creative practices.

CANA 1001
DRAM 1701 * see note below
ENGL 1111, 1121, 1501, 1801 * see note below
FINH 2101
FREN 1801, 2801
GERM 2701, 2811
SPAN 1801, 1811
MUSC 2001, 2011, 2021

Language and Culture. These courses involve the study of language and learning a foreign language or culture, which enable students to gain insight into the many intersections between language and culture. Note: if a student is placed in a language course at a higher level than the course listed for distribution, the course at the higher level may be counted for distribution.

FREN 1651, 1811, 2841
GERM 1001
GREK 1001
JAPA 1001
LATI 1001
LING 2001
SPAN 1101, 1801, 1811

*DRAM/ENDL cross-listed courses (DRAM 1701) may not be used for distribution in combination with other English courses (ENGL 1111, 1121, 1501, 1801).
Humanities (6 credits required)

**Belief, Thought, and Meaning.** These courses examine aspects of philosophical, social, and religious systems, ideologies, and traditions. They allow students to explore and understand the ways in which value systems, and ethical thought interact with and shape systems of meaning, cultures, and everyday cultural practices.

CLAS 1641, 1651 * see note below
PHIL 1600 series
RELG 1600 series, 2401, 2801, 2811, 2831, 2841

**Legacies of the Past.** These courses study past cultures and societies, their economic, political, and social development over time, as well as human responses to change. Some focus on certain historical periods, while others examine the processes of change over time from a comparative perspective.

CLAS 1631, 2021, 2501 * see note below
HIST 1600 series, 2001, 2011, 2031, 2041, 2411, 2421, 2511, 2731, 2741 * see note below

*CLAS/HIST cross-listed courses (CLAS/HIST 1631 and 2021) may not be used for distribution in combination with other Classics or History courses.
Natural Science (6 credits required)

**Living World.** These courses introduce the study of the living world through observation and experimentation. They employ scientific methods to investigate questions and concepts encountered in the life sciences.

- BIOC 1001
- BIOL 1201
- PHYS 1021
- PSYC 1001

**Physical World.** These courses introduce the study of the physical world and non-living materials. They explore the laws governing its processes and phenomena as well as the methods used in its investigation.

- CHEM 1001
- GENS 1401
- PHYS 1021, 1031, 1041, 1051, 1401

**Analytic and Quantitative Reasoning.** These courses involve analytic reasoning and might include the study of abstract structures or the analysis and interpretation of quantitative and categorical information. They often introduce methods of problem solving and logical thinking in approaching these types of information.

- COMP 1631
- MATH 1111, 1151, 1251, 2311
- PHIL 2611
- PHYS 1041, 1051
Social World (6 credits required)

**Diversity and Identity.** These courses consider aspects of human behaviour and interaction, social institutions, and cultural norms and encompass such themes as diversity and identity.

- ANTH 1011
- SOCI 1001
- WGST 1001

**Citizenship, Power and Politics.** These courses consider aspects of social institutions as they inform such themes as citizenship, power and politics.

- ANTH 1011
- POLS 1001
- CANA 1001
- SOCI 1001

**Humanity, Nature, and the Economy.** These courses consider aspects of human behaviour and interaction, social institutions, and how they impact nature and the economy.

- ANTH 1011
- ECON 1001, 1011
- GENV 1201, 2001
- SOCI 1001
Mathematics Degree Maps

Bachelor of Arts Honours in Mathematics
Bachelor of Science Honours in Mathematics
Bachelor of Arts Major in Mathematics
Bachelor of Science Major in Mathematics
Bachelor of Arts or Science Minor in Mathematics
Bachelor of Arts Honours in Mathematics

Complete by the end of First Year

Complete by the end of Second Year

Complete by the end of Third Year / Fourth Year

*Strong students are encouraged to take MATH 2221 in their first year.

6 credits from the following:
- MATH 3011 Set Thry, Logic
- MATH 4111 Topology
- MATH 4121 Real Analysis II
- MATH 4221 Modern Alg. II
- MATH 4311 Prob & Stats II
- MATH 4951 Ind. Study
- MATH 4991 Special Topic

3 credits from the following:
- MATH 3111 Real Analysis I
- MATH 3211 Modern Alg. I
- MATH 3311 Prob & Stats I
- MATH 3411 Numerical

Complete by the end of First Year

Complete by the end of Second Year

Complete by the end of Third Year / Fourth Year

6 credits from Mathematics or Computer Science at the 3000/4000 level

21 credits from Mathematics at the 3000/4000 level

6 credits from the following:
- Computer Science, Economics, or Mathematics at the 2000 level or above,
  or from COMM 3411, LING 2001, LING 3001, PHIL 2611, PHIL 3631

6 credits from the following:
- MATH 2211 Discrete Str.
- MATH 2221 Linear Algebra*
- MATH 2111 Multi Calculus
- MATH 2121 DEs I
- MATH 3111 Real Analysis I
- MATH 3211 Modern Alg. I
- MATH 3311 Prob & Stats I
- MATH 3411 Numerical
- MATH 3011 Set Thry, Logic
- MATH 4111 Topology
- MATH 4121 Real Analysis II
- MATH 4221 Modern Alg. II
- MATH 4311 Prob & Stats II
- MATH 4951 Ind. Study
- MATH 4991 Special Topic

21 credits from Mathematics at the 3000/4000 level

6 credits from Mathematics or Computer Science at the 3000/4000 level

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*Strong students are encouraged to take MATH 2221 in their first year.
Bachelor of Science Honours in Mathematics

- **3 credits** from the following:
  - MATH 1111 Calculus I
  - MATH 1121 Calculus II
  - MATH 1111 Calculus I
  - MATH 1121 Calculus II
  - MATH 2111 Multi Calculus
  - MATH 2121 DEs I
  - MATH 2211 Discrete Str.
  - MATH 2221 Linear Algebra*
  - MATH 2221 Linear Algebra*
  - MATH 2111 Multi Calculus
  - MATH 2121 DEs I
  - MATH 2211 Discrete Str.
  - MATH 2221 Linear Algebra*

- **6 credits** from the following:
  - MATH 3111 Real Analysis I
  - MATH 3211 Modern Alg. I
  - MATH 3311 Prob & Stats I
  - MATH 3411 Numerical

- **6 credits** from the following:
  - MATH 3011 Set Thry, Logic
  - MATH 4111 Topology
  - MATH 4121 Real Analysis II
  - MATH 4211 Modern Alg. II
  - MATH 4311 Prob & Stats II
  - MATH 4951 Ind. Study
  - MATH 4991 Special Topic

- **9 credits** from the following:
  - CHEM 1001 Intro Chem I
  - CHEM 1021 Intro Chem II
  - PHYS 1051 General Phys I
  - PHYS 1551 General Phys II
  - COMP 1631 Intro to CS
  - COMP 1731 Prog Tech + Alg

- **21 credits** from Mathematics at the 3000/4000 level

- **21 credits** from Mathematics or Computer Science at the 3000/4000 level

- **9 credits** from the following:
  - BIOL 1001, BIOL 1501, BIOC 1001, GENS 1401, PSYC 1001, PSYC 1011

*Strong students are encouraged to take MATH 2221 in their first year.
Bachelor of Arts Major in Mathematics

3 credits from the following:
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 2111 Multi Calculus
- MATH 2211 Discrete Str.
- MATH 2221 Linear Algebra*

3 credits from the following:
- MATH 2121 DEs I
- MATH 2211 Discrete Str.
- MATH 2221 Linear Algebra*
- MATH 2311 Statistics I
- COMP 1631 Intro to CS
- COMP 1731 Prog Tech + Alg

3 credits from the following:
- MATH 3111 Set Thry Logic
- MATH 3211 Modern Alg. I
- MATH 3221 Adv. Linear Alg.
- MATH 3231 Number Theory
- MATH 3241 Numerical
- MATH 3411 Vector Calculus
- MATH 3511 Complex Var.

3 credits from the following:
- MATH 3121 Real Analysis I
- MATH 3141 Vector Calculus
- MATH 3151 Complex Var.
- MATH 3161 Complex Var.

12 credits from complementary disciplines chosen in consultation with the Program Advisor

15 credits from Mathematics at the 3000/4000 level

Complete by the end of First Year
Complete by the end of Second Year
Complete by the end of Third Year / Fourth Year

*Strong students are encouraged to take MATH 2221 in their first year.
Bachelor of Science Major in Mathematics

**9 credits** from the following:
- CHEM 1001 Intro Chem I
- CHEM 1021 Intro Chem II
- PHYS 1051 General Phys I
- PHYS 1551 General Phys II
- COMP 1631 Intro to CS

**3 credits** from the following:
- MATH 2211 Discrete Str.
- MATH 2221 Linear Algebra*
- MATH 2111 Multi Calculus
- MATH 2121 DEs I
- MATH 2211 Discrete Str.
- MATH 2221 Linear Algebra*
- MATH 2111 Multi Calculus
- MATH 2121 DEs I

**3 credits** from the following:
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 2111 Multi Calculus
- MATH 2121 DEs I

**15 credits** from the following:
- MATH 3111 Real Analysis I
- MATH 3141 Vector Calculus
- MATH 3161 Complex Var.

**3 credits** from Mathematics at the 3000/4000 level

**14 credits** recommended prerequisite

**Complete by the end of First Year**

**Complete by the end of Second Year**

**Complete by the end of Third Year / Fourth Year**

*Strong students are encouraged to take MATH 2221 in their first year.*
Bachelor of Arts or Science Minor in Mathematics

12 credits from the following:

- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 2111 Multi Calculus
- MATH 2121 DEs I
- MATH 2211 Discrete Str.
- MATH 2221 Linear Algebra*
- MATH 2311 Statistics I
- MATH 2321 Statistics II

6 credits from Mathematics at the 3000/4000 level

*Strong students are encouraged to take MATH 2221 in their first year.
Computer Science Degree Maps

Bachelor of Arts Honours in Computer Science
Bachelor of Science Honours in Computer Science
Bachelor of Arts Major in Computer Science
Bachelor of Science Major in Computer Science
Bachelor of Arts or Science Minor in Computer Science
Bachelor of Arts Honours in Computer Science

3 credits from the following:
- MATH 2311 Statistics I
- COMP 2211 Discrete Str

3 credits from the following:
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 2221 Linear Algebra*

12 credits from Computer Science at the 3000/4000 level
- COMP 1631 Intro to CS
- COMP 1731 Prog Tech + Alg
- COMP 2211 Discrete Str
- COMP 2611 Data Str + Alg I
- COMP 2931 Intro Sys Prog
- COMP 2631 Data Str + Alg II
- COMP 2731 Data Str + Alg III
- COMP 3131 Obj Oriented
- COMP 3631 Alg Analysis
- COMP 3911 Operating Sys
- COMP 3971 Org + Arch

6 credits from Mathematics or Computer Science at the 3000/4000 level
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 2221 Linear Algebra*

9 credits from complementary courses in Arts and Letters, Humanities, and Social Sciences chosen in consultation with the Program Advisor

3rd year standing

Complete by the end of First Year
Complete by the end of Second Year
Complete by the end of Third Year / Fourth Year

*Strong students are encouraged to take MATH 2221 in their first year.
Bachelor of Science Honours in Computer Science

**6 credits from the following:**
- CHEM 1001 Intro Chem I
- PHYS 1051 General Phys I
- PHYS 1551 General Phys II

**3 credits from the following:**
- BIOL 1001, BIOL 1501, BIOC 1001, GENS 1401, PSYC 1001, PSYC 1011

**12 credits from Computer Science at the 3000/4000 level**

**Complete by the end of First Year**
- COMP 1631 Intro to CS
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 2311 Statistics I

**Complete by the end of Second Year**
- COMP 2211 Discrete Str
- MATH 2221 Linear Algebra*
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 1731 Prog Tech + Alg
- COMP 2931 Intro Sys Prog

**Complete by the end of Third Year / Fourth Year**
- 3rd year standing
- COMP 3611 Alg Analysis
- COMP 3721 Obj Oriented
- COMP 3911 Operating Sys
- COMP 3971 Org + Arch
- COMP 3361 Digital Sig Proc
- COMP 4721 SW Design
- COMP 3990 Honours Thesis

3 credits from the following:
- COMP 3971 Org + Arch
- COMP 3361 Digital Sig Proc

*Strong students are encouraged to take MATH 2221 in their first year.
Bachelor of Arts Major in Computer Science

3 credits from the following:
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 2311 Statistics I

3 credits from Computer Science at the 3000/4000 level
- COMP 1631 Intro to CS
- COMP 2211 Discrete Str
- MATH 2221 Linear Algebra*
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 2931 Intro Sys Prog
- COMP 1731 Prog Tech + Alg
- MATH 1121 Calculus II
- MATH 2311 Statistics I

3 credits from the following:
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 2931 Intro Sys Prog
- COMP 1731 Prog Tech + Alg
- MATH 2221 Linear Algebra*
- COMP 2211 Discrete Str
- MATH 1121 Calculus II
- MATH 2311 Statistics I

3 credits from Computer Science at the 3000/4000 level
- COMP 1631 Intro to CS
- COMP 2211 Discrete Str
- MATH 2221 Linear Algebra*
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 2931 Intro Sys Prog
- COMP 1731 Prog Tech + Alg
- MATH 1121 Calculus II
- MATH 2311 Statistics I
- COMP 2211 Discrete Str
- MATH 2221 Linear Algebra*
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 2931 Intro Sys Prog
- COMP 1731 Prog Tech + Alg
- MATH 1121 Calculus II
- MATH 2311 Statistics I

3 credits from Computer Science at the 3000/4000 level
- COMP 1631 Intro to CS
- COMP 2211 Discrete Str
- MATH 2221 Linear Algebra*
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 2931 Intro Sys Prog
- COMP 1731 Prog Tech + Alg
- MATH 1121 Calculus II
- MATH 2311 Statistics I
- COMP 2211 Discrete Str
- MATH 2221 Linear Algebra*
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 2931 Intro Sys Prog
- COMP 1731 Prog Tech + Alg
- MATH 1121 Calculus II
- MATH 2311 Statistics I

9 credits from complementary courses in Arts and Letters, Humanities, and Social Sciences chosen in consultation with the Program Advisor

9 credits from Computer Science at the 3000/4000 level

Complete by the end of First Year

Complete by the end of Second Year

Complete by the end of Third Year / Fourth Year

required prerequisite

not required for degree

required for degree

*Strong students are encouraged to take MATH 2221 in their first year.
Bachelor of Science Major in Computer Science

MATH 1111 Calculus I
MATH 1121 Calculus II
MATH 2311 Statistics I

COMP 1631 Intro to CS

COMP 2211 Discrete Str
MATH 2221 Linear Algebra*

COMP 2611 Data Str + Alg I
COMP 2631 Data Str + Alg II

COMP 1731 Prog Tech + Alg
COMP 2931 Intro Sys Prog

COMP 3611 Alg Analysis
COMP 3721 Obj Oriented
COMP 3911 Operating Sys
COMP 4721 SW Design

3 credits from the following:
COMP 3971 Org + Arch
COMP 3361 Digital Sig Proc

3rd year standing

Complete by the end of First Year
Complete by the end of Second Year
Complete by the end of Third Year / Fourth Year

required prerequisite

MATH 1111 Calculus I
MATH 1121 Calculus II
MATH 2311 Statistics I

CHEM 1001 Intro Chem I
PHYS 1051 General Phys I
PHYS 1551 General Phys II

6 credits from the following:

PHYS 1051 General Phys I
PHYS 1551 General Phys II

PHYS 1051 General Phys I
PHYS 1551 General Phys II

3 credits from the following:
BIOL 1001, BIOL 1501, BIOC 1001, GENS 1401, PSYC 1001, PSYC 1011

20 credits

9 credits from Computer Science
at the 3000/4000 level

*Strong students are encouraged to take MATH 2221 in their first year.
Bachelor of Arts or Science Minor in Computer Science

6 credits from the following:

COMP 1631 Intro to CS
COMP 1731 Prog Tech + Alg
COMP 2611 Data Str + Alg I
COMP 2631 Data Str + Alg II
COMP 2931 Intro Sys Prog
COMP 2211 Discrete Str

6 credits from Computer Science at the 3000/4000 level

Complete by the end of First Year
Complete by the end of Second Year
Complete by the end of Third Year / Fourth Year

required prerequisite
Mathematics and Computer Science Degree Maps

Bachelor of Arts Joint Honours in Mathematics and Computer Science
Bachelor of Science Joint Honours in Mathematics and Computer Science
Bachelor of Science Joint Honours in Mathematics and Computer Science

3 credits from the following:
- MATH 3011 Set Thry, Logic
- MATH 3221 Adv Linear Alg
- MATH 3231 Number Theory
- MATH 3251 Graph Theory
- MATH 4221 Modern Alg. II
- MATH 3211 Modern Alg. I
- MATH 3111 Real Analysis I
- MATH 3311 Prob & Stats I

3 credits from the following:
- BIOL 1001
- BIOL 1501
- BIOC 1001
- GENS 1401
- PSYC 1001
- PSYC 1011

Complete by the end of Second Year

3 credits from the following:
- COMP 3721 Obj Oriented
- COMP 3911 Operating Sys
- COMP 4721 SW Design

9 credits from the following:
- PHYS 1051 General Phys I
- PHYS 1551 General Phys II
- CHEM 1001 Intro Chem I
- CHEM 1021 Intro Chem II

Complete by the end of First Year

3 credits from the following:
- COMP 3971 Org + Arch
- COMP 3361 Digital Sig Proc

Complete by the end of Third Year / Fourth Year

6 credits from Mathematics or Computer Science at the 3000/4000 level
- MATH 2111 Multi Calculus
- MATH 2211 Discrete Str
- MATH 2221 Calculus II
- MATH 2221 Linear Algebra
- MATH 3411 Num Analysis
- MATH 3211 Linear Algebra*

12 credits from Computer Science at the 3000/4000 level
- COMP 2211 Discrete Str
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 1631 Intro to CS
- COMP 3411 Num Analysis
- COMP 3211 Calculus I

Complete by the end of Second Year

3 credits from COMP

Complete by the end of Third Year / Fourth Year

3 credits from the following:
- COMP 1631 Intro to CS
- COMP 2631 Data Str + Alg II
- COMP 2211 Discrete Str

6 credits from Mathematics or Computer Science at the 3000/4000 level
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 1111 Calculus I
- MATH 1121 Calculus II

12 credits from Computer Science at the 3000/4000 level
- COMP 2211 Discrete Str
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 1631 Intro to CS
- COMP 3411 Num Analysis
- COMP 3211 Calculus I

Complete by the end of Third Year / Fourth Year

3 credits from the following:
- COMP 3971 Org + Arch
- COMP 3361 Digital Sig Proc

Complete by the end of Third Year / Fourth Year

3 credits from the following:
- COMP 3721 Obj Oriented
- COMP 3911 Operating Sys
- COMP 4721 SW Design

3rd year standing

*Strong students are encouraged to take MATH 2221 in their first year.
Bachelor of Arts Joint Honours in Mathematics and Computer Science

3 credits from the following:
- MATH 3011 Set Thry, Logic
- MATH 3221 Adv Linear Alg
- MATH 3231 Number Theory
- MATH 3251 Graph Theory
- MATH 4221 Modern Alg. II

MATH 3211 Modern Alg. I
- MATH 2211 Discrete Str
- MATH 1111 Calculus I
- COMP 3411 Num Analysis
- COMP 2211
- COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 2931 Intro Sys Prg
- COMP 1631 Intro to CS
- MATH 1121 Calculus II
- MATH 1111 Calculus I

COMP 2611 Data Str + Alg I
- COMP 2631 Data Str + Alg II
- COMP 2931 Intro Sys Prg
- COMP 1631 Intro to CS
- MATH 1111 Calculus I
- COMP 2211

COMP 3611 Alg Analysis
- COMP 3721 Obj Oriented
- COMP 4721 SW Design

COMP 3911 Operating Sys

3 credits from the following:
- COMP 3971 Org + Arch
- COMP 3361 Digital Sig Proc
- COMP 3411 Num Analysis

PHYS 1551 General Phys II

3 credits from the following:
- COMP 3711 Org + Arch
- COMP 3361 Digital Sig Proc

3 credits from the following:
- BIOL 1001, BIOL 1501, BIOC 1001, GENS 1401, PSYC 1001, PSYC 1011

6 credits from Mathematics or Computer Science at the 3000/4000 level

12 credits from Computer Science at the 3000/4000 level

*Strong students are encouraged to take MATH 2221 in their first year.

Complete by the end of First Year

Complete by the end of Second Year

Complete by the end of Third Year / Fourth Year

3rd year standing

required prerequisite
recommends prerequisite
not required for degree
required for degree
Interdisciplinary Degree Maps

Bachelor of Science Honours in Mathematics and Physics
Bachelor of Arts Honours in Economics and Mathematics
Bachelor of Arts or Science Minor in Geographic Information Systems
Bachelor of Arts Joint Honours in Economics and Mathematics

3 credits from the following:
- MATH 2311 Statistics II
- MATH 2411 Linear Algebra I
- MATH 2511 Linear Algebra II

6 credits from Economics at the 3000/4000 level which may include ECON 4990
- ECON 1001 Princ of Micro
- ECON 1011 Princ of Macro
- ECON 1701 Data Analysis
- ECON 2001 Inter Micro I
- ECON 2011 Inter Micro II
- ECON 2101 Inter Macro I
- ECON 2111 Inter Macro II
- ECON 2701 Intro Economet.
- ECON 4801 Adv Micro
- ECON 4811 Adv. Macro

12 credits from the following:
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 2111 Multi Calculus
- MATH 2121 DEs I
- MATH 2211 Discrete Str
- MATH 2221 Linear Algebra*
- MATH 2222 Modern Alg I
- MATH 2223 Modern Alg II
- MATH 3111 Real Analysis I
- MATH 3121 Real Analysis II
- MATH 3131 DEs II
- MATH 3141 Complex Var.
- MATH 3211 Prob & Stats I
- MATH 3221 Prob & Stats II
- MATH 3231 Num + Mod
- MATH 3241 Modern Alg III
- MATH 3251 Modern Alg IV
- MATH 3311 Topology
- MATH 3411 Numerical
- MATH 3511 Sim + Mod
- MATH 3611 Algebra
- MATH 3711 Group Theory
- MATH 3811 Abstract Algebra
- COMP 1631 Intro to CS

3rd year standing
- MATH 1111 Calculus I
- MATH 1121 Calculus II
- MATH 2111 Multi Calculus
- MATH 2121 DEs I
- MATH 2211 Discrete Str
- MATH 2221 Linear Algebra*
- MATH 2222 Modern Alg I
- MATH 2223 Modern Alg II
- MATH 3111 Real Analysis I
- MATH 3121 Real Analysis II
- MATH 3131 DEs II
- MATH 3141 Complex Var.
- MATH 3211 Prob & Stats I
- MATH 3221 Prob & Stats II
- MATH 3231 Num + Mod
- MATH 3241 Modern Alg III
- MATH 3251 Modern Alg IV
- MATH 3311 Topology
- MATH 3411 Numerical
- MATH 3511 Sim + Mod
- MATH 3611 Algebra
- MATH 3711 Group Theory
- MATH 3811 Abstract Algebra
- COMP 1631 Intro to CS

*Strong students are encouraged to take MATH 2221 in their first year.
Bachelor of Arts or Science Minor in Geographic Information Systems

3 credits from the following:
- GENV 1201 Human Env
- GENS 1401 Physical Env
- GENS 2411 Geomorph

3 credits from the following:
- MATH 2311 Statistics I
- GENS 2431 Data Analysis
- GENS 4721 Adv GIS

3 credits from the following:
- GENS 3401 Research Env
- GENV 3701 Res Hum G&E

3 credits from COMP

3rd year standing

COMP 3851 Comp + Society

3 credits from Science

required prerequisite
required prerequisite is from orange or pink but not both

Complete by the end of First Year

Complete by the end of Second Year

Complete by the end of Third Year / Fourth Year

COMP 1631 Intro to CS

COMP 1731 Prog Tech + Alg

COMP 2611 Data Str + Alg I
# Current Upper Year Mathematics Course Rotation

The following is the intended sequence of upper year course offerings for the next two years. Note that many factors could change this list slightly.

<table>
<thead>
<tr>
<th>2018/2019</th>
<th>2019/2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3031 History of Math</td>
<td>MATH 3111 Real Analysis I</td>
</tr>
<tr>
<td>MATH 3131 Differential Equations II</td>
<td>MATH 3161 Complex Variables</td>
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<tr>
<td>MATH 3141 Vector Calculus</td>
<td>MATH 3211 Modern Algebra I</td>
</tr>
<tr>
<td>MATH 3111 Real Analysis I</td>
<td>MATH 3221 Advanced Linear Algebra</td>
</tr>
<tr>
<td>MATH 3231 Number Theory</td>
<td>MATH 3251 Graph Theory</td>
</tr>
<tr>
<td>MATH 3301 Game Theory (ECON 3301)</td>
<td>MATH 3301 Game Theory (ECON 3301)</td>
</tr>
<tr>
<td>MATH 3311 Probability and Statistics I</td>
<td>MATH 3411 Numerical Analysis (COMP 3411)</td>
</tr>
<tr>
<td>MATH 3321 Probability and Statistics II</td>
<td>MATH 3451 Math Methods for Physics (PHYS 3451)</td>
</tr>
<tr>
<td>MATH 3451 Math Methods for Physics (PHYS 3451)</td>
<td>MATH 3151 Introduction to Mathematical Modelling</td>
</tr>
<tr>
<td>MATH 4631 Theory of Computation</td>
<td>MATH 4111 Topology</td>
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<tr>
<td></td>
<td>MATH 4651 Cryptography (COMP 4651)</td>
</tr>
</tbody>
</table>
Current Upper Year Computer Science Course Rotation

The following is the intended sequence of upper year course offerings for the next two years. Note that many factors could change this list slightly.

2018/2019

COMP 3611 Algorithm Analysis
COMP 3651 Artificial Intelligence
COMP 3721 Object-Oriented Design
COMP 3971 Computer Organization and Architecture
COMP 4631 Theory of Computation (MATH 4631)
COMP 4721 Software Design

2019/2020

COMP 3361 Digital Signal Processing (PHYS 3361)
COMP 3411 Numerical Analysis (MATH 3411)
COMP 3611 Algorithm Analysis
COMP 3711 Principles of Programming Languages
COMP 3811 Database Systems
COMP 3851 Computers and Society
COMP 3911 Operating Systems
COMP 4651 Cryptography (MATH 4651)
COMP 4911 Computer Networks
Course Descriptions

Mathematics Courses
Computer Science Courses
**MATH 1011**

*Functions*

- **3 credits**
- **Lecture**: 3 hours
- **Laboratory**: 1.5 hours
- **Prerequisite Courses**: None

This course focuses on the real number system, inequalities, plane analytic geometry (lines and conics), functions, inverse functions, polynomials, rational functions, trigonometric functions, and exponential and logarithmic functions. It emphasizes fundamental methods of graphing functions, using non-calculus based techniques.

*Note:* This course is primarily intended for non-science students or as a prerequisite for MATH 1111 or 1151 for those students who have not passed the Mathematics Placement Test. Science students who have passed the Mathematics Placement Test require the permission of the Department of Mathematics and Computer Science to enrol in this course. Credit will not be given for this course if credit has already been granted for MATH 1111 or 1151.

**MATH 1111**

*Calculus I*

- **3 credits**
- **Lecture**: 3 hours
- **Laboratory**: 1.5 hours
- **Prerequisite Courses**: None

This course introduces differential calculus. Topics include derivatives of algebraic, trigonometric, and exponential functions and applications such as curve sketching, related rates, and optimization problems.
MATH 1121
Calculus II

3 credits
Lecture 3 hours
Laboratory 1.5 hours
Prerequisite Courses MATH 1111 or permission of the Department

This course continues the introduction to calculus begun in MATH 1111. Topics include techniques of integration; applications of the integral such as finding volumes and solving elementary differential equations; and sequences and series.

MATH 1151
Applied Calculus

3 credits
Lecture 3 hours
Laboratory 1.5 hours
Prerequisite Courses None

This course introduces differential and integral calculus with an emphasis on applications. Topics include modeling with functions, interpretation of the derivative and integral, and some computational methods.

Note: This course is designed for students in the life sciences and Commerce who do not intend to take MATH 1121.
MATH 1251
Finite Mathematics

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses None

This course introduces common applications of finite mathematics. Topics include Markov chains, linear programming and game theory.

Note: This course is restricted to non-mathematics majors and is intended in particular for students in behavioural sciences, commerce, and social sciences. Mathematics majors require the instructor's permission to enrol.

MATH 1991
Special Topic in Mathematics

3 credits
Lecture Variable
Laboratory Variable
Prerequisite Courses Set by Department/Program when the topic and level are announced

This course either focuses on topics not covered by the current course offerings in a department or program or offers the opportunity to pilot a course that is being considered for inclusion in the regular program.

Note: When a Department or Program intends to offer a course under this designation, it must submit course information, normally at least three months in advance, to the Dean. Students may register for MATH 1991 more than once, provided the subject matter differs.
MATH 2111  
Multivariable Calculus

3 credits  
Lecture 3 hours  
Laboratory None  
Prerequisite Courses MATH 1121 or permission of the Department

This course introduces the calculus of functions of several variables, including conic sections, quadric surfaces, polar coordinates in the plane, cylindrical and spherical coordinates in three space, continuity, partial derivatives, tangent planes, chain rule, maximum and minimum values, Lagrange multipliers, and double and triple integrals.

MATH 2121  
Differential Equations I

3 credits  
Lecture 3 hours  
Laboratory None  
Prerequisite Courses MATH 1121 or permission of the Department

This course introduces first and second order differential equations. Topics include techniques for solving simple differential equations and the qualitative analysis of linear and non-linear equations. Applications include growth and decay, heating and cooling, and mixing chemical reactions.
MATH 2221
Linear Algebra

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses 3 credits from MATH 1111, 1151, or permission of the Department

An introductory course in linear algebra covering such topics as linear equations, matrices, determinants, vector spaces, linear transformations, inner products, eigenvalues, and eigenvectors. Whenever possible, concepts are given a geometric interpretation in two and three-dimensional space.

Note: Strong students are encouraged to take this course in their first year.

MATH 2211
Discrete Structures

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses 3 credits from MATH 1111, 1151, or permission of the Department

An introduction to the terminology and concepts of discrete mathematics, covering such topics as: logical arguments, proofs and algorithm verification, sets, relations, functions and cardinality of sets, induction and recursion, enumeration, algorithms and complexity.

Note: This course is cross-listed as COMP 2211 and may therefore count as three credits in either discipline.
MATH 2311  
Statistics I

3 credits  
Lecture: 3 hours  
Laboratory: None  
Prerequisite Courses: None

This course introduces some of the concepts and techniques of probability and statistics. Topics include descriptive statistics, elementary probability, probability distributions, statistical estimation, hypothesis testing, and the use of a statistical software package in analyzing data. Examples come from a wide variety of disciplines.

MATH 2321  
Statistics II

3 credits  
Lecture: 3 hours  
Laboratory: 1 hour  
Prerequisite Courses: 3 credits from MATH 2311, 3311, or permission of the Department

This is a second course in the concepts and techniques of probability and statistics. The course covers a selection of topics from analysis of variance, linear and nonlinear regression, correlation estimation and prediction, independence, Wilcoxon and goodness-of-fit tests and includes data analysis using statistical software. Examples come from a wide variety of sources and disciplines.
MATH 2991
Special Topic in Mathematics

3 credits
Lecture Variable
Laboratory Variable
Prerequisite Courses Set by Department/Program when the topic and level are announced

This course either focuses on topics not covered by the current course offerings in a department or program or offers the opportunity to pilot a course that is being considered for inclusion in the regular program.

Note: When a Department or Program intends to offer a course under this designation, it must submit course information, normally at least three months in advance, to the Dean. Students may register for MATH 2991 more than once, provided the subject matter differs.

MATH 3011
Set Theory and Mathematical Logic

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses MATH 2211, or permission of the Department

This course provides a mathematical introduction to the basic ideas of set theory and logic. Topics covered may include: axiom of choice, cardinal and ordinal numbers, Boolean algebras and their applications, completeness, decidability, philosophies of mathematics.
MATH 3031  
History of Mathematics

3 credits  
Lecture  3 hours  
Laboratory None  
Prerequisite Courses 6 credits from MATH 2111, 2121, 2211, 2221, or permission of the Department

A survey of the history of Mathematics. Topics include: the achievements of early civilizations, the developments in Europe leading to the calculus and its consequences, the growth of rigor in the 18th and 19th centuries, the axiomatic method in the 20th century.

MATH 3111  
Real Analysis I

3 credits  
Lecture  3 hours  
Laboratory None  
Prerequisite Courses MATH 2111, 2211, or permission of the Department

A systematic and rigorous study of the real numbers and functions of a real variable, emphasizing limits and continuity.
### MATH 3131
**Differential Equations II**

- 3 credits
- Lecture: 3 hours
- Laboratory: None
- Prerequisite Courses: MATH 2111, 2121, 2221, or permission of the Department

This course focuses on ordinary and partial differential equations. Topics for ordinary differential equations include existence and uniqueness of solutions, systems of differential equations, power series solutions, Laplace and Fourier transforms, and Fourier series. Topics for partial differential equations include separation of variables, generalized Fourier series, Sturm-Liouville theory, Legendre polynomials, Bessel functions, Green's functions, and the calculus of variations.

### MATH 3141
**Vector Calculus**

- 3 credits
- Lecture: 3 hours
- Laboratory: None
- Prerequisite Courses: MATH 2111, 3 credits from MATH 2221, MATH/PHYS 3541, or permission of the Department

This course covers the calculus of vector-valued functions and curves, vector fields, line and surface integrals, vector differential operators, and the various forms of Stokes' Theorem. It may also include the differential geometry of curves and differential forms.
MATH 3151
An Introduction to Mathematical Modelling

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses Third year standing, 3 credits from MATH 1111, 1151, or permission of the Department

This course introduces the nature of theoretical mathematical modelling illustrated by examples drawn from the physical sciences, population dynamics (mathematical ecology), traffic flow, sociological problems (for example voting, kinship and cultural stability) and other areas depending on the interests of the class.

MATH 3161
Complex Variables with Applications

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses MATH 2111, or permission of the Department

This course covers analytic functions, Cauchy-Riemann equations, conformal mapping, complex integrals, Cauchy's integral theorem, Taylor and Laurent Series, residues, evaluation of real integrals, and inverse transforms.
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
<th>Lecture</th>
<th>Laboratory</th>
<th>Prerequisite Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3211</td>
<td>Modern Algebra I</td>
<td>3</td>
<td>3 hours</td>
<td>None</td>
<td>MATH 2211, MATH 2221, or permission of the Department</td>
</tr>
<tr>
<td></td>
<td>An introduction to the theory of groups and rings.</td>
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</tr>
<tr>
<td>MATH 3221</td>
<td>Advanced Linear Algebra</td>
<td>3</td>
<td>3 hours</td>
<td>None</td>
<td>MATH 2211 recommended, MATH 2221, or permission of the Department</td>
</tr>
<tr>
<td></td>
<td>An advanced course in linear algebra, covering selected topics from: change of basis and similarity of matrices; multilinear forms and determinants; canonical forms; Primary Decomposition Theorem, Jordan form; semisimple and normal operators; spectral theory; quadratic forms; applications to geography, electrical networks, linear programming, differential equations, or the geometry of conic sections.</td>
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</tr>
</tbody>
</table>
MATH 3231  
Number Theory

3 credits  
Lecture: 3 hours  
Laboratory: None

Prerequisite Courses: MATH 2211 or permission of the Department

An introductory half-course in the theory of numbers covering such topics as: Euclidean algorithm, Fundamental Theorem of Arithmetic, congruences, diophantine equations, Fermat and Wilson Theorems, quadratic residues, continued fractions, Prime number theorem.

MATH 3251  
Graph Theory

3 credits  
Lecture: 3 hours  
Laboratory: None

Prerequisite Courses: MATH 2211 or permission of the Department

This course introduces terminology, techniques, and applications of graph theory and examines parameters for a variety of classes of graphs. Topics include trees, planarity, colouring, matchings, and network flow problems.
MATH 3301
Introduction to Game Theory

3 credits
Lecture 3 hours
Laboratory 1 hour
Prerequisite Courses ECON 1001 and 1011; or 3 credits from MATH 1111, 1151; or permission of the Department

This course introduces the basic tools and methods of Game Theory. Game Theory is a mathematically oriented approach to understanding the strategic interaction of self-interested agents. Emphasis is on non-cooperative games. Topics include backwards induction, iterative deletion of dominated strategies, Nash equilibrium, repeated games, some equilibrium refinements, evolutionary game theory, and Bayesian Nash equilibria.

Note: This course is cross-listed as ECON 3301 and therefore may count as 3 credits in either discipline. This course counts as a Commerce elective for students taking a Bachelor of Commerce or a Major or Minor in Commerce.

MATH 3311
Probability and Statistics I

3 credits
Lecture 3 hours
Laboratory 1 hour
Prerequisite Courses MATH 2111 or permission of the Department

This course focuses on the mathematical theory of probability. It includes topics such as: sample space, events, axioms, conditional probability, Bayes' Theorem, random variables, combinatorial probability, moment generating functions, transformations of random variables, univariate and joint distributions with reference to the binomial, hypergeometric, normal, Gamma, Poisson, and others; convergence of sequences of variables; and the Central Limit Theorem.
MATH 3411  
**Numerical Analysis**

3 credits  
Lecture 3 hours  
Laboratory None  
Prerequisite Courses MATH 1121, 3 credits from COMP, or permission from the Department

This course introduces numerical methods for solving a variety of problems in mathematics, the natural sciences, and engineering and the implementation of numerical methods on a computer. Topics include numerical stability, polynomial approximation and interpolation, integration and solution of differential equations, solution of linear and nonlinear systems of equations, and matrix factorization.

Note: This course is cross-listed as COMP 3411 and may therefore count as three credits in either discipline.

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MATH 3451  
**Methods of Mathematical Physics**

3 credits  
Lecture 3 hours  
Laboratory 3 hours  
Prerequisite Courses MATH 2111, 3 credits from MATH 2121, PHYS 2251, or permission from the Department

This course provides students with a selection of mathematical skills needed in more advanced physics courses. It introduces frequently utilized mathematical methods in theoretical physics in close connection with physics applications. Topics include vector and tensor analysis, use of special functions, operators and eigenvalue problems, Fourier analysis, and complex variable techniques.

Note: This course is cross listed as PHYS 3451 and may therefore count as three credits in either discipline.
MATH 3531
Simulation and Modelling

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses MATH 1111, 3 credits from MATH 2311, 3311, PSYC 2001, 2011, 3 credits from COMP, or permission from the Department

An introduction to the simulation technique for studying mathematical models. Specific titles include: systems theory and system models, continuous system simulation, discrete system simulation, Monte Carlo methods, random number generators, and simulation languages. Emphasis will be placed upon computer implementation of the methods studied.

Note: This course is cross listed as COMP 3531 and may therefore count as three credits in either discipline.

MATH 3991
Special Topic in Mathematics

3 credits
Lecture Variable
Laboratory Variable
Prerequisite Courses Set by Department/Program when the topic and level are announced.

This course either focuses on topics not covered by the current course offerings in a department or program or offers the opportunity to pilot a course that is being considered for inclusion in the regular program.

Note: When a Department or Program intends to offer a course under this designation, it must submit course information, normally at least three months in advance, to the Dean. Students may register for MATH 3991 more than once, provided the subject matter differs.
MATH 4111
Topology

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses MATH 3111, or permission of the Department

This course introduces metric and topological spaces, convergence, and continuous functions.

MATH 4121
Real Analysis II

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses MATH 3111, or permission of the Department

This course continues the study of analysis begun in MATH 3111 and includes a rigorous study of the Riemann and Lebesgue integrals based on formal definitions and proofs.
<table>
<thead>
<tr>
<th>Course</th>
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<th>Lecture</th>
<th>Laboratory</th>
<th>Prerequisite Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 4221 Modern Algebra II</td>
<td>3</td>
<td>3 hours</td>
<td>None</td>
<td>MATH 3211, or permission of the Department</td>
</tr>
<tr>
<td>MATH 4311 Probability and Statistics II</td>
<td>3</td>
<td>3 hours</td>
<td>None</td>
<td>MATH 3311, or permission of the Department</td>
</tr>
</tbody>
</table>

The classical theory of fields and rings and their applications.

This course focuses on mathematical statistics. It includes topics such as: estimation, unbiasedness, efficiency, Cramer-Rao lower bound, consistency, sufficiency, maximum likelihood estimators, hypothesis testing, power of tests, likelihood ratio, regression analysis and analysis of variance.
MATH 4631  
Theory of Computation

3 credits  
Lecture 3 hours  
Laboratory None  
Prerequisite Courses COMP 1731, COMP/MATH 2211, or permission of the Department

This course is an introduction to theoretical aspects of Computer Science such as formal language and automata theory and complexity theory.

Note: This course is cross listed as COMP 4631 and may therefore count as three credits in either discipline.

MATH 4651  
Cryptography

3 credits  
Lecture 3 hours  
Laboratory None  
Prerequisite Courses COMP 1731, COMP/MATH 2211, MATH 2221, or permission of the Department

This course is an introduction to cryptographic algorithms and to the cryptanalysis of these algorithms, with an emphasis on the fundamental principles of information security. Topics include: classical cryptosystems, modern block and stream ciphers, public-key ciphers, digital signatures, hash functions, key distribution and agreement.

Note: This course is cross listed as COMP 4651 and may therefore count as three credits in either discipline.
MATH 4950/51
Independent Study in Mathematics

3 credits
Lecture: None
Laboratory: None
Prerequisite Courses: Permission of the Department/Program Advisor

This course permits senior students, under the direction of faculty members, to pursue their interest in areas not covered, or not covered in depth, by other courses through a program of independent study.

Note: Students must obtain consent of an instructor who is willing to be a supervisor and must register for the course prior to the last day for change of registration in the term during which the course is being taken. A program on Independent Study cannot duplicate subject matter covered through regular course offerings. Students may register for MATH 4950/51 more than once, provided the subject matter differs.

MATH 4991
Special Topic in Mathematics

3 credits
Lecture: Variable
Laboratory: Variable
Prerequisite Courses: Set by Department/Program when the topic and level are announced.

This course either focuses on topics not covered by the current course offerings in a department or program or offers the opportunity to pilot a course that is being considered for inclusion in the regular program.

Note: When a Department or Program intends to offer a course under this designation, it must submit course information, normally at least three months in advance, to the Dean. Students may register for MATH 4991 more than once, provided the subject matter differs.
COMP 1631
Introduction to Computer Science

3 credits
Lecture 3 hours
Laboratory 3 hours
Prerequisite Courses None

This course provides a broad survey of computer science and an introduction to programming. Topics include: origins of computers, data representation and storage, Boolean algebra, digital logic gates, computer architecture, assemblers and compilers, operating systems, networks and the Internet, theories of computation, and artificial intelligence.

Note: University preparatory level course in Mathematics is required.

COMP 1731
Programming Techniques and Algorithms

3 credits
Lecture 3 hours
Laboratory 3 hours
Prerequisite Courses COMP 1631, or permission of the Department

In the context of solving several larger problems, the techniques of topdown problem solving will be emphasized in order to further develop good programming style. Topics include: documentation, debugging and testing, string processing, internal searching and sorting, elementary data structures, recursion and algorithmic analysis.
COMP 1991
Special Topic in Computer Science

3 credits
Lecture Variable
Laboratory Variable
Prerequisite Courses Set by Department/Program when the topic and level are announced

This course either focuses on topics not covered by the current course offerings in a department or program or offers the opportunity to pilot a course that is being considered for inclusion in the regular program.

Note: When a Department or Program intends to offer a course under this designation, it must submit course information, normally at least three months in advance, to the Dean. Students may register for COMP 1991 more than once, provided the subject matter differs.

COMP 2211
Discrete Structures

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses 3 credits from MATH 1111, 1151, or permission of the Department

An introduction to the terminology and concepts of discrete mathematics, covering such topics as: logical arguments, proofs and algorithm verification, sets, relations, functions and cardinality of sets, induction and recursion, enumeration, algorithms and complexity.

Note: This course is cross-listed as MATH 2211 and may therefore count as three credits in either discipline.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecture Hours</th>
<th>Laboratory Hours</th>
<th>Prerequisite Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP 2611</td>
<td>Data Structures and Algorithms I</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>COMP 1731, or permission of the Department</td>
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</tr>
<tr>
<td>COMP 2631</td>
<td>Data Structures and Algorithms II</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>COMP 2611, or permission of the Department</td>
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</tbody>
</table>

Effective methods of data organization, focusing on data structures and their algorithms via abstract data types with use of recursive procedures. Design of flexible file structures and related methods e.g. indexes, system file structures, hashed access. Object-oriented programming techniques are used in depth.

Advanced structures for data organization, with an emphasis on associated algorithms and their complexity. Topics include: binary and text file structures, compression, distributed computing, event-driven programming, advanced user interface design.
COMP 2931
Intro to Systems Programming

3 credits
Lecture: 3 hours
Laboratory: 3 hours
Prerequisite Courses: COMP 1731, or permission of the Department

This course is an introduction to programming at the systems level. Topics include: basic machine organization, assembly language, the UNIX environment, shell scripting, and C/C++ programming.

COMP 2991
Special Topic in Computer Science

3 credits
Lecture: Variable
Laboratory: Variable
Prerequisite Courses: Set by Department/Program when the topic and level are announced

This course either focuses on topics not covered by the current course offerings in a department or program or offers the opportunity to pilot a course that is being considered for inclusion in the regular program.

Note: When a Department or Program intends to offer a course under this designation, it must submit course information, normally at least three months in advance, to the Dean. Students may register for COMP 2991 more than once, provided the subject matter differs.
COMP 3361
Digital Signal Processing and Electronics

3 credits
Lecture 3 hours
Laboratory 3 hours
Prerequisite Courses COMP 1631, PHYS 1551, or permission of the Department

This course introduces students to both digital electronic circuits and digital signal processing, and would be valuable both for those planning to go on in technical careers in computer science or in physics, and for scientists who wish to develop tools for the collection and analysis of data. Topics to be covered include digital logic gates, Boolean algebra, counting circuits, digital signal conditioning, sampling considerations such as the Nyquist criterion, analog to digital and digital to analog conversion, Fourier Transform theory and application as FFT, correlation and convolution, digital filtering using finite impulse response and infinite impulse response circuits including the ztransform and filter design, and digital image processing including two dimensional FFT techniques, microprocessors, microcontrollers and digital signal processing integrated circuits.

Note: This course is cross-listed with PHYS 3361 and may therefore count as three credits in either discipline.
COMP 3411
Numerical Analysis

3 credits  
Lecture 3 hours  
Laboratory None  
Prerequisite Courses MATH 1121, 3 credits from COMP, or permission from the Department

This course introduces numerical methods for solving a variety of problems in mathematics, the natural sciences, and engineering and the implementation of numerical methods on a computer. Topics include numerical stability, polynomial approximation and interpolation, integration and solution of differential equations, solution of linear and nonlinear systems of equations, and matrix factorization.

Note: This course is cross-listed as MATH 3411 and may therefore count as three credits in either discipline.

COMP 3531
Simulation and Modelling

3 credits  
Lecture 3 hours  
Laboratory None  
Prerequisite Courses MATH 1111, 3 credits from MATH 2311, 3311, PSYC 2001, 2011, 3 credits from COMP, or permission from the Department

An introduction to the simulation technique for studying mathematical models. Specific titles include: systems theory and system models, continuous system simulation, discrete system simulation, Monte Carlo methods, random number generators, and simulation languages. Emphasis will be placed upon computer implementation of the methods studied.

Note: This course is cross listed as MATH 3531 and may therefore count as three credits in either discipline.
COMP 3611  
Algorithm Analysis

3 credits  
Lecture: 3 hours  
Laboratory: None  
Prerequisite Courses: COMP 2631, COMP/MATH 2211, or permission from the Department

This course applies analysis and design techniques to non-numeric algorithms that act on data structures. The design of efficient algorithms leads to in-depth investigations of computational complexity such as NP-hard problems.

COMP 3651  
Artificial Intelligence

3 credits  
Lecture: 3 hours  
Laboratory: None  
Prerequisite Courses: COMP 2631, COMP/MATH 2211, or permission from the Department

This course introduces general problem solving methods associated with automated reasoning and simulated intelligence. Topics include: state space heuristic search theory, mechanical theorem proving, game playing, natural language processing, propositional logic, learning and cognitive models and expert systems.
COMP 3711
Principles of Programming Languages

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses COMP 2631, COMP 2931, or permission from the Department

An introduction to the principles of design and implementation of procedural and functional programming languages; modular, object and logic programming. Topics include language syntax and processors and semantic models of data and control structures.

COMP 3721
Object-Oriented Design and Methodology

3 credits
Lecture 3 hours
Laboratory 3 hours
Prerequisite Courses COMP 2631, or permission from the Department

Continues the introduction to object-oriented programming begun in earlier CS courses, emphasizing further development of algorithms, data structures, software engineering, and the social context of computing.
COMP 3811
Database Systems

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses COMP 2631, COMP/MATH 2211 or permission from the Department

This course introduces the major types of database systems and provides experience with at least one database model. It emphasizes the theoretical and practical aspects of the relational model, including database query systems and database design.

COMP 3831
Computer Graphics

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses COMP 2631, 2931, MATH 2221, or permission from the Department

This course introduces the principles and tools of interactive computer graphics: implementation of device drivers, 3D transformations, clipping, perspective views, input routines, user interface design, data structures, hidden lines, surface removal, colour shading and ray tracing.
COMP 3851
Computers and Society

This course examines the historical development and growth of the computer and related digital technology. The impact of the computer and the digitalization of society are discussed, including ethical issues related to the modern information age. Privacy and data protection, computer crime, data theft, and legal issues in software creation and use are examined. The responsibilities of the computer professional and computer user are examined from the technical, personal, and societal perspectives.

Note: Counts as a Commerce elective for students taking a Bachelor of Commerce or a Major or Minor in Commerce.

COMP 3911
Operating Systems

This course examines the major concepts underlying the design of operating systems such as process management, scheduling, memory management, device management, security, and network structures.
COMP 3971
Computer Organization and Architecture

3 credits
Lecture 3 hours
Laboratory None
Prerequisite Courses COMP 2631, COMP 2931, or permission of the Department

This course introduces modern computer design and its relation to system architecture and program function. Topics include system bus design, memory organization, I/O device access, instruction set design, instruction pipelining, leading to an investigation of how these tools are used to support multi-processor systems.

COMP 3991
Special Topic in Computer Science

3 credits
Lecture Variable
Laboratory Variable
Prerequisite Courses Set by Department/Program when the topic and level are announced.

This course either focuses on topics not covered by the current course offerings in a department or program or offers the opportunity to pilot a course that is being considered for inclusion in the regular program.

Note: When a Department or Program intends to offer a course under this designation, it must submit course information, normally at least three months in advance, to the Dean. Students may register for COMP 3991 more than once, provided the subject matter differs.
**COMP 4631**
Theory of Computation

3 credits  
Lecture 3 hours  
Laboratory None  
Prerequisite Courses COMP 1731, MATH/COMP 2211, or permission of the Department

This course is an introduction to theoretical aspects of Computer Science such as formal language and automata theory and complexity theory.

Note: This course is cross-listed with MATH 4631 and may therefore count as three credits in either discipline.

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**COMP 4651**
Cryptography

3 credits  
Lecture 3 hours  
Laboratory None  
Prerequisite Courses COMP 1731, MATH/COMP 2211, or permission of the Department

This course is an introduction to cryptographic algorithms and to the cryptanalysis of these algorithms, with an emphasis on the fundamental principles of information security. Topics include: classical cryptosystems, modern block and stream ciphers, public-key ciphers, digital signatures, hash functions, key distribution and agreement.

Note: This course is cross listed as MATH 4651 and may therefore count as three credits in either discipline.
COMP 4721
Software Design

3 credits
Lecture 3 hours
Laboratory 2 hours
Prerequisite Courses Third-year standing, COMP 3721, or permission of the Department

This course focuses on software design culminating in a major project. It studies life cycle models and their phases: planning, requirements, specifications, design, implementation, testing, and maintenance.

COMP 4911
Computer Networks

3 credits
Lecture 3 hours
Laboratory 2 hours
Prerequisite Courses COMP 2631, COMP 2931, or permission of the Department

An introduction to computer network applications and design. Topics will include: layered models, data transmission protocols, network topology, and security.
COMP 4950/51
Independent Study in Computer Science

3 credits
Lecture: None
Laboratory: None
Prerequisite Courses: Permission of the Department/Program Advisor

This course permits senior students, under the direction of faculty members, to pursue their interest in areas not covered, or not covered in depth, by other courses through a program of independent study.

Note: Students must obtain consent of an instructor who is willing to be a supervisor and must register for the course prior to the last day for change of registration in the term during which the course is being taken. A program on Independent Study cannot duplicate subject matter covered through regular course offerings. Students may register for COMP 4950/51 more than once, provided the subject matter differs.

COMP 4990
Honours Thesis

3 credits
Lecture: None
Laboratory: None
Prerequisite Courses: Consent of supervising staff member and permission of the Department

Independent research and study under direction of a member of the Department; for students in Computer Science Honours program.
COMP 4991
Special Topic in Computer Science

3 credits
Lecture Variable
Laboratory Variable
Prerequisite Courses Set by Department/Program when the topic and level are announced.

This course either focuses on topics not covered by the current course offerings in a department or program or offers the opportunity to pilot a course that is being considered for inclusion in the regular program.

Note: When a Department or Program intends to offer a course under this designation, it must submit course information, normally at least three months in advance, to the Dean. Students may register for COMP 4991 more than once, provided the subject matter differs.