MATHEMATICS (MATH)

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Chair: Professor N. Rampersad; Professors: J. Currie, V. Linek, A. Stokke, R. Stokke; Associate Professor: S. Dueck; Assistant Professors: P. Eskandari, I. Smythe, M. Wiersma; Instructors: M. Despic, E. Herrera, M. Nasri; Professor Emerita: O. Oellermann

DEGREES/PROGRAMS OFFERED

3-Year BA
3-Year BSc
3-Year BSc (Business Stream)
4-Year BA
4-Year BSc
4-Year BSc (Business Stream)
BSc Honours
Minor

INTRODUCTION

Mathematics is the supreme intellectual achievement and the most original creation of the human spirit - Morris Kline.
Mathematics is the Queen and servant of the Sciences - Karl Friedrich Gauss.

The scope of Mathematics ranges from Computer Science to Philosophy, from Physics to Finance. Mathematics emphasizes precision and logic, but also creativity and problem solving. Students heading for Law or Medicine are well served by a first degree in Mathematics. Other graduates move into the financial sector or high technology. Some graduates choose to go on to advanced degrees, not only in Mathematics, but also in Statistics, Computer Science, Meteorology or Physics.

The department offers 3-Year and 4-Year BA and BSc degrees, and the Honours BSc. Students pursuing a 3-year or 4-year BSc also have the opportunity to take a Business Stream – a set of core courses in the Faculty of Business that will provide them with the skills needed to enter and succeed in industry and business. See the "Science with a Business Stream" section of this Course Calendar.

The Mathematics department features one of the highest levels of research activity in the University, and offers students a unique glimpse into the ongoing creation of Mathematics.

REQUIREMENTS FOR A 3-YEAR BA/BSc IN MATHEMATICS

ADMISSION REQUIREMENT

Students must consult with the Department Advisor/Honours Advisor in planning their program. Students who have not obtained a grade of at least C in **MATH-1103(3)** Introduction to Calculus I AND **MATH-1104(3)** Introduction to Calculus II or the equivalent **MATH-1101(6)** Introduction to Calculus are advised not to proceed in a Mathematics major.

GRADUATION REQUIREMENT

90 credit hours

RESIDENCE REQUIREMENT

Degree:	Minimum 30 credit hours.
Major:	Minimum 18 credit hours.

GENERAL DEGREE REQUIREMENT

Humanities:	12 credit hours in Humanities
Writing:	Minimum 3 credit hours of Academic Writing.
Indigenous:	3 credit hours in designated Indigenous requirement courses
Maximum Introductory Courses:	Students may use a maximum of 42 credit hours at the 1000 level. Of these, a maximum of 6 credit hours may be below the 1000 level. As a result, students must take a minimum of 48 credit hours at the 2000-level or above in order to not exceed the maximum number of introductory courses.
Distribution:	Minimum three (3) credit hours from each of five (5) different subjects.

MAJOR REQUIREMENT

Single Major	Minimum 36 credit hours/Maximum 54 credit hours.
Double Major	Minimum 36 credit hours in Mathematics and specified number of credit hours in the other department/program.
Required courses:	**MATH-1103(3)** Introduction to Calculus I **and MATH-1104(3)** Introduction to Calculus II or the equivalent **MATH-1101(6)** Introduction to Calculus **MATH-1401(3)** Discrete Mathematics **MATH-2105(3)** Intermediate Calculus I **and MATH-2106(3)** Intermediate Calculus II **MATH-1201(3)** Linear Algebra I **and MATH-2203(3)** Linear Algebra II

A minimum additional fifteen (15) credit hours chosen from the following courses, of which six (6) credit hours must be at the 3000 or 4000 level:

MATH-2102(3) Differential Equations I
MATH-2103(3) Differential Equations II
MATH-2202(3) Cryptography and Other Applications of Algebra
MATH-2405(3) Real Analysis I
MATH-2501(3) Introductions to Number Theory
MATH-3101(6) Introduction to Mathematical Analysis
MATH-3103(3) Methods in Advanced Calculus
MATH-3202(3) Group Theory
MATH-3203(3) Linear Algebra III
MATH-3401(3) Graph Theory
MATH-3402(3) Combinatorics
MATH-4003(3) Topics in Mathematics
MATH-4101(3) Complex Analysis
MATH-4202(3) Rings and Fields
MATH-4204(3) Topics in Algebra
MATH-4401(3) Networks, Graph Theory and Combinatorial Optimization
MATH-4403(3) Set Theory
MATH-4602(3) Measure Theory and Integration
MATH-4603(3) Topology

Combined Major:	Minimum 48 credit hours from two (2) different majors with not less than 18 credit hours from each major subject. Required math courses: MATH-1103(3) and MATH-1104(3) or MATH-1101(6), and MATH-1201(3), and MATH-2105(3) and MATH-2106(3), and at least 3 credit hours of math courses at the 3000 or 4000 level.
Prescribed courses:	To be determined in consultation with the Department as above.

Students who have not obtained a grade of at least C in **MATH-1103(3)** Introduction to Calculus I **and MATH-1104(3)** Introduction to Calculus II or the equivalent **MATH-1101(6)** Introduction to Calculus are advised not to proceed in a Mathematics major.
Students intending to major in Mathematics are strongly advised to take MATH-1401(3) Discrete Mathematics in their first year. It is a prerequisite for most second and third-year courses in Mathematics.
Students majoring in Mathematics are strongly advised to take both **MATH-2105(3)** Intermediate Calculus I and **MATH-2106(3)** Intermediate Calculus II **and MATH-2203(3)** Linear Algebra II by the end of their second year, since several third-year courses have these as prerequisites.
Students are encouraged to take more than 36 credit hours in Mathematics.
Students planning to go on to graduate studies are advised to consult with the Department before choosing second year courses.

REQUIREMENTS FOR THE 3-YEAR BSc IN MATHEMATICS WITH A BUSINESS STREAM

Students must complete the requirements of the 3-year BSc in Mathematics degree (see previous section) and the set of core courses indicated in the "Science with a Business Stream" section of the Calendar.

REQUIREMENTS FOR THE 4-YEAR BA/BSc IN MATHEMATICS

ADMISSION REQUIREMENT	36 credit hours previously completed towards a BA/BSc in Mathematics. Students must consult with the Department Chair/Honours Advisor in planning their program.
GRADUATION REQUIREMENT	120 credit hours
RESIDENCE REQUIREMENT	Degree: 60 credit hours Major: 30 credit hours
GENERAL DEGREE REQUIREMENT	
Humanities:	12 credit hours in Humanities
Science:	6 credit hours in Science
Social Sciences (BA only):	12 credit hours
Writing:	3 credit hours of Academic Writing
Indigenous:	3 credit hours in designated Indigenous requirement courses
Maximum Introductory Courses:	Students may use a maximum of 42 credit hours at the 1000 level. Of these, a maximum of 6 credit hours may be below the 1000 level. As a result, students must take a minimum of 78 credit hours at the 2000-level or above in order to not exceed the maximum number of introductory courses.
Distribution:	Minimum three (3) credit hours from each of five (5) different subjects.
MAJOR REQUIREMENT	
Single:	Minimum 48 credit hours/Maximum 72 credit hours.
Double Major:	Minimum 48 credit hours in each Major as specified by the department/program.

Required courses:

MATH-1103(3)	Introduction to Calculus I **and MATH-1104(3)** Introduction to Calculus II or the equivalent **MATH-1101(6)** Introduction to Calculus
MATH-1401(3)	Discrete Mathematics
MATH-2105(3)	Intermediate Calculus I
MATH-2106(3)	Intermediate Calculus II
MATH-1201(3)	Linear Algebra I
MATH-2203(3)	Linear Algebra II
MATH-2405(3)	Real Analysis I
MATH-3101(6)	Introduction to Mathematical Analysis
MATH-3202(3)	Group Theory
MATH-3203(3)	Linear Algebra III
MATH-4101(3)	Complex Analysis
MATH-4202(3)	Rings and Fields
ACS-1903(3)	Programming Fundamentals I or **ACS-1905(3)** Programming Fundamentals or **ACS/PHYS-2102(3)** Scientific Computing

Students who have not obtained a grade of at least C in **MATH-1103(3)** Introduction to Calculus I **and MATH-1104(3)** Introduction to Calculus II or the equivalent **MATH-1101(6)** Introduction to Calculus are advised not to proceed in a Mathematics major.
Students intending to major in Mathematics are strongly advised to take **MATH-1401(3)** Discrete Mathematics in their first year. It is a prerequisite for most second and third-year courses in Mathematics.
Students majoring in Mathematics are strongly advised to take both **MATH-2105(3)** Intermediate Calculus I **and MATH-2106(3)** Intermediate Calculus II and **MATH-2203(3)** Linear Algebra II by the end of their second year, since several third-year courses have these as prerequisites.
Students planning to go on to graduate studies are advised to consult with the Department before choosing second-year courses.

Combined Major: Minimum 60 credit hours from two (2) different majors with not less than 24 credit hours from each major subject.
Required math courses: MATH-1103(3) and MATH-1104(3) or MATH-1101(6), and MATH-1201(3), and MATH-2105(3) and MATH-2106(3), and at least 6 credit hours of math courses at the 3000 or 4000 level.

Prescribed courses: To be determined in consultation with the Department as above.

REQUIREMENTS FOR THE 4-YEAR BSc IN MATHEMATICS WITH A BUSINESS STREAM

Students must complete the requirements of the 4-year BSc in Mathematics degree (see previous section) and the set of core courses indicated in the "Science with a Business Stream" section of the Calendar.

REQUIREMENTS FOR AN HONOURS BSc IN MATHEMATICS

ADMISSION REQUIREMENT	60 credit hours previously completed in a BA or BSc of which at least 21 credit hours are in Mathematics. Students must consult with the Department Chair/Honours Advisor in planning their program.
GRADUATION REQUIREMENT	120 credit hours
Graduation GPA Requirement**:**	To graduate with a BSc Honours, students must have a minimum GPA of 3.0 in all Honours subject courses which will be calculated on all course attempts and a 2.75 GPA in all Non-Honours courses which will be calculated as for the general degree (i.e., F's are not included and, in the case of repeated courses, only the highest grade will be used).
RESIDENCE REQUIREMENT	Minimum 60 credit hours. Minimum 30 credit hours, including minimum 18 credit hours in upper-level courses 3000/4000) of which a minimum of 9 credit hours are at the 4000 level.
GENERAL DEGREE REQUIREMENT	
Humanities:	12 credit hours
Writing:	Minimum 3 credit hours of Academic Writing
Indigenous:	3 credit hours in designated Indigenous requirement courses
Maximum Introductory Courses:	Students may use a maximum of 42 credit hours at the 1000 level. Of these, a maximum of 6 credit hours may be below the 1000 level. As a result, students must take a minimum of 78 credit hours at the 2000-level or above in order to not exceed the maximum number of introductory courses.
Distribution:	Minimum three (3) credit hours from each of five (5) different subjects.

HONOURS SUBJECT REQUIREMENT

Single Honours: Minimum 66 credit hours/Maximum 72 credit hours in the Honours subject.
Minimum 30 credit hours in upper-level courses (3000/4000), not including courses that are cross-listed with Statistics, and of which a minimum of 12 credit hours must be at the 4000 level.

Required courses:

MATH-1103(3)	Introduction to Calculus I **and MATH-1104(3)** Introduction to Calculus II or the equivalent **MATH-1101(6)** Introduction to Calculus
MATH-1401(3)	Discrete Mathematics
MATH-2105(3)	Intermediate Calculus I
MATH-2106(3)	Intermediate Calculus II
MATH-1201(3)	Linear Algebra I
MATH-2203(3)	Linear Algebra II
MATH-2405(3)	Real Analysis I
MATH-3101(6)	Introduction to Mathematical Analysis
MATH-3202(3)	Group Theory
MATH-3203(3)	Linear Algebra III
MATH-4101(3)	Complex Analysis
MATH-4202(3)	Rings and Fields
ACS-1903(3)	Programming Fundamentals I or **ACS-1905(3)** Programming Fundamentals or **ACS/PHYS-2102(3)** Scientific Computing

Students who have not obtained a grade of at least C in **MATH-1103(3)** Introduction to Calculus I **and MATH-1104(3)** Introduction to Calculus II or the equivalent **MATH-1101(6)** Introduction to Calculus are advised not to proceed in a Mathematics major.
Students intending to major in Mathematics are strongly advised to take **MATH-1401(3)** Discrete Mathematics in their first year. It is a prerequisite for most second and third-year courses in Mathematics.
Students majoring in Mathematics are strongly advised to take both **MATH-2105(3)** Intermediate Calculus I and **MATH-2106(3)** Intermediate Calculus II and **MATH-2203(3)** Linear Algebra II by the end of their second year, since several third-year courses have these as prerequisites.
Students planning to go on to graduate studies are advised to consult with the Department before choosing second year courses.

REQUIREMENTS FOR A MINOR IN MATHEMATICS

Degree: Students completing any undergraduate degree program are eligible to complete the Minor.

Minor: 18 credit hours in the Minor subject, with a minimum of 12 credit hours above the 1000-level

Residence Requirement: Minimum 12 credit hours in the Minor subject

Required courses: MATH-1103(3) Introduction to Calculus I and MATH-1104(3) Introduction to Calculus II or, the equivalent, MATH-1101(6) Introduction to Calculus.

An additional 12 credit hours at the 2000 level, or higher, chosen from the following list:

MATH-2102(3)	Differential Equations I
MATH-2103(3)	Differential Equations II
MATH-2105(3)	Intermediate Calculus I
MATH-2106(3)	Intermediate Calculus II
MATH-2202(3)	Cryptography and Other Applications of Algebra
MATH-2203(3)	Linear Algebra II
MATH-2405(3)	Real Analysis I
MATH-2501(3)	Introduction to Number Theory
MATH-3101(6)	Introduction to Mathematical Analysis
MATH-3103(3)	Methods in Advanced Calculus
MATH-3202(3)	Group Theory
MATH-3203(3)	Linear Algebra III
MATH-3401(3)	Graph Theory
MATH-3402(3)	Combinatorics
MATH-4003(3)	Topics in Mathematics
MATH-4101(3)	Complex Analysis
MATH-4202(3)	Rings and Fields
MATH-4204(3)	Topics in Algebra
MATH-4401(3)	Networks, Graph Theory and Combinatorial Optimization
MATH-4403(3)	Set Theory

Note: Most upper-level math courses require MATH-1201(3) Linear Algebra I, and/or MATH-1401(3) Discrete Mathematics, as prerequisites. Students wishing to obtain a minor in Mathematics are therefore encouraged to take one or both of these courses early on in their program.

Restrictions: Students cannot declare the same subject as a Major and a Minor.

REQUIREMENTS FOR A 3-YEAR TEACHABLE MAJOR IN MATHEMATICS

MATHEMATICS MAJOR – Teaching stream

Required courses:

MATH-1103(3) Introduction to Calculus I **and MATH-1104(3)** Introduction to Calculus II or the equivalent **MATH-1101(6)** Introduction to Calculus

MATH-1401(3) Discrete Mathematics

MATH-2105(3) Intermediate Calculus I **and MATH-2106(3)** Intermediate Calculus II

MATH-1201(3) Linear Algebra I **and MATH-2203(3)** Linear Algebra II

A minimum additional fifteen (15) credit hours chosen from the following courses, of which a minimum of six (6) credit hours must be at the 3000 or 4000 level:

MATH-2102(3) Differential Equations I
MATH-2103(3) Differential Equations II
MATH-2202(3) Cryptography and Other Applications of Algebra
MATH-2405(3) Real Analysis I
MATH-2501(3) Introduction to Number Theory
MATH-3101(6) Introduction to Mathematical Analysis
MATH-3103(3) Methods in Advanced Calculus
MATH-3202(3) Group Theory
MATH-3203(3) Linear Algebra III
MATH-3401(3) Graph Theory
MATH-3402(3) Combinatorics
MATH-4003(3) Topics in Mathematics
MATH-4101(3) Complex Analysis
MATH-4202(3) Rings and Fields
MATH-4204(3) Topics in Algebra
MATH-4401(3) Networks, Graph Theory and Combinatorial Optimization
MATH-4403(3) Set Theory
MATH-4602(3) Measure Theory and Integration
MATH-4603(3) Topology

STAT-1301(3) Statistical Analysis I
STAT-1401(3) Statistics I for Business and Economic
STAT-1501(3) Elementary Biological Statistics I
STAT-1302(3) Statistical Analysis II
STAT-2001(3) Elementary Biological Statistics II

RESTRICTIONS: Students may not receive credit for more than one of STAT-1301(3), STAT-1401(3), and STAT-1501(3). Students may not receive credit for more than one of STAT-1302(3) and STAT-2001(3).

REQUIREMENTS FOR A TEACHABLE MINOR IN MATHEMATICS

MATHEMATICS TEACHABLE MINOR (Senior Years)

Required courses: **MATH-1103(3)** Introduction to Calculus I **and MATH-1104(3)** Introduction to Calculus II or the equivalent **MATH-1101(6)** Introduction to Calculus

An additional 12 credit hours chosen from the following list of classes:

MATH-1201(3) Linear Algebra I
MATH-1401(3) Discrete Mathematics
MATH-2102(3) Differential Equations I
MATH-2103(3) Differential Equations II
MATH-2105(3) Intermediate Calculus I
MATH-2106(3) Intermediate Calculus II
MATH-2202(3) Cryptography and Other Applications of Algebra
MATH-2203(3) Linear Algebra II
MATH-2405(3) Real Analysis I
MATH-2501(3) Introduction to Number Theory
MATH-3101(6) Introduction to Mathematical Analysis
MATH-3103(3) Methods in Advanced Calculus
MATH-3202(3) Group Theory
MATH-3203(3) Linear Algebra III
MATH-3401(3) Graph Theory
MATH-3402(3) Combinatorics
MATH-4003(3) Topics in Mathematics
MATH-4101(3) Complex Analysis

STAT-1301(3) Statistical Analysis I
STAT-1401(3) Statistics I for Business and Economics
STAT-1501(3) Elementary Biological Statistics I

RESTRICTIONS: Students may not receive credit for more than one of STAT-1301(3), STAT-1401(3) and STAT-1501(3).

MATHEMATICS TEACHABLE MINOR (Early and Early/Middle Years)

Required courses: **MATH-2903(3)** Math for Early/Middle Years Teachers I

An additional 9 credit hours chosen from the following list of classes:

MATH-1103(3)	Introduction to Calculus I
MATH-1104(3)	Introduction to Calculus II
MATH-1101(6)	Introduction to Calculus
MATH-1201(3)	Linear Algebra I
MATH-1401(3)	Discrete Mathematics
MATH-2102(3)	Differential Equations I
MATH-2103(3)	Differential Equations II
MATH-2105(3)	Intermediate Calculus I
MATH-2106(3)	Intermediate Calculus II
MATH-2202(3)	Cryptography and Other Applications of Algebra
MATH-2203(3)	Linear Algebra II
MATH-2405(3)	Real Analysis I
MATH-2501(3)	Introduction to Number Theory
MATH-2904(3)	Math for Early/Middle Years Teachers II

RESTRICTIONS: Students may not receive credit for either MATH-1103(3) or MATH-1104(3) and also receive credit for MATH-1101(6).

GENERAL INFORMATION

Prerequisites: Pre-Calculus Mathematics 40S or Applied Mathematics 40S.

Degree Credit for Introductory Courses: Students are reminded that a maximum of 6 credit hours at the 0000-level may be counted towards the degree. Nevertheless, 0000-level Mathematics courses are not eligible for degree credit. Credit towards the degree will not be granted for both **MATH-1102(3)** Basic Calculus (Terminal), **MATH-1103(3)** Introduction to Calculus I and **MATH-1104(3)** Introduction to Calculus II, or the equivalent **MATH-1101(6)** Introduction to Calculus

COURSE LISTINGS

Courses are listed in numerical sequence: Students are advised to consult WebAdvisor or the appropriate Timetable on the website for courses to be offered in an upcoming term, as certain courses may not be available in each term. Students are advised to ensure that currently listed courses do not duplicate material studied previously under different course numbers.

MATH-0031(0)	Math Access for Early/Middle Years Teachers
MATH-0041(0)	Mathematics Access I
MATH-0042(0)	Mathematics Access II
MATH-1103(3)	Introduction to Calculus I
MATH-1104(3)	Introduction to Calculus II
MATH-1201(3)	Linear Algebra I
MATH-1301(3)	Applied Mathematics for Business & Administration
MATH-1401(3)	Discrete Mathematics
MATH-2102(3)	Differential Equations I
MATH-2103(3)	Differential Equations II
MATH-2105(3)	Intermediate Calculus I
MATH-2106(3)	Intermediate Calculus II
MATH-2202(3)	Cryptography and Other Applications of Algebra
MATH-2203(3)	Linear Algebra II
MATH-2405(3)	Real Analysis I
MATH/STAT-2413(3)	Introduction to Mathematical Finance
MATH-2501(3)	Introduction to Number Theory
MATH/STAT-2612 (3)	Mathematical Statistics I
MATH-2903(3)	Mathematics for Early/Middle Years Teachers I
MATH-2904(3)	Mathematics for Early/Middle Years Teachers II
MATH-3101(6)	Introduction to Mathematical Analysis
MATH-3103(3)	Methods in Advanced Calculus
MATH-3202(3)	Group Theory
MATH-3203(3)	Linear Algebra III
MATH-3401(3)	Graph Theory
MATH-3402(3)	Combinatorics
MATH/STAT-3412(3)	Introduction to Operations Research
MATH/STAT-3612(3)	Mathematical Statistics II
MATH-4001(6)	Directed Readings in Mathematics
MATH-4003(3)	Topics in Mathematics
MATH-4101(3)	Complex Analysis
MATH-4202(3)	Rings and Fields
MATH-4401(3)	Networks, graph theory and combinatorial optimization
MATH-4403(3)	Set Theory
MATH-4602(3)	Measure Theory and Integration
MATH-4603(3)	Topology

EXPERIMENTAL COURSE

MATH-4204(3)	Topics in Algebra

COURSE DESCRIPTIONS

All course descriptions for all undergraduate programs can now be found in one large PDF called “All course descriptions” in the “Academic Calendar” section of the University website:
http://uwinnipeg.ca/academics/calendar/index.html