UPER Project – Final Report

Report Completion Date: 2023-06-02

1. PROJECT OVERVIEW

1.1 General Information

Faculty/Department:	Science / Mathematics		
Degree Program:	B.Sc., B.A.		
Project Title:	Review and Evaluation of Baccalaureate Programs in Mathematics at UBCV		
Principal Investigator/ Department Head:	Philip D Loewen (Professor)		
Other Applicants:	Young-Heon Kim, Elyse Yeager, and others		
Report Submitted By:	Philip D Loewen (Professor)		
Project Initiation Date:	2019-07-01	**Project Completion Date:**	2021-06-30

2. GOALS, UNANTICIPATED OUTCOMES and NEXT STEPS

The report template suggests addressing four themes in this section:

- Goals,
- Unanticipated Outcomes,
- Next Steps, and
- Future Support.

All of these, and much more, are detailed in the attached PDF report. Please note the names of the authors listed on the front cover of that report: these are the people who gathered the data, completed the analysis, and produced the valuable recommendations alluded to in this brief summary.

3. IMPACT

The Mathematics Department now has an UPER Committee, which has taken ownership of the findings and initiatives detailed in the PDF report attached here. The committee has significant overlap with the Department's Undergraduate Affairs Committee, and together they are driving steady progress on the implementation of recommendations from the report. For example, the recommended new course MATH 319 has been designed, launched, and is running successfully. The course MATH 446 has been revitalized and is again in our standard rotation of offerings. The plan to cancel MATH 414 is in motion, with the course removed from the requirements list in all of our offerings. Instead of cancelling MATH 230, as the report recommends, we have opted to keep the number and completely overhaul the content. The exciting result is an essentially new course, "Marvels of Mathematics", that will be offered for the first time in 2023WT2. The redesign of MATH 360 and a parallel introduction of a new modeling course (MATH 361) is proceeding. We are also putting the finishing touches on a suite of well-coordinated thematic packages that students can use to turn their preferences into coherent choices from our rich variety of course offerings. Patrick Walls's interactive tool to support this is worth a visit: see https://ubcmath.github.io/coursemap/ for a preview.

In addition to working through the detailed action-items collected in the attached report, the Department's leaders are taking further initiatives to address some of the report's general findings. For example, we will be dedicating special sections of certain key 200-level courses to students whose program of study involves a Mathematics major: the goal is to build community and identity, and to explicitly build up some of the program-level learning outcomes articulated in the report.

4. REFLECTION

The Math Department is still in the process of turning the results of this project into concrete changes for the better. Students in our majors programs will benefit directly, but thriving students make for happy faculty as well. Support from the CTLT, both in funding and in expert assistance (thanks, PJ!), was a critical input in making this progress possible. Thank you very much.

UPER Project

Summary and Curriculum Renewal Recommendations

UBC Department of Mathematics UPER Committee
Matt Coles, Young-Heon Kim, Patrick Walls, Elyse Yeager
with PJ Rayner, CTLT

Summary

The purpose of the Undergraduate Program Evaluation and Renewal (UPER) committee is to produce a road map for renewal in the Department of Mathematics undergraduate programs. The committee focused primarily on the BA and BSc Major in Mathematics programs. The process included outlining program level outcomes, gathering information about the current programs through an alumni survey, faculty and staff focus groups and student enrolment and graduation data, evaluating the current program in terms of the desired program outcomes and finally drafting a set of recommendations to improve the program in line with the program outcomes.

Project Goals

- Clearly articulate learning outcomes for BA and BSc Major in Mathematics programs
- Gather relevant data, analyze current programs and compare with program outcomes
- Provide recommendations for learning opportunities to align with program outcomes
- Communicate program outcomes and learning opportunities to students and faculty
- Propose effective advising systems and course planning guides for students
- Propose systems to support sustainable curriculum renewal

Work Completed

- Program Outcomes Statement: program-level learning outcomes for majors programs
- Alumni survey and faculty focus groups
- Interactive Course Map: web application to explore courses, tracks and programs
- Tracks Guide for Students: sub-curricular paths to encourage depth in course planning
- Data pipeline for enrolment data and graduation data
- MATH 446 History of Mathematics: revived course to be offered in 2021/2022
- MATH 319 Introduction to Real Analysis: new course to be offered in 2021/2022

Brief Summary of Recommendations

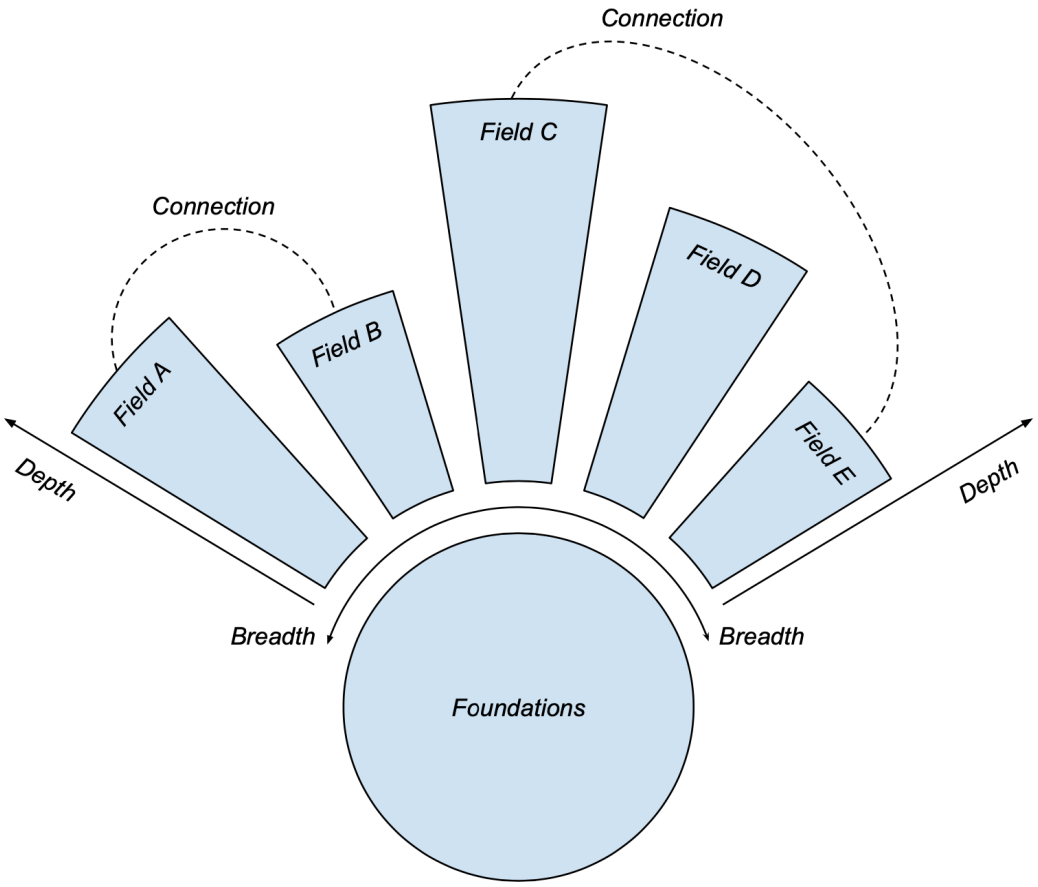
- Cancel unnecessary or orphaned courses (such as MATH 230 and 414)
- Redesign MATH 360 and 441 with emphasis on mathematical computing
- Create “Mathematical Computing Coordinator” roles
- Provide continuous instructor and TA training focused on mathematical software
- Create more depth in algebra, geometry and discrete mathematics
- Update website with current advising information including the interactive course map, tracks guide and alumni profiles
- Create a welcome package for new majors including advising and co-op opportunities
- Foster a sense of community among undergraduates through social events and track cohorts (students with shared interests in the same classes)
- Perform annual data collection and analysis including SISC data, faculty focus groups, alumni survey, and environmental assessments (student inclusion and treatment)

Program Outcomes

The UPER committee consulted the Faculty Advisory Committee and individual faculty members to establish a program outcome statement which outlines the desired learning outcomes for graduates of the BA and BSc Major in Mathematics programs. The outcome statement serves as a guide for the program renewal efforts and a promise to prospective mathematics students.

Summary of Program Outcomes

Upon graduation, students are expected to have a foundational knowledge in core subjects, breadth of knowledge in select fields of their choosing, depth of knowledge in select fields of their choosing, and be able to apply concepts from one field of mathematics to another. This is illustrated in the following diagram. Furthermore, students are expected to develop mathematical and professional skills such as the ability to construct mathematical proofs and assess their validity, effective communication and collaboration, awareness of equity, diversity and inclusion issues and best practices, problem solving and independent research.



Program Outcomes Statement

I. Knowledge of fundamental concepts, applications, and modern developments
   A. To be able to state and apply fundamental concepts, principles, and basic tools in widely used core mathematical subjects (calculus, linear algebra, differential equations) and a selection of specialized subjects.
   B. To be able to apply concepts and techniques from one mathematical subject to other mathematical subjects and to other disciplines.
   C. To be able to use current technological tools, including computer software and programming languages.
   D. To be exposed to some modern developments in mathematical research and/or its practical applications.

II. Basic usage of mathematical language
   A. To be able to judge the logical validity of an argument.
   B. To be able to generate a logically correct, clear, and precise argument, including giving mathematical proofs.

III. Problem solving abilities
   A. To be able to recognize and express mathematical patterns.
   B. To be able to express problems in a mathematically precise way, and to interpret the consequences of mathematical conclusions in both mathematical and real-world problems.
   C. To be able to use computational tools to generate and analyze data, to build intuition about mathematical phenomena, to solve problems that would otherwise be too time-consuming, or to approximate solutions that cannot be found analytically.
   D. To be able to extract a special case or simplification of a general problem that captures its essence.
   E. To be able to divide a complicated problem into several simple ones.
   F. To be able to identify mathematical concepts that will be useful in analyzing a new problem.
   G. To be able to generalize an argument.
   H. Perseverance
      - Students should be able to work independently on a problem and not give up right away.
      - At the same time, students should know when and how to seek help.

IV. Professional skills
   A. Communication Skills
      - Students should be proficient in communications in written and spoken forms, in both formal and informal situations.
      - They should be able to communicate using data, visualizations and computer tools.
   B. Working well in groups, including to know how to negotiate collaborative efforts (for example group-projects).
   C. Ethics

        - Students should know the benefits of equity/diversity/inclusion, the existence of biases and barriers to equitable treatment of others, and tools for overcoming those biases and barriers.
        - Students should know when and how to give credit to their peers or literature sources.

V. Independent inquiry skills and real world problem solving: We want our majors to be able to do more than just do homework or take tests. They should be able to handle real-world problem solving, useful in both academia and industry. In addition to the skills in III., our students are expected to graduate with experiences in independent inquiry activities:
    A. Identify a question that needs answering.
    B. Search related literature.
    C. Explore the problem using computation, visualization, and analytical tools.
    D. Formulate a conjecture and test it using analytical, visual, and computational methods.

See the additional notes in Appendix: Program Outcome Statement Additional Notes.

Current Program Analysis

The UBC Department of Mathematics offers over 90 undergraduate courses and over 10 undergraduate degree programs. The UPER committee surveyed recent alumni and collected enrolment and graduation data to investigate how current courses and programs align with the program outcomes.

Alumni Survey Results

The survey (conducted in 2019) targeted alumni who graduated from the math program in the previous 3 to 5 years. The survey was sent to about 228 alumni and received 82 responses. The main points mentioned by respondents were:

- **More training in mathematical computing and programming**. Students identified the lack of practical programming skills as a key stumbling block in finding employment after graduation. (25 respondents)
- **Stronger connections to real world settings and the applications of mathematics.** (19 respondents)
- **Diversity in instruction, classroom environment, and assessment.** Generally, respondents wanted more progressive teaching: more tutors who can help with upper-level content, more attention to student mental health, less emphasis on memorization, etc. (16 respondents)
- **Assistance with navigating career options.** (6 respondents)
- **More effective advising** including help with course planning. (6 respondents)

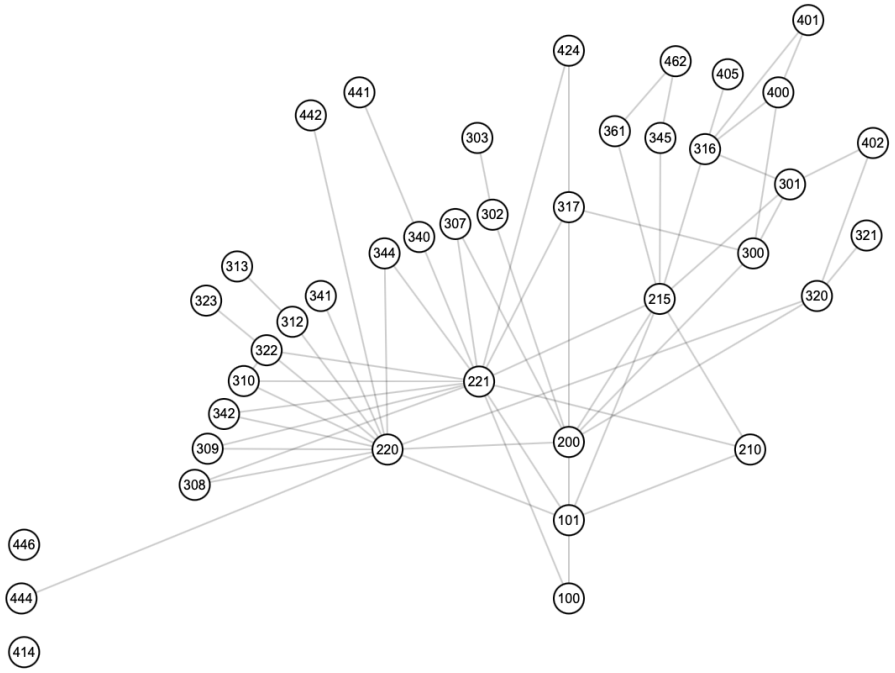
Students think the program was effective at teaching them to state problems carefully and precisely. It was only somewhat effective at demonstrating that mathematical theory is enlightening or useful, teaching general problem solving, exposing them to various levels of mathematical sophistication or becoming proficient with programming software.

Among alumni who graduated in the last 5 years about 10% were looking for employment when surveyed. Over 70% were employed and over 20% were in graduate school. 45 out of 55 respondents see their degree as being related to their current job. More than half of employed graduates were teaching or in the business sector (economist, financial analyst, data analyst, risk modelling, etc.).

Skills students rated important to their current employment were (starting with the highest-rated): problem solving approaches learned in mathematical studies, computational applications, communication of mathematical ideas to non-specialists, mathematical argumentation and justification, and mathematical modeling.

Interactive Course Map

There are over 90 MATH courses in the undergraduate program. The courses along with the web of prerequisites and corequisites create a complex network. We created an interactive data visualization to explore courses, prerequisites/corequisites and degree programs.



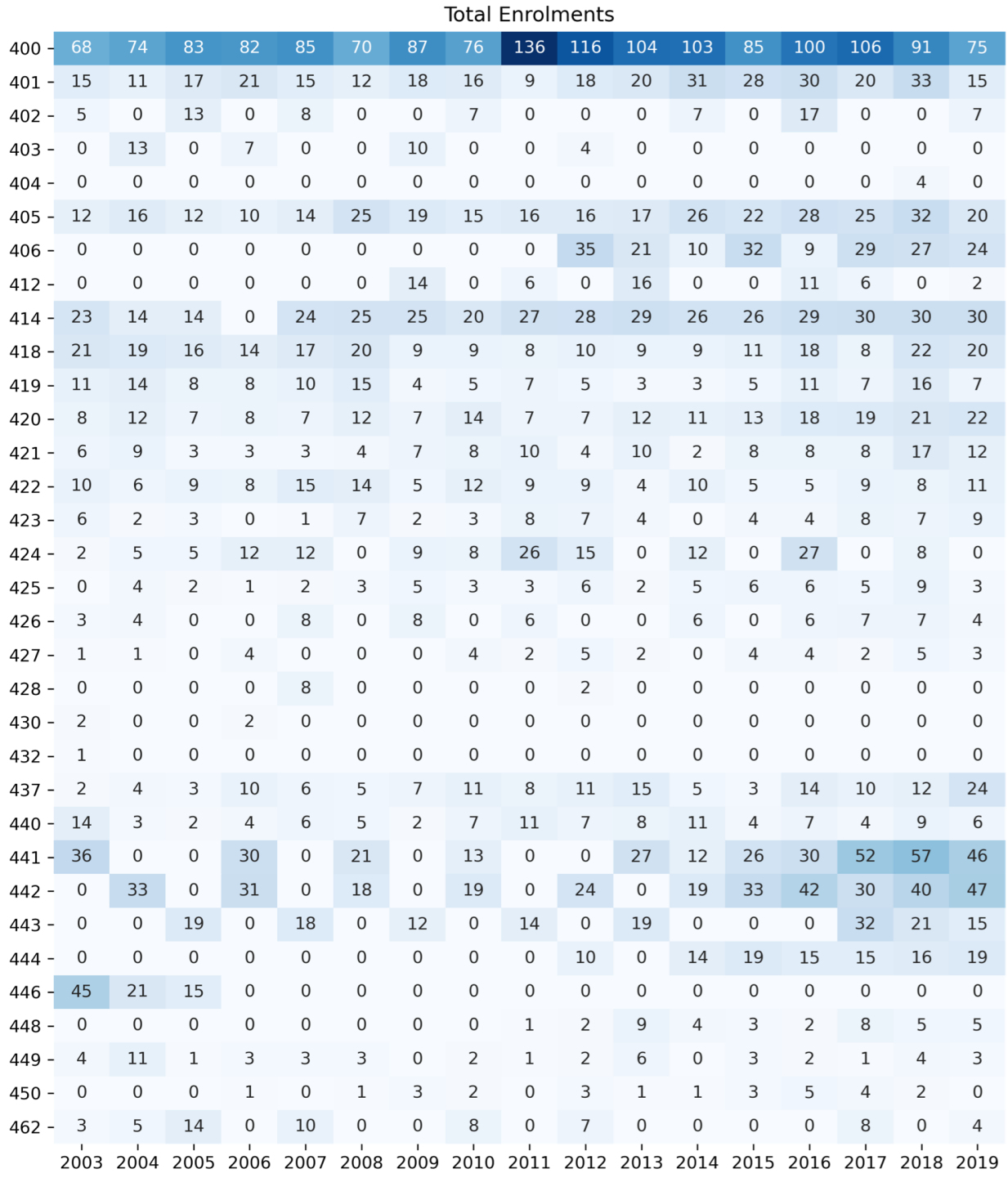
The figure above presents courses intended for BA and BSc students and excludes courses intended for honours, engineering or other programs. See the full interactive course map at https://ubcmath.github.io/coursemap/. See also the complete list of courses offered by the Department of Mathematics in the UBC Course Calendar.

Enrolment Data

Course enrolment data is available through the SISC. The tables below indicate the total enrolment in 300 and 400 level MATH courses from 2003 to 2019 (Winter and Summer sessions included). Note that several 400 level courses are cross-listed with graduate courses and the enrolment numbers in the table below include undergraduate students only.

Total Enrolments

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
300	209	246	254	226	234	233	238	170	157	145	181	206	199	239	179	222	239
301	79	78	65	82	92	86	81	74	26	41	28	31	34	41	26	31	24
302	200	188	205	228	195	214	200	218	202	222	228	240	249	211	342	336	407
303	51	72	84	74	77	83	64	79	72	88	87	74	89	107	196	215	191
305	0	0	0	0	0	0	0	58	60	70	71	77	80	81	79	95	74
307	388	347	343	291	285	228	257	268	243	263	269	333	296	387	539	540	550
308	43	58	41	46	55	54	43	50	67	67	74	73	85	0	88	0	54
309	19	0	60	28	53	0	45	0	24	0	0	0	0	68	0	32	0
310	0	0	0	0	0	11	0	0	0	23	35	0	24	0	51	0	55
312	180	115	89	72	85	98	89	75	106	85	98	75	121	124	183	173	189
313	38	45	0	21	0	22	0	15	0	16	0	0	32	0	23	0	32
316	220	207	198	190	144	149	189	175	183	186	194	198	203	261	256	300	277
317	292	333	270	284	290	226	231	269	215	238	276	299	275	282	388	382	320
318	90	105	87	84	75	76	82	62	79	72	71	92	55	109	84	103	76
320	53	40	50	43	45	40	41	52	39	76	58	69	77	84	92	82	83
321	37	23	36	33	26	24	31	27	27	34	24	29	38	43	47	39	24
322	28	34	30	36	40	30	41	33	38	35	36	29	41	64	39	38	50
323	0	0	0	0	0	0	0	0	0	18	16	11	21	31	17	21	16
335	133	156	90	94	83	69	89	37	45	41	51	76	93	88	93	62	59
340	248	248	246	239	233	192	221	230	212	235	242	236	259	316	327	376	301
341	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	0	47
342	80	155	173	111	114	114	104	79	78	23	40	42	44	0	57	73	44
344	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	67
345	32	27	37	33	28	29	37	24	14	20	36	45	31	0	33	0	15
358	0	0	0	0	0	0	0	0	1	2	1	1	0	0	1	2	0
360	0	0	0	0	0	0	0	0	24	37	42	0	57	0	74	0	76
361	0	32	0	35	0	24	0	25	0	26	0	42	0	40	0	69	0

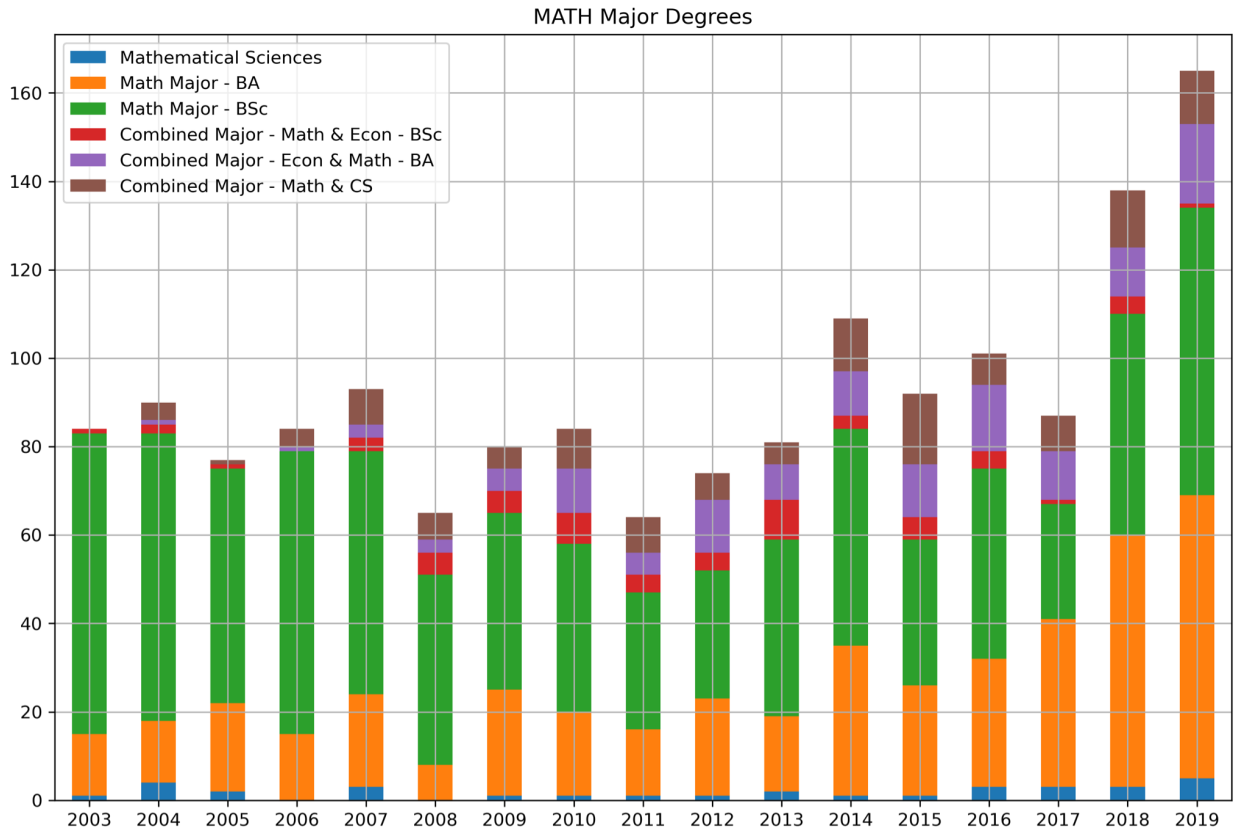

Total Enrolments
400 68 74 83 82 85 70 87 76 136 116 104 103 85 100 106 91 75
401 15 11 17 21 15 12 18 16 9 18 20 31 28 30 20 33 15
402 5 0 13 0 8 0 0 7 0 0 0 7 0 17 0 0 7
403 0 13 0 7 0 0 10 0 0 4 0 0 0 0 0 0 0
404 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 0
405 12 16 12 10 14 25 19 15 16 16 17 26 22 28 25 32 20
406 0 0 0 0 0 0 0 0 0 35 21 10 32 9 29 27 24
412 0 0 0 0 0 0 14 0 6 0 16 0 0 11 6 0 2
414 23 14 14 0 24 25 25 20 27 28 29 26 26 29 30 30 30
418 21 19 16 14 17 20 9 9 8 10 9 9 11 18 8 22 20
419 11 14 8 8 10 15 4 5 7 5 3 3 5 11 7 16 7
420 8 12 7 8 7 12 7 14 7 7 12 11 13 18 19 21 22
421 6 9 3 3 3 4 7 8 10 4 10 2 8 8 8 17 12
422 10 6 9 8 15 14 5 12 9 9 4 10 5 5 9 8 11
423 6 2 3 0 1 7 2 3 8 7 4 0 4 4 8 7 9
424 2 5 5 12 12 0 9 8 26 15 0 12 0 27 0 8 0
425 0 4 2 1 2 3 5 3 3 6 2 5 6 6 5 9 3
426 3 4 0 0 8 0 8 0 6 0 0 6 0 6 7 7 4
427 1 1 0 4 0 0 0 4 2 5 2 0 4 4 2 5 3
428 0 0 0 0 8 0 0 0 0 2 0 0 0 0 0 0 0
430 2 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0
432 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
437 2 4 3 10 6 5 7 11 8 11 15 5 3 14 10 12 24
440 14 3 2 4 6 5 2 7 11 7 8 11 4 7 4 9 6
441 36 0 0 30 0 21 0 13 0 0 27 12 26 30 52 57 46
442 0 33 0 31 0 18 0 19 0 24 0 19 33 42 30 40 47
443 0 0 19 0 18 0 12 0 14 0 19 0 0 0 32 21 15
444 0 0 0 0 0 0 0 0 0 10 0 14 19 15 15 16 19
446 45 21 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0
448 0 0 0 0 0 0 0 0 1 2 9 4 3 2 8 5 5
449 4 11 1 3 3 3 0 2 1 2 6 0 3 2 1 4 3
450 0 0 0 1 0 1 3 2 0 3 1 1 3 5 4 2 0
462 3 5 14 0 10 0 0 8 0 7 0 0 0 0 8 0 4
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019

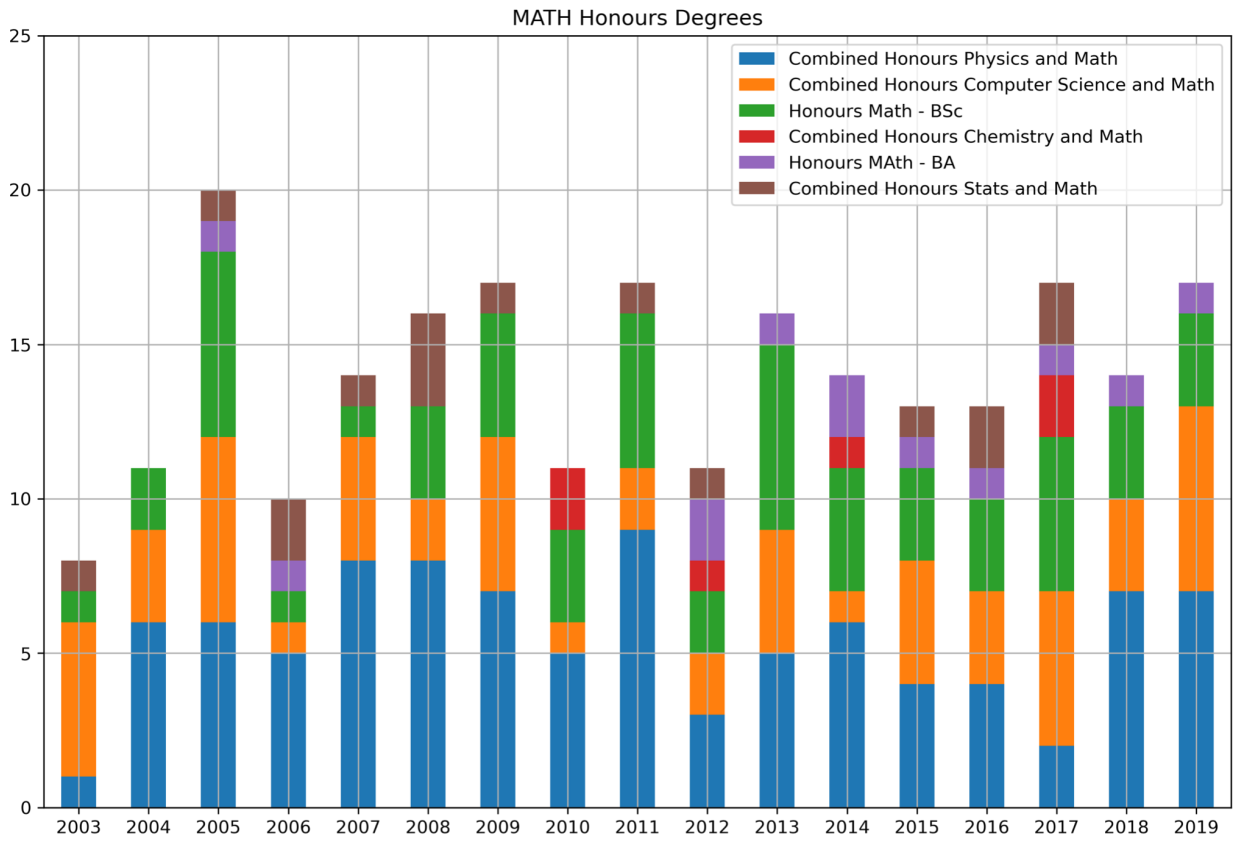
Degree Programs and Requirements

The Department of Mathematics offers Bachelor of Arts (BA) degree programs through the Faculty of Arts, and Bachelor of Science (BSc) degree programs through the Faculty of Science:

- BA Major in Mathematics
- BA Combined Major in Economics and Mathematics
- BA Honours in Mathematics
- BA Combined Honours in Mathematics and Another Subject
- BSc Major in Mathematics
- BSc Major in Mathematical Sciences
- BSc Combined Major in Computer Science and Mathematics
- BSc Combined Major in Mathematics and Economics
- Dual Degree Program: BSc (Mathematics), BEd (Secondary)
- BSc Honours in Mathematics
- BSc Combined Honours in Mathematics and Another Subject

The figures below show the total number of degrees granted by the Department of Mathematics from 2003 to 2019.





Requirements for All MATH Degrees

- Calculus I (MATH 100 or 102 or 104 or 120 or 180 or 184, or 110 for BA only)
- Calculus II (MATH 101 or 103 or 105 or 121)
- Calculus III (MATH 200 or 226)
- Mathematical Proof (MATH 220)
- Linear Algebra (MATH 221 or 223)
- Differential Equations (MATH 215)
- Mathematical Computing (CPSC 210 or MATH 210)

Requirements for BA/BSc Major in Mathematics

- 24 credits of MATH courses numbered 300 and above
- 6 credits of MATH, STAT, or CPSC courses numbered 300 or above

Requirements for BA/BSc Honours in Mathematics

- Calculus IV (MATH 227 or MATH 317 and 220)
- Complex Analysis (MATH 300)
- Real Variables I and II (MATH 320 and 321)

- Algebra I and II (MATH 322 and 323, or MATH 322 and one of 412, 422, or 423 for BA only)
- 15 additional credits from MATH 400-406, 412, 416-429, 433-440, 443, 449
- 9 additional credits of MATH courses numbered 300 or higher

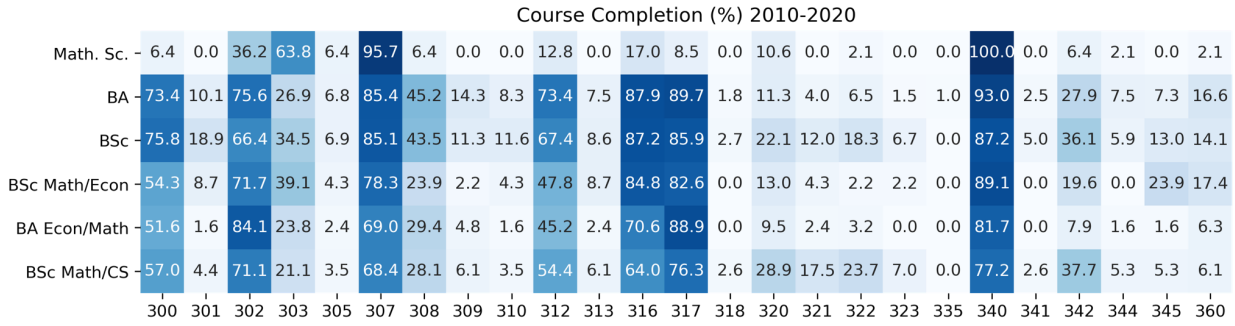
Requirements for BSc Combined Honours in Mathematics and Another Subject

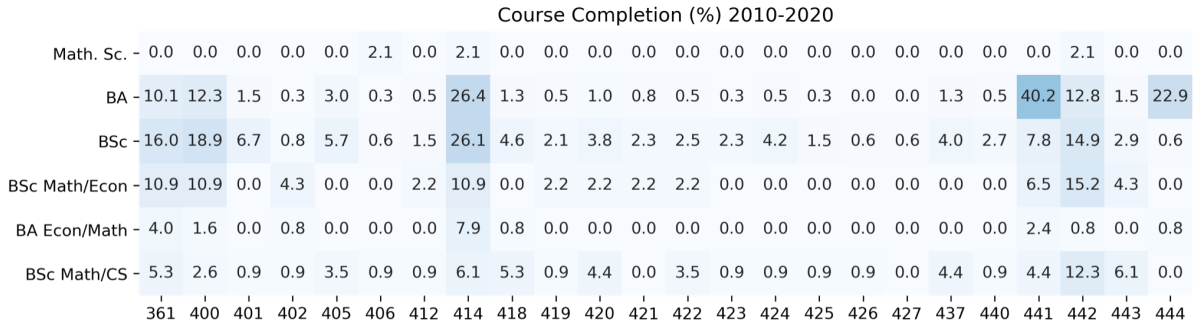
- Real Variables I and II (MATH 320 and 321)
- 9 credits from MATH 300, 301, 316, 322, 323, 331
- 12 credits from MATH 400-406, 412, 418-428, 433-440, 443, 449, 450
- Additional requirements from other department

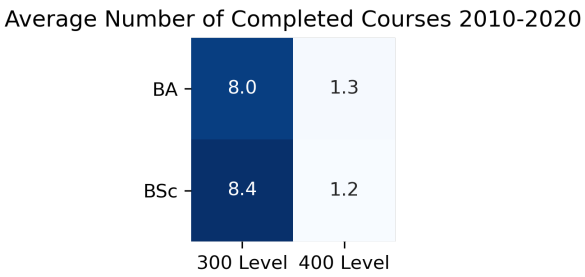
See the Appendix for a more detailed list of degree requirements. See the Faculty of Arts course calendar and Faculty of Science course calendar for complete details.

Course Completion Rates

The degree requirements for majors programs include any 8 MATH courses numbered 300 or above. Course enrolment data and graduation data obtained from the SISC reveal which courses students are taking to satisfy the degree requirements. The tables below show the percentage of students who graduated since 2010 from a given degree program who successfully completed a given course. Note that MATH 341 and 344 were recently created and so their completion rates are lower. Courses with very low enrolment are excluded.







Observations and Analysis

Program Breadth and Depth

- There is a lack of depth in the majors programs in algebra, geometry, topology, discrete mathematics, mathematical computing and applied linear algebra. In particular, MATH 210, 307, 308, 309, 341, 342, 344, 360 and 442 are not connected to any other 300 or 400 level course.
- Courses completed by most majors students are concentrated in a very short list. Since 2010, courses with a completion rate above 50% for BA/BSc graduates are MATH 300, 302, 307, 312, 316, 317 and 340.
- Since 2010, 73% of BA students and 67% of BSc students only took at most one follow-up course: MATH 301, 303, 313, 321, 323, 400, 401, 402, 403, 405, 406, 424, 428, 440, 441, 450, 462.
- Since 2010, 25% of all BSc graduates fulfilled their degree requirements without completing a 400 level course. There are too few 400 level courses for majors other than honours courses and differential equations.
- There are 300 level courses which seem advanced enough to be considered 400 level courses. For example, MATH 313 Topics on Number Theory usually includes analytic and algebraic number theory.

Connections

- MATH 441 is a project course where students solve real-world problems using ideas from multiple fields: optimization, mathematical computing, discrete mathematics.
- MATH 462 is a project course where students solve real-world problems using ideas from multiple fields: ordinary differential equations, mathematical computing, biological systems.
- There are many connections between high-level courses in the honours program.
- There are many connections between high-level courses in partial differential equations and complex analysis.
- There is a lack of opportunity in the majors program to make connections between algebra, geometry, number theory, discrete mathematics, probability, applied linear algebra and real-world applications.

Analysis and Algebra

- Majors students require a score of 80% or higher in MATH 220 to take MATH 320 or 322, and MATH 320 and 322 are prerequisites for many courses.
- MATH 310 can be used by majors as a prerequisite for MATH 322.
- There is currently no analysis option for majors who get less than 80% in MATH 220.
- Since 2010, only 22% of BSc graduates and 11% of BA graduates completed MATH 320, and only 18% of BSc graduates and 7% of BA graduates completed MATH 322.
- MATH 430 Special Topics in Analysis and MATH 432 Special Topics in Algebra have not been offered since 2006.

Mathematical Computing

- MATH 210 and 405 are the only courses with a significant computational component.
- Mathematical computing is implemented in several courses across the program (MATLAB in MATH 152, 221 and 215, and Python in MATH 307, 302 and 303 for example) but there is a need for a more systematic approach to course materials, software and instructor/TA training.

Cross-Listed Courses

- The following courses are cross-listed with graduate courses: MATH 404, 418, 419, 420, 421, 422, 423, 425, 427, 437, 440 and 450.
- These courses are intended for strong honours students and not appropriate for majors.

Courses with Low Enrolment

- MATH 230, 403 and 428 have not been offered in over 10 years.
- MATH 446 has not been offered in many years but reimagining the course provides an opportunity to address equity, diversity and inclusion in mathematics.
- MATH 358 has very low enrolment and should be cut. Bud Homsy was cross-appointed in MATH and MECH and created MECH 358 Engineering Analysis. MATH 358 is cross-listed with MECH 358 however due to Bud's departure years ago we do not have faculty to teach the course and now it is taught by MECH faculty exclusively. Math students should take MATH 316 and not MATH 358.
- MATH 402, 412 and 462 have very low enrolment (but note that MATH 402 was cross-listed as a graduate course in 2019).
- MATH 430 and 432 are topics courses but have not been offered in over 10 years.

Course Overlaps

- MATH 360 and 361 are both courses on mathematical modelling however MATH 361 has MATH 215 as a prerequisite whereas MATH 360 does not. The vast majority of students who take MATH 360 are BA/BSc students who are required to take MATH 215

therefore it does not make sense to offer MATH 360 (which was designed for the Combined Major in Mathematics program).
- There is a lot of overlap between MATH 442 and MATH 443 but they are not credit excluded. Only 3 major students took both MATH 442 and 443 since 2010.
- MATH 305 is a combination of MATH 300 and 301, MATH 318 is a combination of MATH 302 and 303, and MATH 406 is a combination of MATH 401 and 405. MATH 305, 318 and 406 are designed for the Engineering Physics program.

Degree Programs and Requirements

- The total number of honours graduates has remained steady at around 15 per year however the number of majors has more than doubled from 81 in 2013 to 165 in 2019.
- In 2019, 129 of 165 majors were BA/BSc Majors in Mathematics therefore these students should be the focus of our curriculum renewal efforts.
- The degree requirements for the BA/BSc programs needs to be more structured. The minimum 300 and 400 level requirement is simply any 8 MATH courses 300 or above.

Communication, Research and Writing Courses

- MATH 441, 444 and 462 are project courses which satisfy the Research Component of the BA degree requirement (and the list also includes MATH 437, 445, 448).

Equity, Diversity and Inclusion

- There are currently no explicit opportunities for students to address EDI issues in mathematics. Students should be introduced to the importance of EDI in their first and second years. Moreover, EDI issues should come to the fore and be acknowledged as a core competency in STEM programs.
- MATH 446 Topics in the History of Mathematics I has not been offered since 2005. The course can be a good place to include EDI issues in mathematics. We recommend reviving it.

Engineering Courses

- We offer many different versions of our courses for engineering programs.

Mathematics Education

- MATH 335 Introduction to Mathematics is not for credit in the Faculty of Science.
- MATH 414 Mathematical Demonstrations consists of workshops for secondary school students.
- 26% of all BA/BSc students take MATH 414. That is the 11th highest completion rate.

- MATH 414 is required for Dual Degree Program: BSc Mathematics BEd Secondary however there have only been 19 students since 2010 who have completed the dual degree program.

Co-curricular Activities

- Co-operative Work Placement Program: MATH 398, 399, 498 and 499
- There have been 177 co-op work placements for BA/BSc students since 2010.
- There are usually about 5 students in MATH 448 Directed Studies each year.

Recommendations

Courses to Cancel

The analysis of enrolment data and the course map reveal unnecessary or abandoned courses and courses with low enrolment. The following recommendations are directed to the Undergraduate Affairs Committee for review.

Recommendation	Rationale
Cancel MATH 414	MATH 414 consists of delivering workshops to junior high and high school students and enrolment is 25-30 students per year. It is required by the Dual Degree BSc Math BEd Math program however only 19 students since 2010 completed the dual degree. The course is not based on any kind of pedagogical theory or best practices. It's just math students solving tricky problems for secondary school students. Consult with the Faculty of Education to cancel MATH 414.
Cancel MATH 230, 403, and 428	MATH 230, 403 and 428 have not been offered in over 10 years.
Cancel MATH 358	Bud Homsy was cross-appointed in MATH and MECH and created MECH 358 Engineering Analysis. MATH 358 is cross-listed with MECH 358 however due to Bud's departure years ago we don't have faculty to teach the course and now it is taught by MECH faculty exclusively. Math students should take MATH 316 instead.
Undergraduate Affairs Committee should review MATH 412	MATH 412 is an honours course, not cross-listed with a graduate course and has very low enrolment. The Undergraduate Affairs Committee should explore whether to cancel the course or find a way to boost enrolment.

Breadth, Depth and Connection

The program outcome statement includes breadth, depth and connections. In terms of breadth we offer a wide choice of courses, however, our program lacks depth for major students, and has weak connections across different courses. We therefore need to create structured learning opportunities in these areas.

Recommendation	Rationale	Outcomes
Align MATH 443 with MATH 442	MATH 442 is an introduction to graph theory for majors. MATH 443 is an introduction to graph theory for honours. Only 3 students have taken both since 2010. We want to encourage majors to take both as a sequence to add depth to the majors program. Reorganize MATH 443 with prerequisite “one of MATH 442 or MATH 320” and encourage majors to take both 442 and 443 (but allow honours students to skip 442). Perhaps rename 442 as 343 since it really is a 300 level course.	Depth
Require one of MATH 342 or 322 as a prerequisite for MATH 309	MATH 309 requires MATH 221 and 220 only. Liam Watson and Ben Williams are enthusiastic about reimagining MATH 309 as MATH 309 Topics in Algebraic Geometry and Topology. By requiring one of MATH 342 or 322 the course could connect groups, rings and fields to geometry and topology.	Depth and Connection
Require MATH 323 as a prerequisite for MATH 427	Liam Watson and Ben Williams describe difficulty teaching MATH 427 without student prior knowledge of rings and modules. Although MATH 322 and 323 are required for Honours Mathematics, they are not required for combined honours programs. However students who take 427 should probably take 322 and 323.	Connection

Mathematical Communication

Recommendation	Rationale	Outcomes
Look for opportunities to integrate	With our look into MATH 414, it is clear that students looking to pursue education receive no pedagogical training while in MATH courses.	Connection

pedagogical best practices in MATH courses	We can consult with Education to recommend EDUC courses to our Math Majors interested in teaching. Eventually we might consider a course on pedagogical content knowledge for high school math and/or a course on connections between upper level math and high school math.	
Look for opportunities to integrate written and oral communication in current MATH courses	While homework assignments provide opportunities for students to practice communicating mathematics, there is currently very little opportunity for students to practice communicating mathematics orally, learn presentation skills, or prepare and write longer reports on a more substantial project. We would also like to bolster our students' ability to communicate with the general public (much like the popular science communication) so that they can be ambassadors of mathematics.	Professional Communication

Mathematical Computing

Our analysis shows that MATH 210 and 405 are the only courses with a significant computational component. We need to create two kinds of learning opportunities in mathematical computing. First, any one course will not reach all students therefore we need to integrate mathematical computing at a basic level throughout the program. Second, we need to create more opportunities for students to build proficiency in dedicated courses.

Recommendation	Rationale	Outcomes
Redesign MATH 360 as an introduction to computational mathematical modelling	MATH 360 was designed for the Combined Major in Science program and requires only MATH 101. However, in 2019, 53 out of 76 students in MATH 360 were BA/BSc Major in Mathematics students. Redesign MATH 360 with emphasis on computation, prerequisites MATH 210, 221, 215 and 200, and align with MATH 361, 345 and 462.	Connection, Mathematical Computing
Redesign MATH 441 as a projects course in applied linear algebra	MATH 441 fulfills the research degree requirement for the BA program. The only prerequisite is MATH 340 and the applications are dated. Redesign the course as MATH 441 Projects in Applied Linear Algebra with prerequisites MATH 210, 307 and 340 and include modern applications (compressed	Depth, Connection, Mathematical Computing

	sensing, deep learning, medical imaging, operations research, etc.).	
Create new “Mathematical Computing Coordinator” roles (2 faculty members at 0.25 course credit per semester each)	Adding a computing component to large classes creates too much extra work for the instructor in charge to handle on their own. It would be efficient to have one instructor coordinating mathematical computing for all the large courses (similar to the WeBWorK support currently provided by Matt Coles). Mathematical Computing Coordinator consults with IIC, supervises TAs, sets up Canvas assignments and provides support in large courses. (Patrick Walls currently performs this duty for MATH 152, 221, 215, 303, and 307 for 0.25 course credit per semester).	Mathematical Computing
Create mathematical computing training program for TA/instructor	Run software training and pedagogy workshops for instructors and TAs at least twice per year. Focus on mathematical software Python, Julia, Jupyter, Syzygy, nbgrader, GitHib/GitLab, CanvasAPI, MATLAB and mbgrader. Provide educational design training including how to design formative and summative assessments.	Mathematical Computing
Invest resources to create new course materials and assessments for mathematical computing	It takes time and expertise to create new educational content. For example, assignment questions for MATH 215 have been developing very slowly with varying degrees of success (see GitLab repo). Provide course buyouts for faculty to develop new course materials and assessments for mathematical computing.	Mathematical Computing

Changes in Progress

MATH 319 Real Analysis for Majors

The ability to construct and assess a rigorous mathematical proof is an essential program outcome. MATH 220 Mathematical Proof is required for all math majors and provides an introduction to mathematical proof. On its own, however, it does not meet the level of rigour we expect for graduates of our undergraduate program.

MATH 320 Real Variables I has the desired level of rigour, but is too advanced for many. MATH 320 is also a prerequisite for several other courses in the program, leaving these courses out of reach for many majors. In order to encourage a high level of proficiency with mathematical

proofs for all our majors, and to give them a pathway to access to upper-level courses, MATH 319 has been created.

MATH 319 is an analysis course designed for non-honours majors. It will be offered for the first time in 2021/2022. It is a more accessible version of MATH 320 and presents a basic introduction to modern analysis. The purpose of its creation is for all math majors to meet the desired level of rigour of mathematical analysis and to have the chance to take follow-up courses in analysis, topology and probability.

MATH 446 History of Mathematics

MATH 446 Topics in the History of Mathematics I has not been offered since 2005. The course has been revived in collaboration with Kseniya Garaschuk from the University of the Fraser Valley and will be offered in 2021/2022. The goal is to explore a more inclusive history of mathematics and to address issues of equity, diversity and inclusion in mathematics. MATH 446 also satisfies the Research Component of the BA degree requirements.

Tracks Guide for Students

To encourage students to include depth in their course planning, we have set up several sub-curricular paths which we call “tracks”. A track highlights a subset of courses which work well together and provide opportunities to acquire depth of knowledge and to find connections between fields. The full list can be found in the appendix.

Track information is still under development and will be included in the new department website and interactive course map. Each track will include a brief description including potential career goals and feature short profiles of alumni and the tracks they followed.

Expanded Advising

Interactive Student Advising Webpage

The alumni survey revealed that students want more advising in their course selections. Given the size of the program, there is a limit to how much in-person advising is feasible. One of the methods to mitigate the current lack of personalized advising is to set up a new and interactive web page with accessible information to inform students’ curriculum planning.

We know that students have difficulty finding advice about which courses they should take (Science advising gets many of these requests). However, the faculty advising committee members (2nd year, 3rd year, etc) see very little in the way of mathematical requests and mostly deal with registration requests. Our webpage will need to be updated to include detailed information about who to contact for what kind of request, perhaps including a webform to funnel admin requests to the correct people. Talking with undergraduate students about which mathematical courses they should take will make for engaging and rewarding work for some

faculty. Moreover, real human advising will help to retain strong students. In this way, we should encourage our students to seek out in-person advising at some point during their degree.

Welcome Package for Majors

To encourage communication and highlight the new interactive web page, we can send a welcome package to students who newly enroll in the program. The welcome package can also contain a guide for major students, which can be prepared together with the Undergraduate Affairs Committee. Current students can also receive similar info in a friendly email each year advertising program events. The welcome package serves as an additional opportunity to highlight that math is for everyone and in particular to introduce students to EDI early on in the program. The welcome package further addresses the hidden curriculum, giving first-generation students structure and information about how to obtain support.

Community Building Events

Students' confidence/knowledge/familiarity/comfort with the program will be empowered by regular department community building events as well as structured mentoring that pairs undergraduate students with more senior students, graduate students, or faculty, for occasional coffee chats. We currently have a staff member dedicated to community building events. Together with this staff member we should run advising events, talks aimed at the undergraduate level, and panel events which highlight the individual journeys of those who took mathematics in university.

Tracks Guide for Students

The major tracks will be a soft recommendation to begin with, but can become more popular and useful by adding prospective jobs to each track, perhaps with past student profiles. Students are not likely to know what they want to study and what they want to do after graduation, so we should give many tangible options. In addition to highlighting these tracks on our webpage and at events, we should regularly collect info (registration data and survey data) about how students are using the tracks. After piloting the tracks in a soft way, we can motivate more students to follow the tracks by providing a certification from the department.

Expected Impacts

We hope that better advising about course selection will result in students graduating with a better understanding of mathematics at an appropriate level, having been exposed to at least one topic in depth, in particular, through the tracks. We hope they are able to see how the things they've learned relate to one another, rather than seeing each course as disconnected from the others. Further, we hope that our students graduate better prepared for the job market in the field of their choice.

With pre-defined tracks, we also hope that our majors will see familiar faces in their math courses, giving them a better opportunity to connect with one another and feel like part of a community.

The implementation of MATH 319 should open up 400-level classes to more of our majors. We hope that this (combined with better advising and tracking, so students understand the opportunity) will lead to increased enrolment in upper-level classes and students graduating with a more rigorous mathematical foundation.

The reinstitution of the history of mathematics MATH 446 will provide opportunities for our students to understand more about the cultural aspects and the social history of our field. We hope they appreciate the way mathematics has been advanced by collaboration, and that they are pushed to think critically about the ways the community can continue to improve. We hope students from all backgrounds will feel like they can be a part of our shared culture, community, and history.

Having more thorough computational training distributed throughout the curriculum will hopefully give our students an edge in the job market, which increasingly expects programming skills.

Over time, if we graduate students who have a solid understanding of their fields, who have learned relevant job skills, and who are proud of the community they learned in, we hope the reputation of a UBC mathematics degree will grow. This will further help our students when they graduate and find jobs, and might even attract students with more competitive backgrounds.

It is possible that raising the expectations placed on our majors could lower enrolment. If our numbers start to decline, we hope it will be because we are admitting only more highly qualified students. Whether this is desirable is a broader discussion to be had with the department.

Sustainability and Continuous Curriculum Renewal

Permanent UPER Subcommittee

We outline below a new set of responsibilities required to implement and sustain the recommendations of the UPER project and we recommend assigning these responsibilities to a new subcommittee of the Undergraduate Affairs Committee (UAC). The UPER subcommittee will provide information, data analysis and recommendations to the UAC.

Data Collection and Analysis

Faculty, student and alumni surveys were essential to the UPER project and will continue to be essential. The UPER subcommittee should conduct annual surveys to assess the undergraduate program in relation to the program outcomes.

Course enrolment and graduation data analysis was performed in a collection of Jupyter notebooks shared privately on OwnCloud. The same analysis should be performed annually with updated datasets pulled from the SISC.

It is crucial to maintain up-to-date student advising information on the department webpage including the course map, alumni profiles and career information.

Continuous TA and Instructor Training

Mathematical computing skills is one of the key program outcomes identified by the UPER committee. Development of computational components of several courses is currently underway and requires continuous training for TAs and instructors. Mathematical computing workshops should be offered at least twice per year and align with current teaching workshops for new instructors. The workshops should focus on mathematical software such as Python, Julia, Jupyter, Syzygy, nbgrader, GitHib/GitLab, CanvasAPI, MATLAB and mbgrader, and provide educational design training including how to design formative and summative assessments.

Support for Curriculum Development

Curriculum renewal requires updating course material and the job of the instructor of each course, but assistance from the department may ease such a difficult task. The committee may focus on creating examples of assessment such as assignments and exams, that are targeted at the learning outcome; the style of assessment gives the students an important signal what is important to learn. This can be a time-consuming task, so in a given term the committee can focus on a course that is pivotal to the curriculum, e.g. MATH 220 and MATH 319.

Appendix

Program Outcomes Statement Additional Notes

Item	Note
I.A	These three courses are the obvious basics in our current curriculum: all our current major programs require courses in all three subjects, other than the Major in Mathematical Sciences which does not require differential equations.
I.B	It is important to learn how to view and connect ideas from different angles. For example, our students will be able to use knowledge from calculus, differential equations, and linear algebra to solve an optimization problem arising from probability theory. Other disciplines include (but are not limited to) biology, chemistry, computer science, economics, engineering, physics, and statistics.
I.C	One of the major suggestions from the alumni survey was that we need to make a better effort to teach students modern programming skills. A lot of alumni gave lack of programming experience as a real barrier to employment. There is already a computational course in an engineering program, which one of our faculty members is currently teaching. This can certainly be adapted as a math course. Once such a course is taken, students will be more comfortable to use the tools in the subsequent courses they take.
I.D	It is intended to encourage us not to teach only 19th century / early 20th century math.
I.A,I.B	These items are being addressed in our current curriculum by courses such as Math 220.
III	Our intention is that these abilities should apply equally well to pure mathematics and to applied mathematics and modelling.
III.B	There are some courses that focus on this point, like Math 360. Many other courses at a lower level (for example, Math 100, 102, 255, 256) or a higher level deal with it directly or indirectly.
IV.A.1	Written - formal -- students should be able to produce a professional-looking math-heavy document. - blackboard -- good board work. - slides -- put together clear slides.

IV.A.2	Spoken - informal discussion (small and large group), - formal presentation (chalk or projected).
IV.A.3	They should be able to: - Identify and gauge their audience. - Answer questions by diagnosing what the asker doesn't know and conveying optimal info.
V	This should not be interpreted literally that students have to do real research, which can be very challenging for undergraduate students. The goal is to give students experiences of curiosity driven learning activities. Students can be exposed to such research like experiences from early on, e.g. in calculus courses, with open-ended questions and short term-projects. In later years, these experiences can be more amplified/sophisticated in higher level courses, which may include term and/or group projects.

Program Track Details

100 and 200 Level Degree Requirements

The 100 and 200 level degree requirements involving MATH courses are all the same for all MATH degrees:

Calculus I	MATH 100, 102, 104, 120, 180 or 184
Calculus II	MATH 101, 103, 105 or 121
Calculus III	MATH 200 or 226
Linear Algebra	MATH 221 or 223
Differential Equations	MATH 215
Mathematical Proof	MATH 220
Mathematical Computing	MATH 210 or CPSC 210

- Students obtaining 68% or higher in MATH 226 can substitute MATH 220 by 3 credits of electives
- BSc Mathematical Sciences requires CPSC 210

The 300 and 400 level degree requirements vary for each degree but require at least 24 credits of MATH courses numbered 300 or above. The tracks outlined below describe recommended subsets of 300 and 400 level courses.

Applied Track for Graduate School

A rigorous foundation for students wishing to enter graduate school for applied mathematics. Similar to honours but with a focus on applied over pure topics.

300	Introduction to Complex Variables
302	Introduction to Probability
303	Stochastic Processes
301	Applied Analysis
320	Real Variables I
321	Real Variables II

317	Calculus IV (or 227 in previous year)
316	Elementary Differential Equations II
345	Applied Nonlinear Dynamics and Chaos
400	Applied Partial Differential Equations
401	Green's Functions and Variational Methods
405	Numerical Methods for Differential Equations
402	Calculus of Variations
	Electives
420	Real Analysis I
421	Real Analysis II
450	Asymptotic and Perturbation Methods

Notes

- Students with a deep interest in a particular application outside of mathematics may consider one of the combined honours programs: MATH & PHAS, MATH & CPSC, MATH & STAT.
- MATH 316 is a prerequisite for a number of downstream courses (400, 401, 405), so students are encouraged to take this before their fourth year.

Mathematics for Teaching and Communication

This track is intended for students interested in jobs involving general mathematical communication. Students planning on pursuing careers in secondary education, science-based entertainment, or science journalism might be interested in these courses (with the understanding that those jobs often require qualifications beyond a mathematics degree).

	Stat 200, elementary statistics for applications
	Stat 251, Elementary Statistics
307	Applied linear algebra
308	Euclidean geometry
312	Introduction to Number Theory
340	Introduction to Linear Programming

322 or 342	Introduction to group theory or Algebra and Coding Theory
302	Probability
441	Mathematical modeling
444 or 446	Mathematical Research and Writing or Topics in the History of Mathematics I
	Depth Option 1: Take at least 2
341	Introduction to discrete mathematics
344	Mathematical game theory
442	Graphs and networks or
	Depth Option 2: Take both
361	Introduction to mathematical biology
462	Projects in mathematical biology

Notes

- Students interested in secondary education should seriously consider the dual degree in mathematics and education. For a more rigorous generalist specialization, compare to the Pure Mathematics Track.
- Depth option 1 focuses on discrete mathematics, which has applications to networks, cryptography, puzzles, and game theory. Depth option 2 has an emphasis on the mathematics used in biology research and modeling

Mathematical Biology

Mathematical modelling in the biological sciences including stochastics processes, dynamical systems and computational methods. Applications in ecology and evolution, epidemic modelling, developmental biology, physiology and cell and molecular biology.

300	Introduction to Complex Variables
317	Calculus IV
302	Introduction to Probability
303	Introduction to Stochastic Processes
316	Partial Differential Equations
345	Applied Nonlinear Dynamics and Chaos

400	Applied Partial Differential Equations (prerequisite for 401, 450)
405	Numerical Methods for Differential Equations
361	Introduction to Mathematical Biology
462	Projects in Mathematical Biology
	Electives
307	Applied Linear Algebra
401	Green's Functions and Variational Methods
450	Asymptotic and Perturbation Methods
344	Mathematical Game Theory

Applied Mathematics

Analytical and numerical methods for ordinary and partial differential equations, mathematical modelling of real-world phenomenon in science and engineering and practical scientific computing.

MATH 300	Introduction to Complex Variables
MATH 301	Applied Analysis
MATH 302	Introduction to Probability
MATH 303	Introduction to Stochastic Processes
MATH 316	Elementary Differential Equations II
MATH 317	Calculus IV
MATH 345	Applied Nonlinear Dynamics and Chaos
MATH 400	Applied Partial Differential Equations
MATH 401	Green’s Functions and Variational Methods
MATH 405	Numerical Methods for Differential Equations

Mathematical Optimization

Mathematical theory and computational tools for optimization problems arising in economics, data science and engineering.

300	Introduction to Complex Variables
302	Introduction to Probability
317	Calculus IV
307	Applied Linear Algebra (prerequisite for CPSC 406)
340	Introduction to Linear Programming
441	Discrete Optimization
319 or 320	Introduction to Real Analysis or Real Variables I
402	Calculus of Variations
CPSC 406	Computational Optimization
	Electives
344	Mathematical Game Theory
316	Elementary Differential Equations II
303	Introduction to Stochastic Processes
321	Real Variables II (To be taken after Math 320)

Discrete Mathematics

In mathematics, “discrete” is the opposite of “continuous.” Discrete mathematics deals generally with systems made up of individual entities, rather than things existing on a continuum: networks, cryptography, and games are common examples. Possible careers for which this track would be of interest include programming/software development, digital communications, and digital recording.

307	Applied Linear Algebra
312	Introduction to Number Theory
340	Introduction to Linear Programming
341	Introduction to Discrete Mathematics

342	Algebra and Coding Theory
344	Mathematical Game Theory
441	Mathematical Modelling: Discrete Optimization Problems
442	Graphs and Networks
443	Graph Theory
	Elective
302	Introduction to Probability
313	Topics in Number Theory
319	Real Analysis

Mathematics of Information

Mathematical models in signal processing, statistics and machine learning.

MATH 344	Mathematical Game Theory
MATH 302	Introduction to Probability
MATH 303	Introduction to Stochastic Processes
MATH 307	Applied Linear Algebra
MATH 340	Linear Programming
MATH 342	Algebra and Coding Theory
MATH 319	Introduction to Real Analysis
MATH 442	Graphs and Networks
MATH 441	Mathematical Modelling: Discrete Optimization Problems
MATH 443	Graph Theory

Pure Mathematics

This track is intended for those students who are interested in learning basic mathematical subjects such as analysis, algebra, and geometry in a more depth and rigour.

- Foundational: 300, 302, 310, 317, 319, 342, 444/446
- Specializations:
    - Geometry: 308, 309
    - Probability: 303, 344
    - Number Theory: 312, 313
    - Discrete Math: 341, 442

300	Introduction to Complex Variables
302	Introduction to Probability
310	Abstract Linear Algebra
317	Calculus IV (or MATH 227 in previous year)
319	Introduction to Real Analysis
342	Algebra and Coding Theory
444 or 446	Mathematical Research and Writing or Topics in the History of Mathematics I
	Electives I (Take at least two courses in this group)
303	Introduction to Stochastic Processes
308	Euclidean Geometry
309	Topics in Geometry
312	Introduction to Number Theory
313	Topics in Number Theory
341	Introduction to Discrete Mathematics
344	Game Theory
	Electives II (Take at least one course in this group)
402	Calculus of Variations
424	Classical Differential Geometry
442	Graph and Networks

Advanced Pure Mathematics

This track is intended for those who intend to apply for graduate school in areas of pure mathematics. This track is similar to the honours program but with less requirements. Students who consider this track are highly recommended to consider the honours program. Some of the 300 level courses such as 300, 302, 317 are recommended to be taken in their 2nd year.

- Foundational: 300, 302, 317, 320, 321, 322, 323, 426
- Specializations:
    - Algebra and Number Theory: 312, 313, 412
    - Algebra and Discrete Math: 312, 412, 443
    - Algebra and Geometry: 309, 412, 424
    - Analysis: 303, 402

300	Introduction to Complex Variables
302	Introduction to Probability
317	Calculus IV (or MATH 227 in previous year)
320	Real Variables I
321	Real Variables II
322	Introduction to Group Theory
323	Introduction to Rings and Modules
444 or 446	Mathematical Research and Writing or Topics in the History of Mathematics I
	Electives I (courses in this group are optional)
303	Introduction to Stochastic Processes
309	Topics in Geometry
312	Introduction to Number Theory
313	Topics in Number Theory
	Electives II (Take at least two courses in this group)
402	Calculus of Variations
412	Advanced Linear Algebra
424	Classical Differential Geometry
426	Introduction to Topology
443	Graph Theory

Degree Requirements

See the Faculty of Arts course calendar and Faculty of Science course calendar.

All MATH Degrees

- Calculus I (MATH 100 or 102 or 104 or 120 or 180 or 184, or 110 for BA only)
- Calculus II (MATH 101 or 103 or 105 or 121)
- Calculus III (MATH 200 or 226)
- Mathematical Proof (MATH 220)
- Linear Algebra (MATH 221 or 223)
- Differential Equations (MATH 215)
- Mathematical Computing (CPSC 210 or MATH 210)

BA Major in Mathematics

- 24 credits of MATH courses numbered 300 and above
- 6 credits of MATH, STAT, or CPSC courses numbered 300 or above

BA Combined Major in Economics and Mathematics

- 18 credits of MATH courses numbered 300 or higher (from MATH 302, 303, 320, 321, 402, 403, 418, 419, and 443)
- Additional ECON requirements

BA Honours in Mathematics

- Calculus IV (MATH 227 or MATH 317 and 220)
- Complex Analysis (MATH 300)
- Real Variables I and II (MATH 320 and 321)
- Algebra I and II (MATH 322 and one of 412, 422, or 423)
- 15 additional credits from MATH 400-406, 412, 416-429, 433-440, 443, 449
- 9 additional credits of MATH courses numbered 300 or higher

BA Combined Honours in Mathematics and Another Subject

- Calculus IV (MATH 227 or MATH 317 and 220)
- Computer Science (CPSC 110 or CPSC 103 and 107)
- Real Variables I and II (MATH 320 and 321)
- 6 credits chosen from MATH 300, 301, 316, 322, 331
- 12 credits chosen from MATH 400-405, 412, 416-429, 433-440, 443, 449
- Additional requirements from other department

BSc Major in Mathematics

- 24 credits of MATH courses numbered 300 or higher
- 6 credits of MATH, STAT, or CPSC courses numbered 300 or higher

BSc Major in Mathematical Sciences

- Probability (MATH 302)
- Three courses from MATH 215, 303, 307, 340
- Two additional courses from CPSC 302, 303, 320, 340, 402, 406, 420, 421, MATH 215, 303, 307, 340, STAT 404, 406, 443
- Additional CPSC and STAT requirements

BSc Combined Major in Mathematics and Economics

- 18 credits of MATH courses numbered 300 or higher
- Additional ECON requirements

BSc Combined Major in Computer Science and Mathematics

- 21 credits MATH courses numbered 300 or higher
- Additional CPSC requirements

Dual Degree Program: BSc (Mathematics), BEd (Secondary)

- Mathematical Demonstrations (MATH 414)
- 21 credits of MATH courses numbered 300 or higher
- 6 credits of MATH, STAT, or CPSC courses numbered 300 or higher
- Additional EDUC requirements

BSc Honours in Mathematics

- Calculus IV (MATH 227 or MATH 317)
- Complex Analysis (MATH 300)
- Real Variables I and II (MATH 320 and 321)
- Algebra I and II (MATH 322 and 323)
- 15 credits from MATH 400-406, 412, 418-428, 433-440, 443, 449, 450
- 9 credits of MATH courses numbered 300 or higher

BSc Combined Honours in Mathematics and Another Subject

- Real Variables I and II (MATH 320 and 321)
- 9 credits from MATH 300, 301, 316, 322, 323, 331
- 12 credits from MATH 400-406, 412, 418-428, 433-440, 443, 449, 450
- Additional requirements from other department