Writing Development Initiative
2020-2021 Application Form

Course Code
MAT202 – Introduction to Discrete Mathematics

Instructor
TJ Yusun (Lecturer, MCS)

Course Enrolments

	Max enrolment	Final enrolment
Fall 2019, LEC0101	100	88
Winter 2020, LEC0101	100	81
Winter 2020, LEC0102	100	77
Fall 2020	**100**	
Winter 2021	**200**	

Background and Learning Outcomes

The course MAT202 is a requirement for the Mathematics major and specialist programs. In this course students are introduced to counting techniques, elementary number theory, and graph theory; the focus is on developing the argumentation and communication skills that they need to succeed in further math courses.

In the past few years, there hasn't been a significant writing component to this course. The language of mathematical argumentation is introduced in their first-year MAT102 (Introduction to Proofs) course, to some extent; in MAT202 this is typically eschewed in favor of calculations. As a result students leave the course no more fluent in mathematical language than when they enter: for instance, it is a pervasive belief that writing a series of equations suffices as a complete argument, even without using any English words. (This couldn't be farther from reality: a quick skim of journals and textbooks reveal the importance of proper writing to the communication of mathematics.)

The desired learning outcomes attached to the proposed modules and assessments below include:

- Read a mathematical argument and evaluate it for correctness, completeness, and clarity.
- Use the language of mathematics (including terminology, notation, logical connectors and phrasing) to accurately and clearly communicate an argument or solution to a problem.

Course Structure, Fall 2019

The course was delivered in the Active Learning Classrooms (ALCs) in Fall 2019, and was structured as follows: students would read the assigned topic and answer the associated pre-class quiz at the beginning of the week, while in-class time was spent clarifying misconceptions and group discussions and activities.

	Week 1	**Week 2**	**Week 3**
Mon	Week 1 pre-class online quiz	Week 2 pre-class online quiz	Week 3 pre-class online quiz
Tue	Week 1 LEC	Week 2 LEC	Week 3 LEC
Wed	Tutorials Reading for Week 2 posted	Tutorials Reading for Week 3 posted	Tutorials Reading for Week 4 posted
Thu			
Fri	Week 1 LEC	Week 2 LEC	Week 3 LEC

(and so on until Week 12)

The flipped nature of the class necessitated timely and relevant feedback, so we had several low-stakes formative assessments: four assignments and four group tutorial activities spread out over the term. Summative assessments included two term tests and a final exam.

Proposed Interventions, Fall 2020 / Winter 2021

The proposed writing-focused interventions in the Fall 2020 and Winter 2021 terms will be integrated into a similar course structure, replacing tutorial activities and adding a final math portfolio. Assignments will not only be marked for correctness but completeness and clarity of writing.

Intervention 1: Introduction to LaTeX (Online videos)

The overwhelming majority of mathematics articles and texts are typeset using LaTeX [1], a document preparation system developed specifically for producing scientific and technical documents. Students in the mathematics programs are expected to know how to use LaTeX to write mathematics, and the availability of free, online editors like Overleaf [2] provides a low technological barrier to entry. The MAT202 course is a second-year course that is required for all students in the mathematics major and specialist programs, and hence is extremely well-placed for an introduction to LaTeX.

The proposed module will involve the development of a start-up guide to installing LaTeX on one's own system (if desired) and creating a first document; a reference list of common LaTeX commands; source files and course-specific templates. Source files for all assignments will also be provided to the class. Short videos will also be created to introduce students to LaTeX, as a companion to the start-up guide. The instructor will offer additional LaTeX-dedicated office hours for the first three weeks; teaching assistants are expected to be able to answer LaTeX-related questions in their own office hours throughout the semester.

An "Assignment 0" will be due at the end of the second full week of classes where students just have to typeset a short mathematical proof in LaTeX, type an academic integrity statement for the course, and answer some questions about the syllabus. Students will be given a few bonus marks if they submit Assignment 1 or the first Portfolio draft in LaTeX.

Intervention 2: Mathematical Communication (Tutorial Modules)

Tutorials for math courses typically focus on active problem-solving. These proposed instructor-designed modules on mathematical communication will replace three tutorial hours as standalone topics – readings will be posted before each session, and TAs will go over the module in tutorials.

Module A: Reading Mathematics (Week 1 / first tutorial)
- The nature of mathematical argumentation and writing, review of informal logic
- Common mathematical symbols (e.g. logical quantifiers, number systems, operators)
- Common English words and phrases in mathematics (e.g. therefore, thus, implies / since, because, as a consequence of / for example, to illustrate)

Module B: Evaluating Mathematics (Week 2 / second tutorial)
- Evaluation of sample (instructor-provided) solutions and proofs to a variety of problems
- Students will be given a sample rubric for grading – a similar rubric will be used to grade the writing component of their assignments. (Criteria: correctness, completeness, clarity)

Module C: Writing Mathematics (Week 3 / third tutorial)
- Given the ingredients of a proof (just the mathematical lines), students construct a complete and clear write-up. (see Figure 1 for a similar exercise from the course notes)
- Students write-up a solutions to selected problems in a given list. These problems will also be review problems for the term test.

Teaching assistants will be deliver these modules in tutorials, as well as provide feedback to students on their work, which will be submitted on the Crowdmark platform. Students will not be graded for these activities in tutorials. These tutorial sessions will be recorded for students who cannot attend.

Intervention 3: Grading for Writing

Assignment and term test grading will be modified to include a percentage component for writing. This ensures that students consistently receive feedback on their writing, and not just the mathematical correctness of their solutions. The grading rubric will be discussed in Module B (above).

Intervention 4: Final Portfolio

At the end of the semester students will be asked to submit a portfolio of proofs or solutions to 6-8 problems that are related to the course topics, as well as respond to some reflective prompts about their experience in the course. There will be two opportunities to submit drafts for feedback during the term (Weeks 5 and 9).

First and second drafts will only be marked for completion. However, TAs and the instructor will still assign grades to each draft according to the appropriate rubric, and students will incorporate this feedback in their final submissions, which will be graded by the instructor. See [3] and [4] for examples of proof portfolio projects at other institutions.

A tentative schedule of classes for the Fall 2020 term is appended at the end of this proposal to help visualize the interplay of the different assessments in the course.

Teaching Assistant Roles

Additional TA responsibilities that arise from this project include:

- Undergoing training in marking assignments for writing and giving appropriate feedback;
- Undergoing training in delivering the writing modules;
- Evaluating all student assessments for writing, given an instructor rubric, while also providing individualized feedback as appropriate;
- Advising students on writing and LaTeX during office hours; and
- Conferring with the instructor about student progress and recommendations for future steps.

Budget

Fall 2020

In Fall 2019 the course had one LEC section and three TUT sections; two TAs were assigned to the course, one with 95 and one with 55 hours. For this writing-focused implementation of the course I anticipate the following additional hours.

Additional training: 3 hours/TA	1.5 hours for tutorial module delivery 1.5 hours for providing appropriate feedback (writing/LaTeX)
Additional marking: 40 mins/student	6 minutes per assignment x 3 assignments 6 minutes for term test 6 minutes for first portfolio draft (3 proofs/student) 10 minutes for second portfolio draft (6 proofs/student)

Assuming 100 students and 2 TAs, this totals to **72.67 hours**.

Winter 2021

The scale of the Winter offering is essentially double that of the Fall's, with two LEC sections and six TUT sections. Assuming two TAs and 200 students, with the same additional marking time above this totals to **139.33 hours** (may be smaller if a Fall 2020 TA is re-assigned to the course).

Other Resources

Students will be directed to the RGASC for general writing strategies and ELL resources. The instructor will coordinate closely with the RGASC to plan and implement the proposed interventions, as well as ensure accessibility and inclusivity of course design in line with remote delivery.

Additional Notes

1. The instructor has decided to deliver MAT202 completely remotely for the Fall 2020 term, and *most likely* for the Winter 2021 term as well (may change based on public health and university guidelines).
2. The grant applicant will be Assistant Professor (Teaching Stream) at the Department of Mathematical and Computational Sciences effective July 1, 2020.

Confirmation

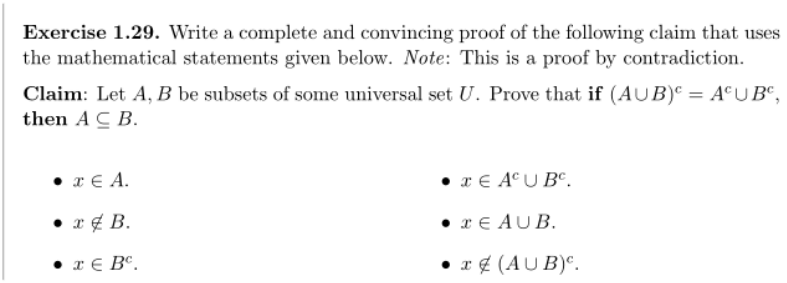
I confirm that I approve this proposal.

I confirm that my Chair supports this proposal.

Timothy Yusun
Lecturer
Department of Mathematical and Computational Sciences
University of Toronto Mississauga

Appendix

Figures



Exercise 1.29. Write a complete and convincing proof of the following claim that uses the mathematical statements given below. *Note*: This is a proof by contradiction.

Claim: Let A, B be subsets of some universal set U. Prove that **if** $(A \cup B)^c = A^c \cup B^c$, **then** $A \subseteq B$.

- $x \in A$.
- $x \notin B$.
- $x \in B^c$.
- $x \in A^c \cup B^c$.
- $x \in A \cup B$.
- $x \notin (A \cup B)^c$.

Figure 1. Exercise in putting together a proof

References

[1] The LaTeX Project. https://www.latex-project.org/ (retrieved April 29, 2020)

[2] Overleaf. https://www.overleaf.com/

[3] Shultis, K. MATH310 Proof Portfolio Instructions and Assessment. https://www.math.unl.edu/~s-kshulti1/Spring2014/Portfolio.Assignment.pdf (retrieved May 24, 2020)

[4] Mohr, A. Proof Portfolio, Intro to Higher Math. http://www.austinmohr.com/19springintro/portfolio.pdf (Retrieved May 24, 2020)

Tentative schedule of classes and assessments

MAT202H5F, Fall 2020

MAT202H5F - Discrete Mathematics
Fall 2020
Schedule of Classes *(subject to change)

Week #	Date	Chapter #	Topics	Tutorials	Assignments	Portfolio
0	Sept. 10 (Th)		Setting the stage / Course intro / MAT102 review			
1	Sept. 15 (T)	2.1	Sum and Product Rules	Writing module A	A0 questions released	
	Sept. 17 (Th)	2.2	Permutations and Combinations			
2	Sept. 22 (T)	2.3	Binomial Coefficients	Writing module B	A0 due (must be in LaTeX)	
	Sept. 24 (Th)	2.4	Balls in Bins, more exercises			
3	Sept. 29 (T)	2.5	Combinatorial proofs	Writing module C	A1 questions released	Portfolio questions released
	Oct. 1 (Th)	2, 3.1	Chapter 2 wrap-up / Pigeonhole Principle			
4	Oct. 6 (T)	3.1	Pigeonhole Principle	Chapter 2 practice	A1 due (bonus for LaTeX)	
	Oct. 8 (Th)	3.2	Inclusion-Exclusion			
			READING WEEK (Oct 12 - Oct 16)			Instructor extra office hours for portfolio
5	Oct. 20 (T)	4.1	Equivalence Relations	Chapter 3 practice		Portfolio draft 1 due (bonus for LaTeX)
	Oct. 22 (Th)	4.2	Congruence			
6	Oct. 27 (T)		Term Test Review	Term test review		Portfolio draft 1 feedback returned
	Oct. 29 (Th)		**TERM TEST (100 minutes)**			
7	Nov. 3 (T)	4.2	Congruence (cont'd)	Term test go-over	A2 released	Remaining portfolio questions released
	Nov. 5 (Th)	4.3	Euler's Theorem and Fermat's Little Theorem			
8	Nov. 10 (T)	4	Chapter 4 wrap-up	Chapter 4 practice	A2 due	
	Nov. 12 (Th)	5.1, 5.2	Graph theory terminology / degree sequences			
9	Nov. 17 (T)	5.2	Eulerian graphs	Chapter 4 practice	A3 released	Portfolio draft 2 due
	Nov. 19 (Th)	5.3	Isomorphisms and subgraphs			
10	Nov. 24 (T)	5.4	Trees and connectedness	Chapter 5 practice	A3 due	Portfolio draft 2 feedback returned
	Nov. 26 (Th)	5.4	Trees and connectedness			
11	Dec. 1 (T)	5.5	Bipartite graphs	Chapter 5 practice		Instructor extra office hours for portfolio
	Dec. 3 (Th)	5.5	Hamiltonian graphs			
12	Dec. 8 (T)		Wrap-up and review for final	Final review		Final portfolio due
	Dec. 10-22		**FINAL EXAM PERIOD**			