University of New Brunswick **Department of Mathematics & Statistics**

MATH 3333— Combinatorial Theory
Fall 2021

Instructor: Dr. Alyssa Sankey // asankey@unb.ca // Tilley Hall 423A // 458-7359
Office hours: Virtual, to be scheduled.

Class meetings: MWF 1:30–2:20 in Keirstead Hall 3
We recognize and respectfully acknowledge that all UNB course interactions take place on unsurrendered and unceded traditional lands of Wolastoqiyik.

Course description
The content for this course falls mostly within the area of enumerative combinatorics, which has to do with counting things. You are likely familiar with some of the standard counting techniques, seen in a course (or chapter, or unit) on permutations and combinations. We will begin with a review of those techniques and build up to the "twelvefold way" which summarizes how to count the number of ways to put some objects into some boxes, under various assumptions. From there we will move to some more advanced counting techniques and touch on a variety of applications. The final three weeks or so of the course will introduce combinatorial designs, in which we study interesting arrangements and/or methods of classifying objects rather than seeking to count them.

Prerequisites: MATH 1003, MATH 1823, or MATH 1833.

Text: Provided

Course marking scheme
30% 6 quizzes or assignments
50% 5 problem sets
20% final exam, to be scheduled.

Quizzes and short assignments
Due dates Sept 17, Oct 1, Oct 8, Oct 22, Nov 5, Nov 26.

These are each worth 5% of your grade and will be administered through Crowdmark, which can be accessed through a browser using your D2L login. The purpose of these relatively short assignments is to test understanding of the main concepts and encourage you to stay on schedule. You are expected to work on these individually as the main point of the assessment is to evaluate your (individual) knowledge of the course material.

Problem sets
Due dates Sept 24, Oct 15, Oct 29, Nov 19, Dec 3.

These are each worth 10% of your grade and will be administered through Crowdmark. The difference between a short assignment and a problem set is that the problem sets are meant to be challenging, and will require a deeper understanding of the material than just the basics. As part of your learning, you will need to work hard at times to solve a problem. This is normal. It is also when the most learning takes place and that is why these assignments form a significant portion of your grade.

Working with others is encouraged, but there are some guidelines you must follow when doing so. The 'others' you are working with should be students in this class. Asking experts for help with your homework is not

collaboration, it is cheating. Finding and using solutions – online, in a book, in a video – that are produced by anyone else is also not collaboration, it is plagiarism – and this is no less true if the author willingly shares their work. Getting help from your instructor when you are stuck is the most acceptable and encouraged form of help available. It is also most likely to yield good results, in the form of a good solution that demonstrates appropriate methods relevant to the course, and is written in the expected style and notation. You will be marked on style, notation, and clarity as well as on the logic and general correctness of the work.

Assignments will be marked using the rubric below. Each question is assessed on a 4-point scale, according to each of three categories shown in the table. The average of these is the score for that question.

Problem	logic	explanation	presentation	overall score
1.	1 2 3 4	1 2 3 4	1 2 3 4	
2.	1 2 3 4	1 2 3 4	1 2 3 4	

Logic refers to the underlying structure of an argument, calculation, or explanation.
Explanation refers to how clearly the ideas are expressed, and whether the argument is complete or misses some details or includes extraneous information.
Presentation includes correct use of notation and terminology, neatness, grammar, spelling.

Grading scale: Letter grades are assigned as final grades in the course, according to the scale below.

A	excellent
B	good
C	satisfactory
D	less than satisfactory
F	failure

This scale is clearly subjective in that it does not spell out how numerical percentages (see the marking scheme above) translate to letter grades. This allows for fair assessment that takes the context of the course into consideration.

Preparing for class

Reading and exercises will be assigned prior to each class meeting. Classes will be more discussion than lecture, so please make notes as you do the reading on what you find challenging or confusing or in need of further explanation. We'll address these points during class time as we work through problems and examples.

Classroom etiquette

1. **Use of electronic devices:** Reasonable use during class time is permitted. Please use good judgement regarding activities that do not pertain to the class and/or might be distracting to your classmates.
2. **Sharing of course materials:** No video or audio recording of lectures or class discussions is permissible without prior written consent of the instructor. Copies of course notes or other materials provided by me cannot be shared without prior written consent, and this includes photos of notes written on the board. All such reproduction is prohibited as an infringement of copyright and is subject to academic penalties. In the case of private use by students with documented disabilities, consent will not be unreasonably withheld.

3. **Late arrival or early departure:** This is distracting to me and is strongly discouraged. On occasion it might be unavoidable, in which case a simple apology or explanation is warranted and will be accepted graciously.

University plagiarism policy

The University of New Brunswick places a high value on academic integrity and has a policy on plagiarism, cheating and other academic offences. Please see the Undergraduate Calendar, University-Wide Academic Regulations, Regulation VIII, or visit nocheating.unb.ca. It is the student's responsibility to know the regulations.

Weekly schedule

The schedule below is an approximation. Check D2L for updates.

DATE	TOPIC/SECTION
Sept 8-10	introduction (1.1–1.5)
Sept 13–17	permutations and combinations of sets (2.1–2.2)
Sept 20–24	permutations and combinations of multisets (2.3)
Sept 27–Oct 1	pigeonhole principle and Ramsey's theorem (3.1–3.2)
Oct 4–8	advanced counting (4.1–4.2)
Oct 11	Thanksgiving
Oct 13–15	special numbers (4.3–4.4)
Oct 18–22	the twelvefold way (5.1–5.2)
Oct 25–29	problems week
Nov 1–5	binomial and multinomial theorems (6.1–6.2)
Nov 8–12	reading week
Nov 15–19	generating functions (6.3–6.4)
Nov 22–26	block designs (7.1)
Nov 29–Dec 3	Steiner systems (7.2)
Dec 6–8	review