Sample Syllabi – Subject to Change

Introduction to Proof-based Discrete Mathematics

Summer Immersion Program
The University of Chicago

Instructor: Matthew Gelvin

Supplementary text: Wallace, D.F. *Everything and More: A compact history of infinity*

Grading:

Participation:	20%	Problem sets:	30%
Presentations:	20%	Exam:	30%

Course Structure

The course will meet twice daily: A morning session from 9.00 to 11.30 and an afternoon session from 13.00 to 15.00. These meetings will consist of:

- **Lectures.** Most days will begin with a lecture from by the instructor. These will serve to introduce new topics and definitions, as well as model rigorous proof techniques. Although the format of this section is a lecture, student contribution is both encouraged and expected—we are aiming for a dialogue, where you are quick to both ask and answer any questions that arise in the course of learning new mathematics.

- **Work sessions.** After key concepts have been introduced in the lecture, we will break into smaller groups to work on exercises. The instructor and course assistant will be present and circulating to offer some help should you get stuck, but this is primarily a time for you to work through new material with your peers.

- **Presentations.** All students will be called on to present solutions to exercises at some point. The emphasis is on practicing your ability to communicate your arguments clearly and concisely—you will not be put on the spot with a new problem, but should rather explain the thinking that went into your group work session or overnight problem set.

In addition to the standard in-class structure, there will be:

- **Problem sets.** Daily exercises assigned at the end of the day and due at the beginning of the following class. You are encouraged to work with your peers on these problem sets, but *every student must write up their individual solutions.*

- **A final exam.** Occurring on the last day of class, this will be a comprehensive review of the topics covered in the course.

The following is a rough outline of the topics we will cover, along with the timing:

- **Week 1:** Counting with sets, finite counting problems, arithmetic operations realized by set operations, special types of functions, algebra of logic, pigeonhole principle, inclusion-exclusion.
- **Week 2:** Counting with numbers, natural number, Peano axioms, arithmetic operations as a consequence of the axioms, well-ordering of $\mathbb{N}$, basic number theory, induction, induction, induction.
- **Week 3:** Infinite counting problems, infinite cardinals, countability of $\mathbb{Q}$, Schröder-Bernstein, counter-intuition.
- **Throughout:** Axiomatic thought, direct proof, proof by contradiction, proof by induction, proof by minimal counter-example, etc.