University *of* New Haven

COLLEGE OF ARTS AND SCIENCES

Department of Mathematics and Physics

§ I: MATH 1121 Foundations of Mathematics Syllabus

Catalog Description

Prerequisite. Placement in MATH 1121 or completion of MATH 1117 with a grade of C or higher. Set theory, logic, counting and the pigeonhole principle, mathematical induction and the well ordering principle, different methods of proofs (including direct and indirect proof, proof by contrapositive and contradiction, and mathematical induction), relations and equivalence relations, functions (injective, surjective, bijective, composition and inverse), infinite sets and cardinality, and the Cantor-Bernstein-Schroeder theorem. 4 credits.

Required Textbook

Book of Proof, by Richard Hammack, Hammack, 2e, ISBN **9780989472104** (2013). All students, regardless of their instructors policies regarding online homework, are encouraged to become familiar with and use online homework as a tool to augment their studies.

Course Objectives

The course, MATH 1121, provides an introduction to the foundations of mathematical proof and teaches critical thinking skills for mathematical problem solving in mathematics, engineering and science through the use of logic, set theory and counting principles as part of the process of proof. The course is also designed to prepare students for more advanced courses such as Modern Algebra, Real Analysis and Number Theory,

   The course provides a rigorous introduction to logic in a manner that allows students to understand and construct proofs of some foundational elementary results in mathematics.

Student Learning Outcomes

After successfully completing this course the expectation is that students will be able to work with:
1. The basics of set theory, to represent sets in different forms, perform set operations, including set-limits, and utilize formulas related to sets.
2. Mathematical logic, including truth tables and symbolic logic.
3. Various methods of mathematical proof and reasoning, including direct proof and mathematical induction.
4. Relations, equivalence relations, and functions; and,
5. Counting principle, properties of natural numbers, including infinite sets and cardinality.

Students will also achieve the following Core Learning Objectives:
6. the student will be able to generate mathematical models based on abstract concepts;
7. justify the correctness of a solution based on assumptions made and known limitations of methods used; and
8. solve complex mathematical problems involving multiple mathematical forms and techniques or draw appropriate conclusions as the result of performing quantitative data analysis based on sound assumptions regarding estimation and modeling.

Required Curriculum Content

Key topics covered include:
1. Sets, logic and counting in order to develop the foundational language of mathematics which forms the backbone of this course.

2. Methods of proof, including direct proof, use of the contrapositive, and proof by contradiction, leading through a discussion of the conditional form, if P, then Q framework, which encompasses much of mathematical reasoning.
3. Proving non-conditional statements, proofs involving sets, disproofs and mathematical induction.
4. An introduction to relations, functions and the cardinality of sets, as a means to more advanced topics in mathematics such as combinatorics, abstract algebra, analysis, and computational theory.

All sections of MATH 1121 Foundations of Mathematics will cover, as a minimum, the material from *Book of Proof*, by Richard Hammack, Hammack, 2e, ISBN **9780989472104** (2013), as listed:

Sec	Textbook Topic
	Chapter 1 - Sets
1.1	Introduction to sets
1.2	The Cartesian product
1.3	Subsets
1.4	Power sets
1.5	Union, intersection and difference
1.6	Complement
1.7	Venn diagrams
1.8	Indexed sets
1.9	Sets that are number systems
1.10	Russel's paradox
	Chapter 2 - Logic
2.1	Statements
2.2	And, or, not
2.3	Conditional statements
2.4	Biconditional statements
2.5	Truth tables for statements
2.6	Logical equivalence
2.7	Quantifiers
2.8	More on conditional statements
2.9	Translating English to symbolic logic
2.10	Negating statements
2.11	Logical inference
	Chapter 3 - Counting
3.1	Counting lists
3.2	Factorials
3.3	Counting subsets
3.4	Pascal's Triangle and the Binomial Theorem
3.5	Inclusion-Exclusion
	Chapter 4 - Direct Proof
4.1	Theorems
4.2	Definitions
4.3	Direct proof
4.4	Using cases
4.5	Treating similar cases
	Chapter 5 - Contrapositive Proof
5.1	Contrapositive proof
5.2	Congruence of integers
5.3	Mathematical writing

Sec	Textbook Topic
	Chapter 6 - Proof by Contradiction
6.1	Proving statements with contradiction
6.2	Proving conditional statements by contradiction
6.3	Combining techniques
	Chapter 7 - Proving Non-Conditional Statements
7.1	If-and-only-if proof
7.2	Equivalent statements
7.3	Existence proofs: Existence and uniqueness proofs
7.4	Constructive versus non-constructive proofs
	Chapter 8 - Proofs involving sets
8.1	How to prove $a \in A$
8.2	How to prove $A \subset B$
8.3	How to prove $A = B$
	Chapter 9 - Disproof
9.1	Counterexamples
9.2	Disproving existence statements
9.3	Disproof by contradiction
	Chapter 10 - Mathematical Induction
10.1	Proof by strong induction
10.2	Proof by smallest counterexample
10.3	Fibonacci numbers
	Chapter 11 - Relations
11.1	Properties of relations
11.2	Equivalence relations
11.3	Equivalence relations and partitions
11.4	The integers modulo n
11.5	Relations between sets
	Chapter 12 - Functions
12.1	Functions
12.2	Injective and surjective functions
12.3	The pigeonhole principle
12.4	Composition
12.5	Inverse functions
12.6	Image and pre-image
	Chapter 13 - Cardinality of Sets
13.1	Sets with equal cardinalities
13.2	Coverable and uncountable sets
13.3	Comparing cardinalities
13.4	The Cantor-Bernstein-Schröeder Theorem

Common Department Requirements for MATH 1121

While students in each section of MATH 1121 are assessed by the course instructor, there are general guidelines that apply to all sections of MATH 1121. These include:

- Calculators and other electronic devices are not allowed on any exams.

Department, College and University Expectations and Policies

It is important that students familiarize themselves with a range of policies and guidelines that have been established by the Department of Mathematics and Physics, the College of Arts and Sciences, and the University of New Haven. These are an integral part of the syllabus for this course.

Adding/Dropping a Class

The final day to drop this course without it appearing on your transcript is discussed on the `Academic Schedules and Registration` web page. After the first week of class, self-service registration will not be enabled for students to directly add or drop classes. Students should contact the Registrar's office directly or the Academic Success Center for assistance with adding and dropping courses during this time.

Attendance Regulations

University attendance policy guidelines require that:

> Students are expected to attend regularly and promptly all their classes, appointments, and exercises. While the university recognizes that some absences may occasionally be necessary, these should be held to a minimum. A maximum of two weeks of absences will be permitted for illness and emergencies. The instructor has the right to dismiss from class any student who has been absent more than the maximum allowed. A dismissed student will receive a withdrawal (W) from the course if they are still eligible for a withdrawal per the university Withdrawal from a Course policy, or a failure (F), if not. A student who is not officially registered in the course is not permitted to attend classes or take part in any other course activities. Students absent from any class meeting are responsible for making up missed assignments and examinations at the discretion of the instructor.

Students are to adhere to the policy attendance policy guidelines outlined in the University Catalog under the heading, *Attendance Regulations*, found online in the `Undergradaduate Catalog` or alternatively found in the `Student Handbook` on `pp.48-49`.

Religious Observance Policy for Students

The University of New Haven respects the right of its students to observe religious holidays that may necessitate their absence from class or from other required university-sponsored activities. Students who wish to observe such holidays should not be penalized for their absence, although in academic courses they are responsible for making up missed work. The College provides that,

> Instructors should try to avoid scheduling exams or quizzes on religious holidays, but where such conflicts occur should provide reasonable accommodations for missed assignment deadlines or exams. If a class, an assignment due date, or exam interferes with the observance of such a religious holiday, it is the student's responsibility to notify their instructor, preferably at the beginning of the term, but otherwise at least two weeks before the holiday.

More information about religious observance policies can be found in the Student Handbook on `pp.48-49` under the heading, *Attendance Policies: Religious Observance Policy for Students*.

Withdrawal from a Course

Students wishing to withdraw must submit a request for an official course withdrawal in writing using the online `Course Withdrawal Form`, or alternatively complete and hand in the pdf based `Course Withdrawal Form`. The final date to request a withdrawal is listed in the `Academic Calendar`. This request must be submitted to the Registrar's Office and signed by the International Office if you are an international student. The grade of W will be recorded, but the course will not affect the GPA. [1]

Incomplete Grade Policy

A grade of Incomplete (INC) is given only in special circumstances and indicates that the student has been given permission by the instructor to complete required course work (with the same instructor) after the end

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[1] Please note that it is the responsibility of the student to assure that the required paperwork and documentation is completed by the deadline.

of the term. In the absence of the instructor a student should contact the Department Chair. Students need to examine carefully the **changed guidelines** pertaining to INC grades, specifically:

To remove the INC grade, the student must complete all required course work in timely fashion as stipulated by the instructor but no later than the end of the following term. Fall and intersession course incomplete grades must be completed no later than the last day of the spring term. Spring and summer course incomplete grades must be completed no later than the last day of the fall term.

If the course work is not submitted within the allotted time, the INC grade will be changed to an F shortly after the deadline by the Office of the University Registrar. Students will be notified via campus email at least two weeks prior to the change of grade process.

The University policy on incomplete grades is discussed in the `Academic Catalog` under the heading, *Incomplete (INC) Grade Policy*.

Academic Integrity Policy and Procedures

The University of New Haven expects its students to maintain the highest standards of academic conduct. Academic dishonesty is not tolerated at the University. To know what it is expected, students are responsible for reading and understanding the statement regarding academic honesty in the Student Handbook. Specifically, students are required to adhere to the Academic Integrity Policies specified in the `Student Handbook`, i.e., on `pp.66-73`.

Please ask your instructor about their expectations regarding permissible or encouraged forms of student collaboration if there is any confusion about this topic. The Department of Mathematics and Physics fully adheres to the Academic Integrity Policy:

Academic integrity is a core university value that ensures respect for the academic reputation of the University, its students, faculty and staff, and the degrees it confers. The University expects that students will conduct themselves in an honest and ethical manner and respect the intellectual work of others. Please be familiar with the University's policy on Academic Integrity. Please ask about expectations regarding permissible or encouraged forms of student collaboration if they are unclear.

Coursework Expectations

This course will require significant in-class and out-of-class commitment from each student. The University estimates that a student should expect to spend two hours outside of class for each hour they are in a class. For example, a three credit course would average six [6] hours of additional work outside of class.[2] Coursework expectations are detailed in the `Academic Catalog` under the heading, *Course Work Expectations*.

Please note, that MATH 1121 is a 4-credit course, and as such requires a total of 12 hours per week invested in study and homework for the average student.

Commitment to Positive Learning Environment

The University adheres to the philosophy that all community members should enjoy an environment free of any form of harassment, sexual misconduct, discrimination, or intimate partner violence. If you have been the victim of sexual misconduct we encourage you to report this. If you report this to a faculty/staff member, they must notify our college's Title IX coordinator about the basic facts of the incident (you may choose to request confidentiality from the University). If you encounter sexual harassment, sexual misconduct, sexual assault, or discrimination based on race, color, religion, age, national origin, ancestry, sex, sexual orientation, gender identity, or disability please contact the Title IX Coordinator, Caroline Koziatek at (203)-932-7479 or `CKoziatek@newhaven.edu`. Further online information about is available at `Title IX`.

Reporting Bias Incidents

At the University of New Haven, there is an expectation that all community members are committed to creating and supporting a climate which promotes civility, mutual respect, and open-mindedness. There also exists an understanding that with the freedom of expression comes the responsibility to support community

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[2]Please note that study guidelines are important, i.e., there is substantial evidence that shows that the pass rates for students in math courses decrease dramatically as the time spent on outside study falls below 2 hours of homework per credit per week.

members' right to live and work in an environment free from harassment and fear. It is expected that all members of the University community will engage in anti-bias behavior and refrain from actions that intimidate, humiliate, or demean persons or groups or that undermine their security or self-esteem.

If you have witnessed or are the target of a bias-motivated incident, please contact the Office of the Dean of Students at 203-932-7432 or Campus Police at 203-932-7014. Further information about this and other reporting options may be found at `Report It`.

University Support Services

The University recognizes students often can use some help outside of class and offers academic assistance through several offices. In addition to discussing any academic issues you may have with your instructor, advisor, or with the the courses or department coordinator or chair, the University provides these additional resources for students:

The Center for Academic Success and Advising (CASA)

The `Academic Success Center` is located in Maxcy 208 for help with your academic studies, or call 203-932-7234 to set up an appointment.

University Writing Center

The mission of the Writing Center (an expansion of the `Writer to Writer` peer-tutoring program) is to provide high-quality tutoring to undergraduate and graduate students as they write for a wide range of purposes and audiences. Tutors are undergraduate and graduate students and they work with students at any stage in the writing process; Bring in your assignment, your ideas, and any writing done so far. To make an appointment, register for an account at `https://newhaven.mywconline.com`.

The Math Zone

Please contact the `Math Zone` if you wish to challenge your Math Placement by taking a Math Challenge Exam or by taking a Math Post Placement Exam. These are discussed more extensively at `http://math.newhaven.edu/mathphysics/placement_html`. The Math Zone also provides a range of tutoring and classroom support service for students taking development math classes.

The Center for Learning Resources (CLR)

The `Center for Learning Resources` located in Peterson Library, provides academic content support to the students of the University of New Haven using metacognitive strategies that help students become aware of and learn to apply optimal learning processes in the pursuit of creating independent learners CLR tutors focus sessions on discussions of concepts and processes and typically use external examples to help students grasp and apply the material.

Accessibility Resources Center

Students with disabilities are encouraged to share, in confidence, information about needed specific course accommodations. The `Accessibility Resources Center` (ARC) provides comprehensive services and support that serve to promote educational equity and ensure that students are able to participate in the opportunities available at the University of New Haven. Accommodations cannot be made without written documentation from the ARC. The ARC is located on the ground floor in the rear of Sheffield Hall. Sheffield Hall is located in the Residential Quad area, and can be contacted at 203-932-7332. The ADA/Section 504 Compliance Officer is Rebecca Johnson, `RJohnson@newhaven.edu`, and can be reached by phone at 203-932-7238. Information on the ARC can be found at

Counseling and Psychological Services

The Counseling Center offers a variety of services aimed at helping students resolve personal difficulties and acquire the balance, skills, and knowledge that will enable them to take full advantage of their experience at the University of New Haven. Information about the, **Counseling and Psychological Services**, is available online.