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SAMPLE SYLLABUS
This document is published as an indication of the core content of the course. Instructors have responsibility of deciding on additional topics to be included, and the emphasis, ordering, and pacing of presentation.

Course Number: **MTH 311**

Course Title: **Introduction to Higher Mathematics**

Credit Hours: **4**

Textbook: ***Outline & Problem Sets*, notes developed at the UB Math Department.**

Supplementary Textbook: **G. Chartrand, A. Polimeni, P. Zhang, *Mathematical Proofs: A Transition to Advanced Mathematics*, 3rd edition.**

Prerequisites: MTH 241

Notes: This is a core course in almost all math major concentrations, and usually the first course in higher mathematics that math majors take. Its primary purpose is to teach students how to read, understand, and write rigorous mathematical proofs. It also introduces basic notions in logic and set theory.

This schedule is written for 13 weeks of instruction. A typical semester has 14 teaching weeks. Thus, some flexibility is built in.

Week	Topics
1	Introduction to logic.
2	Axioms for the integers. Divisibility.
3	Axioms for the real numbers.
4	Rational and irrational numbers. **Midterm Exam I**
5	Induction.
6	Sets.
7	Functions. Inverse functions.
8	Cardinality of sets.
9	Countability. **Midterm Exam II**
10	Algebraic and transcendental numbers.
11	Infinite sequences and limits.
12	Least upper bound axiom. Monotone sequence property.
13	Series. **Midterm Exam III**

Student Learning Outcomes for
MTH 311 Introduction to Higher Mathematics

Assessment measures: weekly homework assignments, 3 midterm exams, final exam.

At the end of this course a student will be able to:	**Assessment**
– Understand the rules of logic and use them proficiently – recognize statements, determine their truth value, and combine them – recognize implications and operate on them to obtain converse and contrapositive – use universal and existential quantifiers – negate statements, including those with quantifiers	HW #1 Midterm Exam I Final Exam
– define well-ordering for integers – understand the role of axioms, assumptions, theorems, proofs, and conjectures in mathematics – prove the additive, multiplicative, and order properties of integers from the axioms – extend well-ordering to bounded sets of integers – write correct direct and indirect proofs	HW #2 Midterm Exam I Final Exam
– analyze the definitions of divisibility and greatest common divisor for integers – write correct proofs using well-ordering	HW #2 Midterm Exam I Final Exam
– contrast the structure of well-known number systems: the naturals, integers, reals, and rationals – prove properties for real numbers – utilize the Archimedean Principle and show equivalence of the Principle to other forms – prove existence of the greatest integer and its properties	HW #3 Midterm Exam I Final Exam
– distinguish rational from irrational numbers – establish properties of sums and products of rational/irrational numbers – show that the square root of 2 is irrational and generalize to other roots and other integers	HW #4 Midterm Exam I Final Exam
– use the principle of induction in proofs – analyze the principle of strong induction and use it in proofs	HW #5 Midterm Exam II Final Exam
– recognize and utilize the fundamentals of sets (inclusion, equality, union, intersection, complement, power set) – prove the basic properties of sets, including de Morgan's laws – analyze the Cartesian product and its properties	HW #6 Midterm Exam II Final Exam
– recognize and utilize the definition of a function (as a subset of the Cartesian product), of composition, of image and inverse image – find all functions from a finite set to a finite set – prove relations between image/inverse image of union and intersections of sets	HW #7 Midterm Exam II Final Exam
– recognize and utilize the definition of one to one function, onto function, restriction of a function to a subset – characterize the identity function – demonstrate that a function has an inverse if and only if it is one to one and onto – show that if a function satisfies the composition properties of the inverse function then it is the inverse function	HW #7 Midterm Exam II Final Exam

– recognize and utilize the definition of one to one correspondence and equivalence of sets – construct equivalences for various finite sets, intervals, unions and Cartesian products – show that equivalence is reflexive, symmetric, and transitive – distinguish finite from infinite sets – show that subsets and unions of finite sets are finite – prove that the natural numbers are infinite	HW #8 Midterm Exam II Final Exam
– differentiate between countable and uncountable sets – show that the set of rational numbers is countable and the set of irrationals is uncountable – prove that subsets, countable unions, and finite Cartesian products of countable sets are countable – show that a set is countable if and only if it can be injected into the natural numbers – show that a set and its power set are never equivalent	HW #9 Midterm Exam II Final Exam
– Distinguish a coherent argument from a fallacious one – Derive precisely formulated mathematical conjectures from examples and test them	HW #1-#9

The table below indicates to what extent this course reflects each of the learning objectives of the undergraduate mathematics program. A description of learning objectives is available online at http://www.buffalo.edu/cas/math/ug/undergraduate-programs.html.

Computational Skills:	**Analytical Skills:**	**Practical Problem Solving:**	**Research Skills:**	**Communication Skills:**
little or not at all	extensively	little or not at all	extensively	extensively