STEPHEN F. AUSTIN STATE UNIVERSITY

Department of Mathematics and Statistics

Math 311–Introduction to Modern Mathematics
Course Syllabus

Course description: Introduction to logic, basic properties of sets, relations, functions, one-to-one functions, set equivalence, Cantor's Theorem, countable and uncountable sets.

Credit hours: 3

Course Prerequisites and Corequisites: MTH 234

Course outline: Approximate time spent

- **Logic** 20%
  - Statements and truth values
  - Compound statements
  - Truth tables
  - Valid and invalid arguments
  - Quantified statements
- **Mathematical Proof Techniques** 30%
  - Proving universally quantified statements
  - Examples and counterexamples
  - Direct conditional proofs
  - Indirect proofs (contrapositive and contradiction)
  - Proof by cases
  - Uniqueness proofs
  - Mathematical induction
- **Set Theory** 20%
  - Subsets, proper subsets, equal sets, empty set, power sets
  - Union, intersection, difference, complement, Cartesian product
  - Venn diagrams
  - Disjoint sets, pairwise disjoint collections of sets
- **Functions** 10%
  - Definition of function, domain, codomain, range
  - Images, pre-images
  - One-to-one functions, surjections, bijections
  - Composite functions
- **Relations** 10%
  - Relations and inverses
  - Reflexive, symmetric, and transitive relations
  - Equivalence relations, equivalence classes, and partitions
  - Congruence relations
  - Order relations
- **Finite and Infinite Sets** 10%
  - Definition of finite set
  - Countable set, uncountable sets
  - Cardinality
- **Other topics (as time permits)**

Student Learning Outcomes (SLO): At the end of MTH 311, a student who has studied and learned the material should be able to:

1. Read and interpret written mathematics and communicate their reasoning both orally and in written form. [PLO: 5]
2. Translate between symbolic logic notation and standard English. [PLO: 3,5]
3. Understand and interpret compound statements, logical arguments, and fallacies. [PLO: 3]
4. Make appropriate inferences based on conditional and biconditional statements. [PLO: 3]
5. Understand the role of quantifiers in mathematical statements. [PLO: 3]
6. Formulate reasonable conjectures and construct rigorous, well written proofs using a variety of proof techniques (including direct and indirect proofs). [PLO: 1,3,5]
7. Construct appropriate counterexamples to disprove statements. [PLO: 3,4]
8. Understand the principle of mathematical induction and use it in the formulation of mathematical proofs. [PLO: 2,3]
9. State and use important definitions in set theory. [PLO: 1,2,3,4]
10. Understand and construct proofs concerning subsets and set equality. [PLO: 2,3,4]
11. Recognize and prove theorems about equivalence relations, including congruence relations on the set of integers. [PLO: 1,2,3,4]
12. Understand the notion of function and be able to state and use definitions of one-to-one, onto, image and pre-image. [PLO: 1,2,3,4]
13. Understand the notions of infinite set and cardinality and use them to prove that given sets have the same cardinality. [PLO: 1,2,3,4]
14. Understand a proof of the uncountability of the set of real numbers. [PLO: 2,3]
15. Apply their understanding of logic and proof in an appropriate mathematical context which may include number theory, graph theory, topology, analysis, algebra or other relevant topics. [PLO: 1,2,3,4]

Program Learning Outcomes (PLO):

Students graduating from SFASU with a B.S. Degree and a major in mathematics will:

1. Demonstrate comprehension of core mathematical concepts. [***Concepts***]
   (notion of theorem, mathematical proof, logical argument)
2. Execute mathematical procedures accurately, appropriately, and efficiently. [***Skills***]
   (calculus, algebra, routine, nonroutine, applied)
3. Apply principles of logic to develop and analyze conjectures and proofs. [***Logical Reasoning***]
   (quantifiers, breaking down mathematical statements, counterexamples)
4. Demonstrate competence in using various mathematical tools, including technology, to formulate, represent, and solve problems. [***Problem Solving***]
   (calculus tools, algebra tools, applied tools, nonstandard problem solving)
5. Demonstrate proficiency in communicating mathematics in a format appropriate to expected audiences. [***Communication***]
   (written, visual, oral)