STEPHEN F. AUSTIN STATE UNIVERSITY

Department of Mathematics and Statistics

Math 540 - Real Variables II
Course Syllabus

Course description: Topics such as sigma-algebras, measure, and integration of measurable functions are developed and covered in detail. Also convergence theorems are discussed.

Credit hours: 3

Course Prerequisites and Corequisites: MTH 539

Course Outline: This is the second part of the two part introductory course in Real Analysis. This course focuses on the measure and integration aspect of Real Analysis. In this course we cover the topics listed below:

	Approximate time spent
• **Systems of Sets**	10%
○ Rings of sets	
○ Semirings of sets	
○ Borel algebras	
• **Measure: Elementary sets**	35%
○ Construction of measures	
○ Sigma-algebras	
○ Finite additivity	
○ Sigma-additivity	
○ Outer and inner measure	
○ Measurable sets	
○ Lebesgue measure	
○ Non-measurable set	
○ Translation invariance of Lebesgue measure	
• **Measurable Functions**	15%
○ Simple functions	
○ Convergence almost everywhere	
• **Integration**	30%
○ Lebesgue integral and properties	
○ Monotone Convergence Theorem	
○ Dominated Convergence Theorem	
○ Convergence in measure	
• **(Time Permitting) L^p spaces**	10%
○ Inequalities	
○ Banach spaces L^p , $1 \leq p \leq \infty$	
○ Metric spaces L^p , $0 < p < 1$	
○ Hilbert space p = 2	

Student Learning Outcomes (SLO): At the end of MTH 540, a student who has studied and learned the material should be able to:

1. Understand and apply the basic concept of measure and its properties. [MTH-PLO: 1,2,3], [STA-PLO: 1]
2. Demonstrate understanding of the notion of measure as a generalization of length. [MTH-PLO: 3,2], [STA-PLO: n.a.]
3. Explain the different types of convergence and the relationship between them. [MTH-PLO: 1,3,5], [STA-PLO: n.a.]
4. Understand, prove and apply the structure and properties of the Lebesgue integral. [MTH-PLO: 1,2,3,5], [STA-PLO: n.a.]
5. Demonstrate use of the Lebesgue as a canonical extension of the Riemann Integral. [MTH- PLO: 2,3], [STA-PLO: 1]
6. Apply the concepts learned in the MTH 539 to the structure of L^p spaces. [MTH-PLO: 1,3,5], [STA-PLO: n.a.]
7. Relate and apply the concepts of measure and integration to other settings, in particular Probability Theory. [MTH-PLO: 1,2,3,5], [STA-PLO: 1]

Program Learning Outcomes (MTH - PLO):

Students graduating from SFASU with a M.S. degree and a major in mathematics will demonstrate:

1. **[*Critical Reasoning*]** Independently apply the principles of logic in mathematics to develop and analyze conjectures and proofs. (understanding of abstract structures, development of definitions, development and proof of conjectures)
2. **[*Skills*]** Execute advanced mathematical procedures and build upon these standard procedures. (learning of new skills, applying or extending skills in new situations)
3. **[*Concepts*]** Demonstrate knowledge of core mathematical concepts. (definitions and theorems in analysis, definitions and theorems in linear or abstract algebra, definitions and theorems in theoretical statistics)
4. **[*Problem Solving*]** Demonstrate initiative in using various mathematical tools, including technology, to formulate, represent, and solve problems. (implement algorithms or definitions, discuss algorithmic proficiency, find numerical approximations)
5. **[*Communication*]** Demonstrate proficiency in communicating mathematics in a format appropriate to expected audiences. (written, visual, oral)

Program Learning Outcomes (STA - PLO):

Students graduating from SFASU with a M.S. degree and a major in statistics will demonstrate:

1. A command of core probability and statistical concepts through major definitions and theorems. **[*Concepts*]** (Probability and Statistical Inference)