Course Goals: Math 431, Real Analysis

I. Real Numbers

Students will be able to demonstrate:

- Knowledge of the axioms of the real numbers, especially the least upper bound axiom.
- The ability to apply the axioms of the real numbers to solve problems, giving careful proofs and using appropriate notation.
- Knowledge of the standard notation used in analysis (e.g. set theory) and be able to use it in context.

II. Sequences

Students will be able to demonstrate:

- Knowledge of the definition of convergent and divergent sequences.
- The ability to prove the standard theorems about the sum, difference, product, and quotient of convergent sequences.
- The ability to prove the convergence of bounded monotonic sequences.
- The ability to prove the nested interval theorem, the Bolzano-Weirstrass theorem, and the equivalence of convergence and Cauchy sequences.
- Familiarity with the concept of divergence to ∞ or $-\infty$ and be able to determine whether a given series is convergent or divergent.

III. Functions

Students will be able to demonstrate:

- Knowledge of the definition of the limit of a function at a point and be able to prove the standard theorems of sums, differences, products, and quotients of limits.
- Knowledge of the definition of continuity and be able to prove that given functions are (or are not) continuous at a given point.
- The ability to prove the Intermediate Value Theorem.
- The ability to prove the Extreme Value Theorem.

IV. The Derivative

Students will be able to demonstrate:

- Knowledge of the definition of the derivative and be able to prove the standard theorems about the derivatives of sums, products, differences, quotients, and inverse functions.
- The ability to prove the mean value theorem.

V. The Integral

Students will be able to demonstrate:

- Familiarity with the definition of the Riemann integral.
- The ability to prove the integrability of monotonic and continuous functions.
- The ability to prove and apply the Fundamental Theorem of Calculus.
- The ability to determine the convergence of improper integrals.

VI. Infinite Series

Students will be able to demonstrate:

- Knowledge of the definition of convergence for a series and be able to prove the standard theorems on the sum of convergence series and the distributive law for series.
- The ability to prove and apply the n^{th} term test for the convergence of a series.
- The ability to prove and apply the integral test, the comparison test, the ratio test, and the root test for the convergence of a series.
- The ability to prove and apply the alternating series test and test a series for conditional and absolute convergence.
- The ability to find the radius of convergence of a power series.
- The ability to compute the Taylor series for a function and be able to apply Taylors theorem with remainder.

VII. Sequences and Series of Functions

Students will be able to demonstrate:

- The ability to test a sequence or series of functions for pointwise convergence.
- The ability to apply the Weierstrass M-Test for uniform convergence of a series.
- The ability to prove that the uniform sum or limit of continuous functions is continuous.
- Familiarity with the existence of continuous nowhere differentiable functions.

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For more information please contact: jewell@edgewood.edu