

## Department of Mathematics and Computer Science Official Syllabus

### Introduction to Real Analysis I, Mathematics 4200 3 hours, Fall 2009

**Instructor:** Robb Sinn

NOC 221 - Office Hours

Tues/Thurs 11 - 12:00

Mon/Wed 11:15 - 12 & 1:30 - 3:30 PM

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Phone: 706-864-1676

**Prerequisite:** Grade of C or above in MATH 2800 or approval of the department head.

**Catalog Description:** An introductory course in functions of a real variable, limits, continuous functions, differentiation, and Riemann integration

**Course Objectives:** After completion of the course the student will be able to:

- Discuss the similarities and differences of the rational number system, real number system, and complex number system;
- Prove theorems based on the least upper bound property of the real number system;
- Determine whether a given set together with a given relation forms a directed set;
- Prove that a given sequence, series, or function converges or does not converge using the definition of a limit;
- Prove that a given function is continuous or is not continuous using the definition of continuity;
- Prove that a given sequence, series, or function converges or does not converge using the Cauchy criterion;
- Prove that a given series converges using the comparison test, ratio test, or alternating series test;
- Determine whether a given convergent series is absolutely convergent;
- Find the Cauchy product of two given convergent series and determine if the product series converges;
- State and provide a proof of the Bolzano-Weierstrass theorem;
- Define and provide an equivalent formulation for the upper limit and lower limit of a real sequence;
- Prove that a given continuous function is or is not uniformly continuous;
- Prove that a given convergent series of functions is or is not uniformly convergent;
- State and prove the product and chain rules for differentiation using the definition of the derivative;
- State and prove the relationship between the derivative of a function and the derivative of the corresponding inverse function;
- State the definition of the Riemann integral as a limit of approximating sums over tagged partitions;
- Prove elementary properties of the Riemann integral, such as linearity, using the definition;
- Determine whether a given function is or is not Riemann-integrable;
- State and prove the fundamental theorem of calculus; and
- Determine whether or not the order of integration and summation or of differentiation and summation can be switched for a given sequence of functions.

**Grading:** Course components are In-Class Proofs (15%), a Proofs Portfolio (15%), two tests (20% each, one of which will likely be take-home) and a final exam (30%).

**Attendance:** Attendance is mandatory. Students missing more than 14% of the required course meetings will be dropped from the course with a WF.

**Methods of Instruction:** The methods of instruction are determined by the instructor; however, the instructor is expected to use a variety of methods. These methods may include, but are not limited to lecture; problem-solving sessions with informal assessment by the student or instructor; discussion; group projects; timely feedback from test, quiz, or project results (formative assessment); question and answer; computer or calculator based explorations; and student presentations. Students will be encouraged to assess and monitor their own problem-solving process to determine when an error has been made or a new strategy should be used.

#### **Metacognitive Model and Teacher Education Program Competencies:**

The NGCSU Secondary Mathematics Education Program prepares teachers to assume within the school community the roles of Decision-Maker, Facilitator, and Leader as identified in the metacognitive model. Twelve Teacher Education Program competencies reflecting the model are aligned to a specific role. Overlap into more than one

role and mathematics course may occur. Current research and professional standards identify these competencies as important for effective teaching (NBPTS and ASCD Framework).

| <b>Decision-Maker</b>         | <b>Facilitator</b>       | <b>Leader</b>            |
|-------------------------------|--------------------------|--------------------------|
| Assessment                    | Individual Differences   | Ethical Perspectives     |
| Planning                      | Subject Matter Knowledge | Reflection/Metacognition |
| Problem Solver                | Communication            | Professional Leadership  |
| Methods, Materials, Resources | Classroom Management     | Research & Evaluation    |

**Evaluation Methods:** Formative assessment will be in the form of written tests and/or short quizzes and summative assessment will be in the form of a final examination. Special projects and daily grades may be used at the discretion of the instructor.

**Course Content:**

1. Algebraic and analytic properties of real numbers
2. Definition and examples of limits
3. Convergence of sequences and series
4. Continuity and uniform continuity
5. Differentiation and integration

**Knowledge Base:**

1. Required Text: Carol Schumacher’s *Closer and Closer: Introducing Real Analysis*, Jones and Bartlett, 2008.

2. Library Resources:

- Royden, H. L. Real Analysis (2<sup>nd</sup> Edition), Macmillan; 1968.
- Gelbaum, Bernard and Olmsted, John. Counterexamples in Analysis, Holden-Day; 1964.
- Bressoud, David M. A radical approach to real analysis, Mathematical Association of America; 1994.
- Hassler, Norman B. Real Analysis, Dover Publications; 1991.
- Stromberg, Karl Robert Introduction to classical real analysis, Wadsworth International Group; 1981.
- Zorich, V.A. Mathematical Analysis, Springer; 2004

4. Web-Based Resources:

- Association for Women in Mathematics - <http://www.awm-math.org>
- Math Archives - <http://archives.math.utk.edu>
- The Math Forum – [www.mathforum.org](http://www.mathforum.org)
- Steve’s Dump - [www.forum.swarthmore.edu/~steve/index.html#browse](http://www.forum.swarthmore.edu/~steve/index.html#browse)
- Waterloo Maple’s Student Center - [www.maple4students.com](http://www.maple4students.com)
- Texas Instruments - <http://www.education.ti.com>
- Key Curriculum Press – [www.keypress.com](http://www.keypress.com)
- Eric Weisstein’s World of Mathematics (Encyclopedia of Mathematics) - <http://mathworld.wolfram.com>
- TEAMS Mathematics Resources - <http://teams.lacoe.edu/documentation/places/math.html>
- Math Nerds – [www.mathnerds.com](http://www.mathnerds.com)
- SOS Mathematics – [www.sosmath.com](http://www.sosmath.com)
- Transformations - [www.utc.edu/~cpmawata](http://www.utc.edu/~cpmawata)
- Intermath – [www.intermath-uga.gatech.edu/](http://www.intermath-uga.gatech.edu/)
- The Geometry Center - <http://www.geom.uiuc.edu>
- Project Interactivate - [www.shodor.org/interactivate](http://www.shodor.org/interactivate)
- Multicultural Pavilion - [www.edchange.org/multicultural](http://www.edchange.org/multicultural)
- Women in Mathematics - [www.agnesscott.edu/lriddle/women/women.htm](http://www.agnesscott.edu/lriddle/women/women.htm)
- Interactive Real Analysis – [www.shu.edu/projects/reals/reals.html](http://www.shu.edu/projects/reals/reals.html)

5. Technology Resources: None

**General Expectations:** The student is expected to abide by the university’s attendance policy and honor code. Additional expectations may be given by the instructor.

Disabilities and Accommodations. Any student with a qualified handicap which requires accommodations should talk with me after class so that arrangements can be made. A student must verify that he/she has a qualified handicap through the Office of Student Disability Resources at 706-867-2782.

(October 2007)