

Math 300 – Perspectives in Analysis

Course Description from Bulletin: The course is focused on selected topics related to fundamental concepts and methods of classic analysis and their applications with emphasis on various problem-solving strategies, visualization, mathematical modeling, and interrelation of different areas of mathematics. (3-0-3)

Enrollment: Elective for Mathematics Education, Applied Mathematics, and other majors. To be cross-listed with MSED 521.

Textbook(s): No formal textbook is available at this time. Problems are drawn from various problem books including:

M. Yaglom, D. O. Shklarsky, N. N. Chentzov (1993), *The USSR Olympiad Problem Book: Selected Problems and Theorems of Elementary Mathematics*, Dover Publications (ISBN 0-486-27709-7)

Roger B. Nelsen (1997), *Proofs without Words: Exercises in Visual Thinking*, Mathematical Association of America (ISBN 0-883-85700-6)

Roger B. Nelsen (2001), *Proofs Without Words II: More Exercises in Visual Thinking (Classroom Resource Material)*, Mathematical Association of America (ISBN 0-883-85721-9)

Bernard R. Gelbaum, John M. H. Olmsted (2003), *Counterexamples in Analysis (Dover Books on Mathematics)*, Dover Publications (ISBN 0-486-42875-3)

A. N. Kolmogorov, S. V. Fomin (1975), *Introductory Real Analysis*, Dover Publications (ISBN 0-486-61226-0)

International mathematics olympiads problem books

Instructor's selected handouts

Other required material: The course instructor may distribute various handouts during class meetings

Prerequisites: MATH 251 and MATH 252, or consent of the instructor

Objectives:

1. Students will develop a deep conceptual understanding of fundamental ideas and methods related to classic analysis.
2. Students will develop various problem solving approaches and strategies emphasizing multi-level logical and analytical reasoning.
3. Students will develop skills to construct and analyze proofs.
4. Students will sharpen analytical and algebraic skills and techniques.
5. Students will be provided with meaningful visual interpretations of the results.
6. Students will be provided with non-trivial connections with the pre-college mathematics concepts from an advanced viewpoint.

Lecture schedule: 1 150 minutes (or 2 75 minutes) lectures per week

Course Outline:

- | | Hours |
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| 1. Introduction. Logical reasoning and foundations of point set theory. Open and closed intervals. Functions. | 5 |
| 2. Infinite sets. Cardinality. Sequences. Method of mathematical induction | 5 |

3. Algebraic structure of rational numbers. Equivalence relations. Real numbers as sequences of rationals 5
4. Proof by contradiction. "Epsilon-Delta" proof. Limits 5
5. Visualization in analysis. Proof without words 5
6. Counterexamples in analysis 4
7. Power series, binomial coefficients, and related problems 4
8. Investigation and graphing functions 4
9. Mathematical modeling of story problems and word problems 4
10. Problems on applications of analysis 4

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| Assessment: | Homework | 10-30% |
| | Project | 10-20% |
| | Tests | 20-50% |
| | Final Exam | 30-50% |

Syllabus prepared by: Zaur Berkaliev

Date: Dec. 15, 2005