Math 4301.001: Mathematical Analysis I

Course section: MATH 4301.001, TR 2:30pm-3:45pm, MC 2.410
Instructor: Dr. Mieczyslaw K. Dabkowski
Office: Founders Building 2.408D
Office hours: TR 1:00pm – 2:00pm, or by appointment
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Textbook and Materials

•**Required Text:** *Introduction to Mathematical Analysis* edited by Wieslaw Krawcewicz, Lecture Notes published on the course website. All assigned homework will be related to this text.

•*Solutions Manual:* The Solutions Manual for all problems in the Lecture Notes will be available for students once the related topics are covered and homework assignment is handed in.

•**Additional Recommended Textbooks:**

- Walter Rudin, *Principles of Mathematical Analysis*, 3rd ed., McGraw Hill
- Kenneth Ross, *Elementary Analysis: Theory of Calculus,* 3rd ed., Springer
- Serge Lang, *Calculus with Several Variables*, 3rd ed., Springer,
- Serge Lang, *Undergraduate Analysis*, 2nd.ed, Springer

Prerequisites

MATH 2451 and MATH 3310

Course description

Logic, sets, real number system, metric spaces, completeness, continuity, compactness, differentiability, Taylor formula, Riemann integration and other selected topics.

1. Introduction to Naive Set Theory: sets and operations on sets. Introduction to Logic: formal statements, connectives and logical statements, tautologies, quantifiers, rules and true-false tables.

2. Product of Sets, Relations and Functions: properties of a relation, equivalence relations, partial order relations, total order relations, function as an example of a relation. Injective, surjective and bijective functions, images and inverse images under a function. Cardinality and Countable Sets (including Axiom of Choice): countability of rational numbers.

3. Techniques of Proofs: Inductive and deductive reasoning, axioms and propositions. Theorems and the structure of a proof: direct proof, counter-positive proof, proof by contradiction, proof by induction.

4. Real Numbers: axioms of a field, ordered field and the completeness axiom—axioms of real numbers. Inductive sets, natural numbers and principle of induction. Formal definition of powers, roots and logarithms.

5. Elementary Theory of Metric Spaces: definition of a metric space and basic topological definition (open/closed sets, interiors, boundaries, closures of a set, limit points). Complete metric spaces, completeness of real numbers (as a metric space), limit of a function, continuity and properties of continuous functions. Compactness in metric spaces, properties of compact sets and continuous functions on compact sets. Compactness in Euclidean spaces. Connected spaces and path-connected spaces. Connectedness of intervals of real numbers. Banach Fixed-Point Principle.

6. Real Functions: basic elementary functions and their properties, continuity of elementary functions. The number e and the natural exponential function e^x, natural logarithm function.

7. Differentiation of Real Functions: derivative of function, fundamental properties of differentiable functions. Chain Rule, Lagrange, Cauchy and Darboux theorems, L'Hospital's Rule, higher derivatives, Leibnitz formula, Taylor formula.

These topics are optional

1. Banach Spaces: normed spaces and Banach spaces, product of normed spaces, examples of normed spaces and Banach spaces. Spaces of continuous functions and Uniform Convergence Theorem. Linear operators in Banach Spaces, invertibility of linear operators.

2. Differentiation in Banach Spaces and Multivariable Calculus: derivative as a linear operator, Frechet and Gateaux derivatives, basic properties of derivatives. Functions of multiple variables and their derivatives: partial derivatives and conditions for differentiability.

Student Learning Objectives

1. Students will be able to use the laws of logic and basic set theory to present formal proofs of mathematical statements.

   - Given properties of a function or a set, students will be able to identify additional properties and present formal proofs to justify their claims.

   - Students will learn direct proofs, contra-positive proofs, proofs by contradictions and proofs by induction.

2. Students will be able to learn formal definitions of analytical and topological concepts used in Mathematical Analysis and will be able to prove the most important theorems in Calculus.

   - Given definition of a metric space, students will be able to identify and prove other properties of this space, including such concepts as: completeness, compactness, connectedness, continuity of specific function. Students will be able to prove and use Banach Fixed-Point Principle.

   - Students will be able to prove all the main theorems of single-variable calculus: chain rule, Darboux Lemma, l'Hôpitals rule, Leibnitz formula, Taylor Formula, Fundamental Theorem of Calculus

3. Students will learn additional topics depending on the available time.

   - Students will learn about general properties of Banach spaces with the finite dimensional spaces as examples of Banach spaces. The idea of continuity and differentiability of functions between Banach spaces, and/or

   - Students will learn additional computational methods in analysis, including the computations of certain difficult indefinite and definite integrals.

Course Policy

Assignments: Homework assignments will be given, collected and graded. All the assignments should be completed independently by the students. Each assignment is due within one week unless otherwise indicated in the assignment. Late assignments will NOT be accepted unless extreme circumferences accepted by the instructor arise. Students are strongly encouraged to work more than class assignments. The selected assignments are intended to supply adequate practice for mastery of the concepts presented. You should challenge yourself by attempting problems which are not part of the assigned problems.

Mandatory Attendance will be enforced in MATH 4301– 5% will be added to the final grade for those students with perfect attendance record. Legitimate excuses for occasional absence will be accepted.

Exams: There will be three examinations (Exam I, Exam II and Final Exam). Exams are closed-book tests and students are required to take them at the announced time unless extreme circumferences accepted by the instructor arise. Missed exams and assignments are a zero. Students are expected to inform the instructor of suspected honor code violations. Show all details of your work for each problem you solve during exams (unsupported answers will receive little or no credit). Graphing calculator, programmable calculators, or calculators with non-numeric displays are NOT ALLOWED during exams, however students may use a scientific or arithmetic calculator. Graded quizzes and exams will be returned to you as soon as possible. Any document not picked up by the end of finals week will be destroyed. The final exam will not be returned to students but held for review for one year.

Two exams (Exam I, **Exam II)**: 25% each

Homework assignments: 15%

Attendance: 5%

Final exam: 30%

Calculators: Students may use a scientific or arithmetic calculator but are not required to have a graphing calculator. Programmable calculators with matrix and/or graphing features will NOT be allowed during tests and exams.

Grade Scale

$[98, 100] \rightarrow A+$	$[93.3, 97.6) \rightarrow A$	$[90, 93.3) \rightarrow A-$
$[86.6, 90) \rightarrow B+$	$[83.3, 86.6) \rightarrow B$	$[80, 83.3) \rightarrow B-$
$[76.6, 80) \rightarrow C+$	$[73.3, 76.6) \rightarrow C$	$[70, 73.3) \rightarrow C-$
$[66.6, 70) \rightarrow D+$	$[63.3, 66.6) \rightarrow D$	$[60, 63.3) \rightarrow D-$
$[0, 60) \rightarrow F$		

Important Dates

Monday, August 24, 2015: Classes begin
Monday, September 7, 2015: University Closings: Labor Day
Wednesday, September 9, 2015: Last Day to Drop a Class without a "W" Full Term Session
Exam I, Tuesday 2:30pm – 3:45pm, September 29, 2015 at MC 2.410
Exam II, Tuesday 2:30pm – 3:45pm, November 10, 2015 at MC 2.410
Monday, November 23 – Wednesday, November 25, 2015: No Classes: Fall break
Thursday, November 26 – Saturday, November 28, 2015: Thanksgiving holidays
Wednesday, December 9, 2015: Last Day of Classes Full-Term Session
Thursday, December 10, 2015: Reading Days (Study days prior to final exams)
Final Exam: Final exam date will be available in the Comet Calendar

Technical Support

If you experience any problems with your UTD account you may send an email to:

assist@utdallas.edu or call the UTD Helpdesk at 972 883-2911.

Field Trip Policies Off-Campus

Instruction and Course Activities Off-campus, out-of-state, and foreign instruction and activities are subject to state law and University policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at the website address

http://www.utdallas.edu/businessaffairs/risk/travel.php5

Additional information is available from the office of the school dean. Below is a description of any travel and/or risk-related activity associated with this course.

Student Conduct & Discipline

The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each student and each student organization to be knowledgeable about the rules and regulations which govern student conduct and activities. General information on student conduct and discipline is contained in the UTD printed publication, A to Z Guide, which is provided to all registered students each academic year. The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the Rules and Regulations, Series 50000, Board of Regents, The University of Texas System, and in Title V, Rules on Student Services and Activities of the university's Handbook of Operating Procedures. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391) and online at

http://www.utdallas.edu/judicialaffairs/UTDJudicialAffairs-HOPV.html

A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.

Academic integrity

The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrate a high standard of individual honor in his or her scholastic work. Scholastic Dishonesty, any student who commits an act of scholastic dishonesty is subject to discipline. Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts. Plagiarism, especially from the web, from portions of papers for other classes, and from any other source is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details). This course will use the resources of http://turnitin.com/, which searches the web for possible plagiarism and is over 90% effective.

Copyright Notice

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials, including music and software. Copying, displaying, reproducing, or distributing copyrighted works may infringe the copyright owners rights and such infringement is subject to appropriate disciplinary action as well as criminal penalties provided by federal law. Usage of such material is only appropriate when that usage constitutes "fair use" under the Copyright Act. As a UT Dallas student, you are required to follow the institutions copyright policy (Policy Memorandum 84-I.3-46). For more information about the fair use exemption, see the following website for details.

`http://www.utsystem.edu/ogc/intellectualproperty/copypol2.html`

Email Use

The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a students U.T. Dallas email address and that faculty and staff consider email from students official only if it originates from a UTD student account. This allows the university to maintain a high degree of confidence in the identity of all individual corresponding and the security of the transmitted information. UTD furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information Resources at U.T. Dallas provides a method for students to have their U.T. Dallas mail forwarded to other accounts.

Withdrawal from Class

The administration of this institution has set deadlines for withdrawal of any college level courses. These dates and times are published in that semester's course catalog. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, I cannot drop or withdraw any student. You must do the proper paperwork to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.

Student Grievance Procedures

Procedures for student grievances are found in Title V, Rules on Student Services and Activities, of the university's Handbook of Operating Procedures. In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondents School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Deans decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the deal will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.

Incomplete Grade Policy

As per university policy, incomplete grades will be granted only for work unavoidably missed at the semesters end and only if 70% of the course work has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of F.

Disability Services

The goal of Disability Services is to provide students with disabilities educational opportunities equal to those of their non-disabled peers. Disability Services is located in room 1.610 in the Student Union. Office hours are Monday and Thursday, 8:30 a.m. to 6:30 p.m.; Tuesday and Wednesday, 8:30 a.m. to 7:30 p.m.; and Friday, 8:30 a.m. to 5:30 p.m. The contact information for the Office of Disability Services is:

The University of Texas at Dallas, SU 22
PO Box 830688
Richardson, Texas 75083-0688
(972) 883-2098 (voice or TTY)
`disabilityservice@utdallas.edu`

If you anticipate issues related to the format or requirements of this course, please meet with the Coordinator of Disability Services. The Coordinator is available to discuss ways to ensure your full participation in the course. If you determine that formal, disability-related accommodations are necessary, it is very important that you be registered with Disability Services to notify them of your eligibility for reasonable accommodations. Disability Services can then plan how best to coordinate your accommodations.

It is the students responsibility to notify his or her professors of the need for such an accommodation. Disability Services provides students with letters to present to faculty members to verify that the student has a disability and needs accommodations. Individuals requiring special accommodation should contact the professor after class or during office hours.

Religious Holy Days

The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, Texas Code Annotated. The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment. If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of TEC 51.911(b), and the student and instructor will abide by the decision of the chief executive officer or designee.

These descriptions and timeliness are subject to change at the discretion of the Professor.