

MATH 503: Introduction to Analysis

Western Kentucky University – Fall 2023

Section Number: 001

Instructor: Zac Bettersworth

Email: Zachary.bettersworth@wku.edu

Class Times: None

Classroom: Web Course Delivery

Office: COHH 3114

Course Description: 3 Credit Hours - A theoretical examination of selected topics in real analysis including sequences, series, limits, continuity, derivatives, and integration.

Learning Objectives: Upon Successful Completion of MATH 503, students will be able to:

1. Demonstrate the interconnectedness among sets, functions, sequences, differentiation, and integration.
2. Develop multiple theoretical, as well as pictorial, representations of functions.
3. Apply theories of advanced calculus to solve problems.
4. Analyze, evaluate, and write proofs using theory development and a theoretical understanding of real analysis.
5. Critique and respond to authentic classroom situations from high school mathematics.

Prerequisite: Admission to the Master of Arts in Mathematics program or permission of the instructor.

Textbook: Kosmala, W. (2004). *A Friendly Introduction to Analysis: Single and Multivariable*. 2nd Edition.

ISBN-10: 0130457965

ISBN-13: 978-0130457967

Course Materials: You will utilize the textbook every week of the course for homework, definitions, and the development of new ideas, proofs, and proof techniques. Learning to read mathematics textbooks is a skill that requires practice and time. One cannot read a math textbook in the same way they read a work of fiction. You must convince yourself that you believe every line of the text, and work any “exercises left to the reader.” Reading a math textbook is a very attention-demanding and cognitively demanding activity.

Internet Access: You must have regular and reliable access to your WKU email account and Blackboard. Lack of internet access or failure to log in to these systems may not be used as an excuse for failing to obtain materials or turn in homework assignments. You should check your WKU email account daily, as all announcements for the class will be sent there. Please contact the Information Technology Helpdesk at 270-745-7000 for more information and questions regarding Blackboard.

Course Content & Instruction: MATH 503 may be different from any course you’ve had before, even if you have previously taken other mathematics coursework at WKU. The content of this course is the study of the real number line, and an attempt to learn how mathematicians have made this analysis more rigorous using proof techniques. While you may have completed a calculus course in the past, we will be “lifting the hood” on some of the theoretical underpinnings of the

theory used by mathematicians to prove some of the theorems you learned about. This will require us to rethink some common mathematical concepts in new ways: functions, sequences, limits, continuity, differentiability, and integrability. At times, it will feel like the “language” of analysis feels very different than the language of calculus, but we are really talking about the same ideas and concepts, just using a lot of the Greek alphabet and definitions that we learn as we go. Notice that you will no longer just be applying calculus ideas to “nice” functions (we’re not just finding derivatives anymore, we’re challenging our understanding of what it means for a function to be differentiable). Analysis is sometimes called the “mathematics of counterexamples” and we will be learning about some very interesting historical examples of functions which again challenge our understanding of what a function actually is. If you want a sneak peek of this, look up the Dirichlet function. It is my hope that engendering this sort of theoretical sensitivity to mathematics will help you make connections between the processes of your own learning and teaching.

I will also borrow some ideas from a group of undergraduate mathematics education researchers who wrote the book *Understanding Analysis and its Connections to Secondary Mathematics Teaching*. This book uses one of my favorite undergraduate analysis textbooks, *Understanding Analysis* by Stephen Abbott to reflect on ways that analysis can provide opportunities to learn more about mathematics and the teaching of mathematics. You are NOT required to purchase either of these books, but I will be using them as additional resources in our course.

Attendance and Absences: We will not have a set meeting time when everyone must be online; however, you are to be online frequently each week to check your WKU email, Blackboard, and the discussion board for discussions about the reading or problem sets.

Assessment and Grading: Your grade in the course will be based on the following:

Exams (60%): There will be two total exams (four unit exams, a midterm and a final) to measure your understanding of the course material. The midterm exam will cover material from the first half of the course, and the final exam will cover material from the second half of the course.

The exams will be taken in two parts. Half of the exam will be uploaded to Blackboard, and this half of the exam will be open-note. The other half of the exam must be completed in a proctored exam environment. You will work with the testing center to determine a location near you where you can complete the proctored portion of each exam. More information about the exams will be distributed on Blackboard.

Homework (40%): It will be very advantageous for you to work through all problems that are assigned as you will receive a completion grade. You will find that doing the homework, reading the textbook, watching the videos, and corresponding with classmates or with the instructor will increase your chances for success on the assignments and assessments. Each week, the assignment will have the following format:

1. **Real Analysis Content.** Highlights a definition, theorem, or proof from the reading.
2. **Secondary Mathematics & Pedagogical Connections and Reflections.** Highlights how the real analysis content can be related to teaching and/or re-considering some of the secondary mathematics. NOTE: This section will be included at the completion of each chapter.
3. **Assigned Exercises.** Practice exercises from the textbook and other sources.

Note: All missed exams will be given a grade of zero. The only exceptions to this policy will be those absences that are caused by University approved activities, or religious observances for which documentation has been provided to the instructor in advance. The instructor will evaluate unexpected illness or unforeseen catastrophic circumstances on a case-by-case basis and determine whether a make-up is appropriate. Every effort must be made by the student to notify the instructor as soon as possible in these cases.

Determination of Final Course Grade: Final course grades will be determined using the following scale, based on the percentage of available points earned:

Percentage	0% – 59%	60% – 69%	70% – 79%	80% – 89%	90% – 100%
Letter Grade	F	D	C	B	A

What Makes a Successful Online Student?

1. **Written Communication.** In the Virtual Classroom, nearly all communication is written, so it is critical that you feel comfortable expressing yourself in writing.
2. **Support Yourself.** Be self-motivated and self-disciplined.
3. **Speak Up.** Be willing to “speak up” if problems arise. If you are having trouble on any level (either with the technology or with the course content), please communicate this immediately. Otherwise, I may never know what is wrong.
4. **Commit Time.** Be willing and able to commit to 4 to 15 hours per week per course and participate in the virtual classroom 5 – 7 days a week. Online is not easier than the traditional educational process. In fact, many students will say it requires much more time and commitment.
5. **Meet Requirements.** Be able to meet the minimum requirements for the program. The requirements for online are no less than that of any other quality educational program. It may help to view online as a convenient way to receive their education – not an easier way.
6. **Think Through Ideas.** Be able to think ideas through before responding. Meaningful and quality input into the virtual classroom is an essential part of the learning process. Time is given in the process to allow for the careful consideration of responses. The testing and challenging of ideas are encouraged; you will not always be right, just be prepared to accept a challenge.
7. **Reading Course Content.** Reading any sort of technical writing is different from reading something like a novel or Cosmopolitan. For one, it will take you longer to read one page of mathematics than it will for you to read one page of a novel or magazine article.

Here are some tips to help you read mathematics more easily:

1. **Go slowly.** Letting your eyes pass over the words on the page is different than letting the ideas knock around your head for a bit.
2. **Focus.** Do not read while watching television/listening to music/checking email. Studies show that no one does better while multitasking.
3. **Read with paper and a pencil.** Write what you need to understand a statement. Sometimes this means seeing how the statement relates to a concrete example, and sometimes this means literally writing down exactly what is in the book to help you focus on it (especially with proofs).
4. **Be active.** Ask questions of the textbook and see if you can answer them yourself. See how statements relate to concrete examples. Summarize in your own words.
5. **Do not skim.** Much of what we read contains filler that is not essential to read to understand the main point. This is not so in mathematics -- almost every word is important.

6. **Re-read.** Both when you are first reading (go back over what you did not understand) and reread a couple of days later.

Academic Dishonesty: Students who commit any act of academic dishonesty will receive from the instructor a failing grade in the course without the possibility of withdrawal. The instructor will also present the case to the Office of Student Conduct for disciplinary sanctions. More information can be found here: <https://www.wku.edu/handbook/academic-dishonesty.php/>

ADA Accommodation: In compliance with University policy, students with disabilities who require academic and/or auxiliary accommodations for this course must contact the Student Accessibility Resource Center located in Downing Student Union, Room 1074. The SARC can be reached by phone number at 270-745-5004 [270-745-3030 TTY] or via email at sarc.connect@wku.edu. Please do not request accommodations directly from the professor or instructor without a faculty notification letter from The Student Accessibility Resource Center.

Cell Phones and Portable Electronic Devices: Cell phones, smartwatches, and other electronic devices provide a distraction to the learning environment for both the users and those around them. During exams, it is expected that all technology, including cell phones & smart watches be silenced (no vibration) and stored out of sight.

WKU Syllabus Statement on COVID-19: All students are strongly encouraged to [get the COVID-19 vaccine](#). In accordance with WKU policy, all students must call the WKU COVID-19 Assistance Line at 270-745-2019 within 4 hours of testing positive for COVID-19 or being identified as a close contact with someone who has tested positive. The COVID Assistance Line is available to answer questions regarding any COVID-19 related issue. This guidance is subject to change based on requirements set forth by federal, state, and local public health entities. Please refer to the Healthy on the Hill website for the most current information www.wku.edu/healthyonthehill.

Title IX / Discrimination/Harassment: Western Kentucky University (WKU) is committed to supporting faculty, staff and students by upholding WKU's [Sex and Gender-Based Discrimination, Harassment, and Retaliation](#) (#0.070) and [Discrimination and Harassment Policy](#) (#0.2040). Under these policies, discrimination, harassment and/or sexual misconduct based on sex/gender are prohibited. If you experience an incident of sex/gender-based discrimination, harassment and/or sexual misconduct, you are encouraged to report it to the Executive Director, Office of Institutional Equity/Title IX Coordinator, Ena Demir, 270-745-6867 or Title IX Investigators, Michael Crowe, 270-745-5429 or Joshua Hayes, 270-745-5121. Please note that while you may report an incident of sex/gender-based discrimination, harassment and/or sexual misconduct to a faculty member, WKU faculty are "Responsible Employees" of the University and MUST report what you share to WKU's Title IX Coordinator or Title IX Investigator. If you would like to speak with someone who may be able to afford you confidentiality, you may contact WKU's [Counseling and Testing Center](#) at 270-745-3159. Further, sexual assault resources can be found here: <https://www.wku.edu/titleix/>

Inclusion Statement: Western Kentucky University (WKU) is committed to ensuring all members of our campus community have access to equitable and inclusive learning, working,

and living environments. At the heart of our mission, we seek to provide holistic education and employment experiences that prepare students, faculty, and staff to become effective scholars, contributors, and leaders in our diverse and evolving communities. Consistent with our campus purpose statement and creed, this classroom will be a respectful space, welcoming all sexes, races, ages, national origins, ethnicities, gender identities/labels/expressions, intellectual and physical abilities, sexual orientations, faith/non-faith perspectives, income levels and socio-economic classes, political ideologies, educational backgrounds, primary languages, family statuses, military experiences, cognitive styles, and communication styles. If at any time during this course you are excluded or feel a sense of alienation from the course content, please feel free to contact me privately without fear of reprisal.

Land Acknowledgement Statement: The history of our community and land gives us the opportunity to recognize, respect, and appreciate our place within that history. Western Kentucky University (WKU) honors and acknowledges the Indigenous peoples' land on which this University was built. All land in the state of Kentucky was once Indigenous territory, which is why it is our duty to acknowledge that WKU exists on Native land. This particular region of Kentucky was home to both the Shawnee (Shawandasse Tula) and Cherokee East (CWJᏍᏏᏉᏍᏏ Tsalaguwetiyi) tribes.

We also honor and acknowledge the former residents of Jonesville. According to the [Jonesville History Project](#), "Jonesville was a predominantly African American community in Bowling Green, Kentucky, that was demolished in the 1960s to make way for the expansion of the WKU campus. This incident echoed a pattern across the country where the power of eminent domain was utilized to seize property from minority communities for large public works projects under the guise of urban revitalization."

****DISCLAIMER: We reserve the right to adjust or change any part of this syllabus, if deemed necessary.**