COURSE SYLLABUS
MH 408-62 Topics in Analysis (online)

Instructor: Dr. James Cook

Semester: Fall 2020

Office: BG 126A

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Office Hours: Monday – Friday 10:00am-12:00pm.

Course Description: This course begins with an analysis of set theory, equivalence relations, functions, cardinality, induction, well ordering principle, axioms of real numbers and completeness. We then turn to study sequential convergence, theory of limits for sequences, monotone sequences, the Bolzano Weierstrauss Theorem, and the limit superior and inferior. Next we introduce the basic topology needed to understand the theory of limits. We prove many results concerning the limit of functions, theory of continuity, derivatives, Mean Value Theorem, Taylor's Theorem, contraction mapping technique, Newton's method, and applications. Finally, in the last part of the course we turn to focus on multivariate topics where some linear algebra is applied. In particular, we introduce the Frechet derivative, discuss how to linearize multivariate maps, understand the inverse function theorem, and finally see how the multivariate power series allows us to understand optimization of a multivariate function via spectral analysis of the Hessian.

Prerequisite: MH 122 and MH 213 or equivalent.

Credit Hours: 3 credit hours.

Course Objectives: Enable students to understand the following topics:
1. Learn how to write proofs
2. Prove basic facts about real numbers
3. Analyze equivalence relations
4. Analyze convergence of sequences
5. Calculate limsup and liminf
6. Define Topology and prove basic topological results
7. Prove basic results concerning continuity and derivatives
8. Optimize a multivariate function via spectral analysis of the Hessian

Course Materials: The following is recommended:
1. Textbook: <u>Introduction to Mathematical Analysis I</u> , Second Edition, ISBN 13: 9781365605529 which is available as an open source textbook via pdf free of charge to the student at:
https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1015&context=pdxopen

2. A reliable and relatively fast method to scan and email pdf files as well as good internet access.

Course Outcomes: The learner will be able to
- Write mathematical proofs concerning the subject matter of this course
- State definitions for the subject matter of this course
- Analyze problems in view of the theoretical results given in this course

Evaluation and Grading Policy: Grades will be determined on the basis of academic work provided by the student. Each assignment will be given a point value. Any student who is dissatisfied with his/her grade during this course is urged to discuss this with the instructor. Grading will be as follows:

Missions (300pts) are required homework which I provide in pdf format. I expect you to provide me a solution in the same fashion. Your writing must be clearly readable so please take time to scan the work properly.
Tests (300pts) given through email or Blackboard once everyone has established a Zoom connection. We will use Zoom to proctor all the Tests and the Final Exam.
Final Exam (200pts) comprehensive.
Zoom Weekly Meeting (100pts) I am hoping that each week we can talk about questions raised in the lectures of the previous week. I'll probably ask some low pressure questions about what you learned from watching the lectures posted in the previous week. These meetings will happen on my Sunday night most weeks.
Presentation (100pts) Sometime soon I will provide a list of topics for presentations at the end of the course. You will prepare slides and share them via Zoom with your classmates. The talk will be 15 minutes with 5

minutes for questions. I am also open to requests for topics, especially if you make the request before I provide the list.

Further details about the scheduling of the above items is provided in the Course Planner which is posted in Blackboard under Course Content. Letter grades follow: let x denote the total points earned in the course:

A if $x \geq 900$,
B if $800 \leq x \leq 899$,
C if $700 \leq x \leq 799$,
D if $600 \leq x \leq 699$,
F if $x < 600$

Course Content:

The number refers to the section in the required text. IP indicates Instructor Provided material to be given on topic since the textbook does not have sufficient discussion of the topic.

1.1: Basic Set Theory 1.1
IP: Relations and Equivalence Relations
1.2: Functions
IP: Cardinality and Countability
1.3: Induction and Well Ordering Principle
1.4: Ordered Field Axioms
1.5: Completeness Axiom for Real Numbers
1.6: Applications of Completeness Axiom
2.1: Convergence
2.2: Limit Theorems
2.3: Monotone Sequences
2.4: Bolzano Weierstrauss Theorem
2.5: Limit Superior/Inferior
2.6: Topology
3.1: Limits of Functions
3.2: Limit Theorems
3.3: Continuity
3.4: Properties of Continuous Functions
4.1: Derivatives
4.2: Mean Value Theorem (MVT)
4.3: Applications of MVT
4.5: Taylor's Theorem
IP: Contraction Mapping and Newton's Method
IP: Linear Algebra Refresh: matrices and linear maps
IP: Frechet Derivative and Linearization of Maps,
IP: Intuition on Inverse Function Theorem
IP: Linear Algebra Refresh: eigenvectors
IP: Multivariate Power Series and Optimization

Rescheduling of Examinations:

Students may request to reschedule one or two of their final examinations if they have three or four exams on the same day. The student must submit a formal written request to reschedule an exam <u>at least two weeks before the first day of final exams.</u> <u>The request must be made to the dean of the college in which the course(s) is taught.</u>

Student Conferences:

Any student making a failing grade during the semester is urged to make a conference with the instructor.

Absence Policy:

Your presence is required in order to learn the course material. **You must attend 2/3 of all scheduled classes days. (This means you can miss no more than 14 days of class, excused or unexcused.)** Let the instructor know if you are going to be absent in order that you may get the assignments ahead of time. **You MUST make arrangements with the instructor if you are going to miss a test. ONLY ONE MAKEUP will be allowed! DO NOT MISS A TEST!!!**

Assessment Day: As a part of the University's plan to assess institutional effectiveness, a day is set aside each semester (except Summer Semester) for assessment activities. <u>Although no day classes</u> meet on this designated day, students are required to participate in assessment activities when they are called upon to do so.

Disability: The University of West Alabama strives to make its programs accessible to qualified persons defined as disabled under Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act. Students who have special needs that require accommodation are responsible for notifying instructors in each course in which they are enrolled and appropriate staff members, who in turn will refer the student to the ADA Compliance Coordinator. Following verification of the student's status, the ADA Compliance Coordinator will work with the instructor or staff member in implementing an appropriate plan for accommodation of the student's needs. Support documentation of special needs from a physician or other qualified professional will be required if deemed necessary. For additional information, students should contact the Student Success Center, Foust Hall Room 7, (205) 652-3651, or the Office of Student Life, Webb Hall, Room 311, (205) 652-3581.

Honesty/Integrity: The UWA Academic Dishonesty policy stated in the *General Catalogue* and the student handbook will be followed in this course.

COVID-19 Syllabus Statement: safety procedures during the pandemic

Due to the COVID-19 pandemic, faculty, staff, and students will be required to take necessary safety precautions to reduce the risk of spread of COVID-19. The following procedures are required for the duration of the pandemic and may be updated as circumstances require:

➢ Staying at home or self-isolating. When you are sick with any known symptoms of COVID-19 or encounter someone known or suspected to have or have been exposed to COVID-19, you are advised to contact your health care provider and are not allowed to come to class until you meet the return to campus guidelines provided for in the University's Operational Plan for Fall Semester 2020. Please contact your instructor through email or phone as soon as possible. Your instructor will work with you to provide any content or materials in an alternate format, so you should not fear missing valuable information. Knowingly attending classes or participating in university functions following a possible exposure, after the onset of suspected symptoms, or while awaiting test results will result in potential disciplinary action.

➢ Practicing hand hygiene and respiratory etiquette. Frequent hand washing with soap and water for at least 20 seconds or use of hand sanitizer that contains at least 70% alcohol is highly recommended. Cover your coughs and sneezes.

➢ Wearing facial coverings. All faculty, staff, and students must wear facial coverings in classrooms, labs, shared office spaces, during on-campus gatherings, and in any other setting on campus when social distancing is difficult to maintain. In the classroom setting, faculty, at their discretion, may require students to wear facial coverings at all times during class regardless of whether social distancing is achievable. Review the proper way to wear, remove, and wash your facial covering. Video tutorials are available.

➢ Social distancing. Academic departments have rearranged schedules and physical spaces to maintain, so far as possible, workable and safe social-distancing arrangements.

➢ Cleaning and disinfecting learning spaces between use. To minimize sharing of high touch surfaces, students will be assigned specific seating, lab equipment, and computers when feasible. Faculty and students will have ample opportunity to wipe down/disinfect their workspace before and after each class.

➤ Scheduling virtual meetings between faculty and students. While faculty members will maintain their regularly scheduled office hours, they will also work with you to conduct these office hour meetings via telephone or teleconference. If a virtual meeting is neither possible nor desired, other arrangements, such as meeting outside or in a large space, will be made.

Please note that due to the ever-changing nature of COVID-19, the course schedule is subject to change. Should university officials need to suspend campus operations for any reasons, and if said closures affect scheduled class meetings and/or assignment due dates, the course will proceed through alternate means. In such circumstances, your instructor will contact you through email with instructions for how to proceed.

Contingency Statement:

If the University suspends in-person class meetings and we begin all online instruction then you should expect to complete Tests and Quizzes at the same time as was previously indicated in the Course Planner. Homework which was to be collected in person will be collected as pdfs through some online method. Further advice on the creation of pdf-scans of homework and the method of communication of said pdf's will be announced soon after the event we suspend residential classes.

Content/Schedule Change: The instructional schedule reflects expected class progress in course subject matter and is considered tentative. The schedule is subject to change in content and scope at the instructor's discretion. The instructor will make corrections as needed and will announce changes in the class.