Course Title	Real Mathematical Analysis
Course Code	MATH 4011
Semester	Summer 2026
Course Length	4 Weeks, 60 Contact Hours
Credits	4
Instructor	TBA
Office	TBA
Email	TBA
Prerequisite	MATH 3370 Introductory Real Analysis

Course Description:

This course offers a rigorous study of the theoretical foundations of multivariable calculus and the topology of Euclidean spaces. We will transition from the properties of the real line to the analysis of mappings between higher-dimensional spaces. Key themes include the completeness of metric spaces, the topological nature of continuity, the contraction mapping principle, and the local behavior of differentiable functions. The course concludes with an introduction to the existence and uniqueness theory for differential equations.

Course Goals:

Students who successfully complete this course will demonstrate competency in the following general education core goals:

- **Critical Thinking Skills** – Students will engage in analytical thinking, demonstrating the ability to critically evaluate, synthesize, and apply knowledge to complex problems, and construct well-reasoned solutions and arguments.
- **Independent Research and Inquiry** – Students will conduct independent research, utilizing academic resources to explore relevant topics, formulating research questions, analyzing data, and presenting findings in a coherent, scholarly manner.
- **Problem-Solving and Application** – Students will apply theoretical concepts and methodologies learned in the course to real-world problems, demonstrating the ability to develop practical solutions informed by academic inquiry.
- **Global and Cultural Awareness** – Students will gain awareness of the global and cultural contexts relevant to the course, appreciating diverse perspectives and considering the implications of their studies in a broader, international context.

Student Learning Outcomes:

Upon completion of this course, students will be able to:

- Navigate the topology of $\mathbb{R}^n$, including compactness, connectedness, and the structure of open sets;
- Distinguish between pointwise and uniform convergence and apply the Ascoli-Arzelà theorem;
- Rigorous demonstrate the Inverse and Implicit Function Theorems using the Banach Fixed Point Theorem;
- Analyze the existence and uniqueness of solutions to systems of ODEs via Picard-Lindelöf.

Textbooks/Supplies/Materials/Equipment/ Technology or Technical Requirements:
Required: *Principles of Mathematical Analysis (3rd Ed.)* by Walter Rudin. McGraw Hill.
Supplemental: *Analysis II (3rd Ed.)* by Terence Tao. Springer.

Course Requirements:

Problem Sets (40%)
These assignments are the core of the learning process. They require students to construct formal proofs regarding topological properties and functional limits. Success requires moving beyond computation to logical derivation.

Midterm Examination (25%)
This exam evaluates the first half of the course, specifically point-set topology in $\mathbb{R}^n$, sequences of functions, and the concept of uniform continuity.

Final Examination (35%)
A comprehensive final focusing heavily on the second half of the course. Students must demonstrate mastery of multivariable differentiability, the Chain Rule, and the Inverse/Implicit function theorems.

Assessments: Activity	Percent Contribution
Problem Sets	40%
Midterm Exam	25%
Final Exam	35%

Grading:

Final grades will be based on the sum of all possible course points as noted above.

Grade	Percentage of available points
A	94-100
A-	90-93
B+	87-89
B	84-86
B-	80-83
C+	77-79
C	74-76
C-	70-73
D	64-69
D-	60-63
F	0-59

Course Schedule:
The schedule of activities is subject to change at the reasonable discretion of the instructor.
Minor changes will be announced in class, major ones provided in writing.

MATH 4011 Schedule		
Lecture	Topic	Readings
L1	The Real Field & Completeness Review	Ch 1
L2	Topology of $\mathbb{R}^n$: Open and Closed Sets	Ch 2
L3	Cluster Points and Boundary Operations	Ch 2
L4	Compactness: Heine-Borel & Bolzano-Weierstrass	Ch 2; PS 1 Due
L5	Perfect Sets: Construction of the Cantor Set	Ch 2
L6	Connectedness and Metric Space Structure	Ch 2
L7	Continuity and Product Spaces	Ch 4
L8	Uniform Continuity & Heine-Cantor Theorem	Ch 4; PS 2 Due
L9	Dense Sets, G_δ and F_σ Classification	Ch 3
L10	Baire Category & Volterra's Theorem	Ch 3
L11	Differentiation in $\mathbb{R}^1$: Darboux's Theorem	Ch 5
L12	**Midterm Examination**	Midterm
L13	Sequences of Functions: Pointwise/Uniform	Ch 7
L14	Uniform Convergence, Integration, & Continuity	Ch 7
L15	Ascoli-Arzelà Theorem & Function Spaces	Ch 7
L16	Multivariable Analysis: Linear Transformations	Ch 9; PS 3 Due
L17	Partial Derivatives and Gradients	Ch 9
L18	Total Differentiability in $\mathbb{R}^n$	Ch 9
L19	Multivariable Chain Rule and Mean Value Theorem	Ch 9
L20	Higher-Order Partials & Clairaut's Theorem	Ch 9; PS 4 Due
L21	Contraction Mapping & Banach Fixed Point	Ch 9
L22	Inverse Function Theorem: Proof & Application	Ch 9
L23	Implicit Function Theorem (Dini's Formulation)	Ch 9
L24	Constrained Extrema & Lagrange Multipliers	Ch 9; PS 5 Due
L25	Picard-Lindelöf: Existence/Uniqueness of ODEs	Ch 10
/	**Final Examination**	Cumulative Exam

Accommodation Statement:

Academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as he/she is not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow.

Academic Integrity Statement

Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in coursework may receive a reduced or failing grade for the work in question and/or for the course.

Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional qualifications within or outside the University; and nondisclosure or misrepresentation in filling out applications or other University records.

Other Items:

Attendance and Expectations
All students are required to attend every class, except in cases of illness, serious family concerns, or other major problems. We expect that students will arrive on time, be prepared to listen and participate as appropriate, and stay for the duration of a meeting rather than drift in or out casually. In short, we anticipate that students will show professors and fellow students maximum consideration by minimizing the disturbances that cause interruptions in the learning process. This means that punctuality is a must, that cellular phones be turned off, and that courtesy is the guiding principle in all exchanges among students and faculty. You will be responsible for the materials and ideas presented in the lecture.

Assignment Due Dates
All written assignments must be turned in at the time specified. Late assignments will not be accepted unless prior information has been obtained from the instructor. If you believe you have extenuating circumstances, please contact the instructor as soon as possible.

Make-Up Work
The instructor will not provide students with class information or make-up assignments/quizzes/exams missed due to an unexcused absence. Absences will be excused and assignments/quizzes/exams may be made up only with written documentation of an authorized absence. Every effort should be made to avoid scheduling appointments during class. An excused student is responsible for requesting any missed information from the instructor and setting up any necessary appointments outside of class.

Access, Special Needs, and Disabilities
Please notify the instructor at the start of the semester if you have any documented disabilities, a medical issue, or any special circumstances that require attention, and the school will be happy to assist.