



湖北工业大学  
HUBEI UNIVERSITY OF TECHNOLOGY

<b>Course Title</b>	Advanced Calculus
<b>Course Code</b>	MATH 4162
<b>Semester</b>	Summer 2026
<b>Course Length</b>	4 Weeks, 60 Contact Hours
<b>Credits</b>	4
<b>Instructor</b>	TBA
<b>Office</b>	TBA
<b>Email</b>	TBA
<b>Prerequisite</b>	MATH 1111 Calculus I MATH 1112 Calculus II MATH 2231 Multivariable Calculus

### Course Description:

This course is designed to provide a rigorous understanding of advanced concepts in calculus, with a focus on real analysis and its applications. Emphasis will be placed on developing strong proof-writing skills and deepening mathematical thinking.

Topics covered include: uniform continuity; differentiation and integration; improper integrals; Gamma and Beta functions; Euler's constant functions of several variables; limits, iterated limits, continuity; partial derivatives (higher order partial derivatives, composition of functions and the chain rule); directional derivative; implicit functions; sequences and series of functions; uniform convergence; power series; Weierstrass approximation theorem and Taylor's theorem.

### 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:

- determine the limit at a point, iterated limits at a point, continuity at a point, partial derivatives, and directional derivatives for a given function of several variables;
- apply tests for convergence of improper integrals, to determine the existence of given improper integrals;
- evaluate the improper integrals using beta and gamma functions;
- utilize Fourier series and Fourier transforms in solving applied mathematics problems;
- strengthen their mathematical reasoning and proof-writing skills.

### Textbooks/Supplies/Materials/Equipment/ Technology or Technical Requirements:

**Required:** Murray R Spiegel & Robert Wrede, *Schaum's Advanced Calculus* 3rd edition, McGraw Hill Publication.

**Supplementary:** K.G. Binmore, *Mathematical Analysis: A Straightforward Approach* 2nd edition, Cambridge University Press.

### Course Requirements:

#### Homework Assignments (30%):

Ten problem sets designed to reinforce lecture topics. These assignments will require students to solve theoretical and applied problems, providing an opportunity to practice proof techniques, computations, and conceptual understanding.

#### Midterm Exams (40%):

Two exams, each contributing 20% to the final grade, will be administered in the exam periods. The midterms will assess students' ability to apply theoretical concepts to problem-solving, analyze functions rigorously, and evaluate integrals and series. These exams will include a mix of proof-based questions testing mastery of key concepts (e.g., uniform convergence, differential forms) and theoretical explanations.

#### Final Exam (30%):

A cumulative exam covering all course topics. This assessment will test students' mastery of the material by requiring them to synthesize and apply concepts across multiple areas of advanced calculus. The exam will contain a combination of direct problem-solving, conceptual analysis, and formal proofs.

<b>Assessments: Activity</b>	<b>Percent Contribution</b>
Homework Assignments	30%
Midterm Exams	40%
Final Exam	30%

### 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 4162 Schedule		
Lecture	Topic	Readings
L1	Course overview Calculus review	Lecture Notes
L2	<b>NUMBERS AND SEQUENCES</b> Real numbers. Limit points. Bolzano-Weierstrass theorem. Algebraic and transcendental numbers. Theorems on limits of sequences. Infinity. Cauchy's convergence criterion. Infinite series.	Cha. 1-2
L3	<b>FUNCTIONS, LIMITS, AND CONTINUITY</b> Functions. Monotonic functions. Inverse functions. Maxima and minima. Types of functions. Transcendental functions. Limits of functions. Infinity. Uniform continuity.	Cha. 3
L4	<b>DERIVATIVES</b> The concept and definition of a derivative. Differentials. Implicit differentiation. Rules for differentiation.	Cha. 4
L5	<b>DERIVATIVES (Continued)</b> Derivatives of elementary functions. Higher order derivatives. Mean value theorems. L'Hospital's rules. Applications.	Cha. 4
L6	<b>INTEGRALS</b> Introduction of the definite integral. Properties of definite integrals. Mean value theorems for integrals. Connecting integral and differential calculus. The fundamental theorem of the calculus.	Cha. 5
L7	<b>INTEGRALS (Continued)</b> Integrals of elementary functions. Improper integrals. Numerical methods for evaluating definite integrals. Arc length. Area.	Cha. 5
L8	<b>PARTIAL DERIVATIVES</b> Functions of two or more variables. Limits. Iterated limits. Continuity. Uniform continuity. Partial derivatives. Higher order partial derivatives. Differentials. Euler's theorem on homogeneous functions.	Cha. 6
L9	<b>PARTIAL DERIVATIVES (Continued)</b> Implicit functions. Jacobians. Partial derivatives using Jacobians. Theorems on Jacobians. Transformation. Curvilinear coordinates. Mean value theorems.	Cha. 6
L10	<b>VECTORS</b>	Cha. 7

	Geometric properties. Linear independence and linear dependence of a set of vectors. Dot or scalar product. Cross or vector product.	
L11	<b>VECTORS (Continued)</b> Vector functions. Limits, continuity, and derivatives of vector functions. Gradient, divergence, curl, and Laplacian in orthogonal curvilinear coordinates.	Cha. 7
/	<b>*Midterm Exam 1</b>	Cha. 1-7
L12	<b>APPLICATIONS OF PARTIAL DERIVATIVES</b> Applications to geometry. Directional derivatives. Differentiation under the integral sign. Method of Lagrange multipliers for maxima and minima.	Cha. 8
L13	<b>MULTIPLE INTEGRALS</b> Double integrals. Iterated integrals. Triple integrals. Transformations of multiple integrals.	Cha. 9
L14	<b>LINE INTEGRALS, SURFACE INTEGRALS, AND INTEGRAL THEOREMS</b> Line integrals. Evaluation of line integrals for plane curves. Properties of line integrals expressed for plane curves. Simple closed curves, simply and multiply connected regions.	Cha. 10
L15	<b>LINE INTEGRALS, SURFACE INTEGRALS, AND INTEGRAL THEOREMS (Continued)</b> Green's theorem in the plane. Conditions for a line integral to be independent of the path. Surface integrals. The divergence theorem. Stoke's theorem.	Cha. 10
L16	<b>INFINITE SERIES</b> Definitions of infinite series and their convergence and divergence. Fundamental facts concerning infinite series. Infinite sequences and series of functions, uniform convergence.	Cha. 11
L17	<b>INFINITE SERIES (Continued)</b> Theorems on uniformly convergent series. Power series. Theorems on power series. Expansion of functions in power series.	Cha. 11
L18	<b>INFINITE SERIES (Continued)</b> Taylor's theorem. Some important power series. Special topics. Taylor's theorem (for two variables).	Cha. 11
/	<b>*Midterm Exam 2</b>	Cha. 8-11
L19	<b>IMPROPER INTEGRALS</b> Definition of an improper integral. Improper integrals of the first kind (unbounded intervals). Improper integrals of the second kind. Cauchy principal value. Improper integrals containing a parameter, uniform convergence.	Cha. 12
L20	<b>IMPROPER INTEGRALS (Continued)</b> Theorems on uniformly convergent integrals. Evaluation of definite integrals. Laplace transforms. Linearity. Convergence. Improper multiple integrals.	Cha. 12
L21	<b>FOURIER SERIES</b> Periodic functions. Fourier series. Orthogonality conditions for the sine and cosine functions.	Cha. 13
L22	<b>FOURIER SERIES (Continued)</b> Odd and even functions. Half range Fourier sine or cosine series. Orthogonal functions.	Cha. 13
L23	<b>GAMMA AND BETA FUNCTIONS</b> The gamma function. Table of values and graph of the gamma function.	Cha. 15

L24	The beta function. Dirichlet integrals. <b>FUNCTIONS OF A COMPLEX VARIABLE</b>	Cha. 16
L25	Functions. Limits and continuity. Derivatives. Cauchy-Riemann equations. Integrals. Cauchy's theorem. Cauchy's integral formulas. <b>FUNCTIONS OF A COMPLEX VARIABLE (Continued)</b>	Cha. 16
/	Taylor's series. Singular points. Poles. Laurent's series. Branches and branch points. Residues. Residue theorem. Evaluation of definite integrals. <b>*Final Exam</b>	Cha. 1-16

**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 without 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.