**Elementary Multivariable Calculus**
**Fall 2850 CRN: 40958 Credit Hours: 4**
**Math 2850 Sec. 04 MTRF 10:00 - 10:55 AM Room: Memorial Field House 2920**


**Instructor:** Dr. David Gajewski
**Office:** University Hall 3014
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## COURSE DESCRIPTION

Geometry of functions of several variables, partial differentiation, multiple integrals, vector algebra and calculus (including Theorems of Green, Gauss and Stokes), and applications.

## PREREQUISITES

Minimum grade of C- in Math 1860 or Math 1840 or Math 1930. Students who enroll in Math 2850 but have not passed either prerequisite may be administratively dropped from the class.

**TEXTBOOK:** *Calculus – Volume III*, OpenStax (Print ISBN-13: 978-1-938168-07-9; Digital ISBN-13: 978-1-947172-16-6), Senior Contributing Authors: Edwin "Jed" Herman and Gilbert Strang. The ebook is available for free at https://openstax.org/details/books/calculus-volume-3.

## GRADING AND EVALUATION

| % Score | Grade |
|---|---|
| 90-100 | A range |
| 80-89.99 | B range |
| 70-79.99 | C range |
| 60-69.99 | D range |
| $< 60$ | F |

(Note that minus and plus grades will be awarded for grades within 2.5% of the lower and upper ends of the given ranges respectively, and that there are not A+ grades at The University of Toledo.)

| Component | points |
|---|---|
| Homework | 15% |
| Quizzes | 15% |
| Three (3) Exams | 45% |
| Final Exam | 25% |

## ONLINE HOMEWORK

Homework for this course is online and is located at http://www.webassign.net and is also linked from Blackboard. Late homework will have a 40% penalty. Students must purchase a WebAssign Access Code.

## QUIZZES

There will be weekly quizzes. The lowest two quiz scores will be dropped.

## TESTS AND FINAL EXAM

There will be 3 tests one after each 4 weeks. Tentatively they will be held on September 29, October 27, and December 1. The final is comprehensive and will be held on **Monday December 11 2023, 10:15-12:15pm** in the regular classroom. Please note that the final exam may not be taken early under any circumstances in accordance with department policy.

## IMPORTANT DATES

The instructor reserves the right to change the content of the course material if he perceives a need due to postponement of class caused by inclement weather, instructor illness, etc., or due to the pace of the course.

Last day to add/drop this class: Monday September 11 2023
Last day to withdraw from this class with a grade of W: Friday November 3 2023

**MISSED CLASS POLICY**
If circumstances occur in accordance with "The University of Toledo Missed Class Policy" (found at `http://www.utoledo.edu/facsenate/missed_class_policy.html` ) result in a student missing a quiz, test, exam or other graded item, the student must contact the instructor in advance by phone, e-mail or in person, provide official documentation to back up his or her absence, and arrange to make up the missed item as soon as possible.

**INSTITUTIONAL CLASSROOM ATTENDANCE POLICY**
Please be aware that the university has implemented an attendance policy, which requires faculty to verify student participation in every class a student is registered at the start of each new semester/course. For this course, if you have not attended/participated in class (completed any course activities or assignments) within the first 14 days, I am required by federal law to report you as not attended. Unfortunately, not attending/participating in class impacts your eligibility to receive financial aid, so it is VERY important that you attend class and complete course work in these first two weeks. Please contact me as soon as possible to discuss options and/or possible accommodations if you have any difficulty completing assignments within the first two weeks.

**ACADEMIC DISHONESTY**
Any act of academic dishonesty as defined by the University of Toledo policy on academic dishonesty (found at `http://www.utoledo.edu/dl/students/dishonesty.html`) will result in an F in the course or an F on the item in question, subject to the determination of the instructor. In particular, tests, quizzes and exams must be entirely the student's own work and any use of outside websites, apps, technology or persons to assist with completing these items will be considered academic dishonestly.

**POLICY STATEMENT ON NON-DISCRIMINATION ON THE BASIS OF DISABILITY (ADA)**
The University is an equal opportunity educational institution. Please read The University's Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance. Students can find this policy along with other university policies listed by audience on the University Policy webpage (`http://www.utoledo.edu/policies/audience.html/#students`).

**ACADEMIC ACCOMMODATIONS**
The University of Toledo embraces the inclusion of students with disabilities. We are committed to ensuring equal opportunity and seamless access for full participation in all courses. For students who have an Accommodations Memo from the Office of Accessibility and Disability Resources, I invite you to correspond with me as soon as possible so that we can communicate confidentially about implementing accommodations in this course.

For students who have not established accommodations with the Office of Accessibility and Disability Resources and are experiencing disability access barriers or are interested in a referral to health care resources for a potential disability, please connect with the office by calling 419.530.4981 or sending an email to `StudentDisability@utoledo.edu`.

**RELIGIOUS ACCOMODATIONS**
A student is permitted to be absent, *without penalty*, for up to three days each academic semester to take holidays for reasons of faith or religious or spiritual belief system or to participate in organized activities conducted under the auspices of a religious denomination church, or other religious or spiritual organization.

Alternative accommodations will be provided to students who miss exams and/or other academic requirements because of such absences under the following circumstances:

i. The student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement; and
ii. the student submits a form through `https://forms.office.com/r/gBBCQkQj3H` (which includes a link to the non-exhaustive list of religious holidays/holy days) within 14 days after the first day of instruction; and
iii. the Office of the Provost will send notification to each instructor indicating the specific dates for which the student will be absent; and
iv. the student and faculty member agree on how and when the missed coursework and/or exam will be completed, which may be prior to or after the missed class, but must be completed before the end of the term.

**GRIEVANCE PROCEDURE**
A student may notify the institution of any grievance regarding the policy's implementation using the 3364-71-05.1 Academic grievance procedure (`https://www.utoledo.edu/policies/academic/undergraduate/pdfs/3364-71-05-1_AcademicGrievanceProcedure.pdf`).

**ACADEMIC AND SUPPORT SERVICES**
Please follow this link to view a comprehensive list of Student Academic and Support Services (http://www.utoledo.edu/studentaffairs/departments.html) available to you as a student.

**SAFETY AND HEALTH SERVICES FOR UT STUDENTS**
Please use the following link to view a comprehensive list Campus Health and Safety Services (http://www.utoledo.edu/offices/provost/utc/docs/CampusHealthSafetyContacts.pdf) available to you as a student.

**STUDENT PRIVACY**
Federal law and university policy prohibits instructors from discussing a student's grades or class performance with anyone outside of university faculty/staff without the student's written and signed consent. This includes parents and spouses. For details, see the "Confidentiality of student records (FERPA)" section of the University Policy Page at http://www.utoledo.edu/policies/academic/undergraduate/index.html

**OTHER UNIVERSITY POLICIES**
Refer to the student handbook at http://www.utoledo.edu/studentaffairs/pdfs/handbook.pdf

**RESOURCES**
Free math tutoring on a walk-in basis is available in the Math Learning and Resources Center located in Rm B0200 in the lower level of Carlson Library (phone ext 2176). The Center operates on a walk-in basis. MLRC hours can be found at http://www.math.utoledo.edu/mlrc/MLRC.pdf

**Suggested Schedule**

| | | | |
|---|---|---|---|
| Chapter | 2 | **Vectors in Space** | (total 4 hr) |
| | 2.1 | **(Op.)** Vectors in the Plane; *Lines and Planes* | |
| | 2.2 | **(Op.)** Vectors in Three Dimensions; *Lines and Planes* | |
| | 2.3 | The Dot Product; *Lines and Planes* | 1 |
| | 2.4 | The Cross Product; *Lines and Planes* | 1 |
| | 2.5 | Equations of Lines and Planes in Space; *Lines and Planes* | 1.5 |
| | 2.6 | Quadric Surfaces; *Graphs* | 0.5 |
| | 2.7 | **(Op.)** Cylindrical and Spherical Coordinates | |
| Chapter | 3 | **Vector-Valued Functions** | (total 2.5 hr) |
| | 3.1 | Vector-Valued Functions and Space Curves; *Vector-valued Functions* | 1 |
| | 3.2 | Calculus of Vector-Valued Functions; *Vector-valued Functions* | 1 |
| | 3.3 | **(Op.)** Arc Length and Curvature; *Vector-valued Functions* | |
| | 3.4 | Motion in Space; *Vector-valued Functions* | 0.5 |
| Chapter | 4 | **Differentiation of Functions of Several Variables** | (total 9 hr) |
| | 4.1 | Functions of Several Variables; *Graphs* | 0.5 |
| | 4.2 | Limits and Continuity; *Limits* | 1.5 |
| | 4.3 | Partial Derivatives; *Partial Derivatives* | 1 |
| | 4.4 | Tangent Planes and Linear Approximations; *Tangent Planes* | 1 |
| | 4.5 | The Chain Rule; *Chain Rule* | 1.5 |
| | 4.6 | Directional Derivatives and the Gradient; *Partial Derivatives* | 1.5 |
| | 4.7 | Maxima/Minima Problems; *Extrema* | 2 |
| | 4.8 | **(Op.)** Lagrange multipliers | |
| Chapter | 5 | **Multiple Integration** | (total 9.5 hr) |
| | 5.1 | Double Integrals over Rectangular Regions; *Multiple Integrals* | 2 |
| | 5.2 | Double integrals over General Regions; *Multiple Integrals* | 2 |
| | 5.3 | Double integrals in Polar Coordinates; *Multiple Integrals* | 1.5 |
| | 5.4 | Triple Integrals; *Multiple Integrals* | 1.5 |
| | 5.5 | Triple Integrals in Cylindrical and Spherical Coordinates; *Multiple Integrals* | 2 |
| | 5.6 | Calculating Centers of Mass and Moments of Inertia; *Multiple Integrals* | 0.5 |
| | 5.7 | **(Op.)** Change of Variables in Multiple Integrals | |
| Chapter | 6 | **Vector Calculus** | (total 14 hr) |
| | 6.1 | Vector Fields; *Vector Fields* | 1.5 |
| | 6.2 | Line integrals; *Line/Surface Integrals* | 2 |
| | 6.3 | Conservative Vector Fields; *Vector Fields* | 1.5 |
| | 6.4 | Green's Theorem; *Important Theorems* | 1.5 |
| | 6.5 | Divergence and Curl; *Vector Fields* | 2 |
| | 6.6 | Surface Integrals; *Line/Surface Integrals* | 2 |
| | 6.7 | Stokes' theorem; *Important Theorems* | 2 |
| | 6.8 | The Divergence Theorem; *Important Theorems* | 1.5 |
| | | Total Hours | 39 |

**STUDENT LEARNING OUTCOMES:**
Upon successful completion of this class a student should be able to:

- **Lines and Planes:** Perform and apply vector operations, including the dot and cross product of vectors, in the plane and space.
- **Vector-valued Functions:** Differentiate and integrate vector-valued functions. For a position vector function of time, interpret these as velocity and acceleration.
- **Limits:** Evaluate limits and determine the continuity and differentiability of functions of several variables.
- **Graphs:** Describe graphs, level curves and level surfaces of functions of several variables.
- **Partial Derivatives:** Find partial derivatives, directional derivatives, and gradients and use them to solve applied problems.
- **Tangent Planes:** Find equations of tangent planes and normal lines to surfaces that are given implicitly or parametrically.
- **Chain Rule:** Use the chain rule for functions of several variables (including implicit differentiation).
- **Extrema:** For functions of several variables, find critical points using first partials and interpret them as relative extrema/saddle points using the second partials test. Find absolute extrema on a closed region. Apply these techniques to optimization problems.
- **Multiple Integrals:** Evaluate multiple integrals in appropriate coordinate systems such as rectangular, polar, cylindrical and spherical coordinates and apply them to solve problems involving volume, surface area, density, moments and centroids.
- **Line/Surface Integrals:** Evaluate line and surface integrals. Identify when a line integral is independent of path and use the Fundamental Theorem of Line Integrals to solve applied problems.
- **Vector Fields:** Find the curl and divergence of a vector field, the work done on an object moving in a vector field, and the flux of a field through a surface. Use these ideas to solve applied problems. Identify conservative fields.
- **Important Theorems:** Introduce and use Green's Theorem, the Divergence (Gauss's) Theorem and Stokes's Theorem.