

MATH-221: MULTIVARIABLE CALCULUS

Effective Term

Fall 2026

CC Approval

10/03/2025

AS Approval

10/09/2025

BOT Approval

10/16/2025

SECTION A - Course Data Elements

Send Workflow to Initiator

No

CB04 Credit Status

Credit - Degree Applicable

Discipline

Minimum Qualifications	And/Or
Mathematics (Master's Degree)	

Subject Code

MATH - Mathematics

Course Number

221

Department

Mathematics

Division

Mathematics (MATH)

Full Course Title

Multivariable Calculus

Short Title

Multivariable Calculus

CB03 TOP Code

1701.00 - Mathematics, General

CB08 Basic Skills Status

NBS - Not Basic Skills

CB09 SAM Code

E - Non-Occupational

Rationale

Updating course as part of regular curriculum review cycle.

SECTION B - Course Description

Catalog Course Description

The third semester of a three course sequence in differential and integral calculus. Topics include vector valued functions, calculus of functions of more than one variable, partial derivatives, multiple integration, Green's Theorem, Stokes' Theorem, and divergence theorem. Primarily for majors of mathematics, engineering, and science.

SECTION C - Conditions on Enrollment

Open Entry/Open Exit

No

Repeatability

Not Repeatable

Grading Options

Letter Grade Only

Allow Audit

Yes

Requisites

Prerequisite(s)

Completion of MATH-C2220 with a minimum grade of C.

Requisite Justification

Requisite Description

Course in a Sequence

Subject

MATH

Course

C2220

Level of Scrutiny

Content Review

Upon entering this course, students should be able to:

1. Perform integration methods such as substitutions and integration by parts.
2. Calculate and areas and graph in polar coordinates.

SECTION D - Course Standards

Is this course variable unit?

No

Units

5.00

Lecture Hours

90.00

Outside of Class Hours

180

Total Contact Hours

90

Total Student Hours

270

Distance Education Approval

Is this course offered through Distance Education?

Yes

Online Delivery Methods

DE Modalities	Permanent or Emergency Only?
Entirely Online	Emergency Only
Hybrid	Permanent
Online with Proctored Exams	Permanent

SECTION E - Course Content**Student Learning Outcomes**

Upon satisfactory completion of the course, students will be able to:	
1.	Differentiate and integrate vector-valued functions.
2.	Calculate partial derivatives and multiple integrals.
3.	Solve applications using the theorems of Green, Gauss, and Stokes.
4.	Write mathematical proofs in multivariable calculus.

Course Objectives

Upon satisfactory completion of the course, students will be able to:	
1.	Perform vector operations.
2.	Determine equations of lines and planes.
3.	Find the limit of a function at a point.
4.	Evaluate derivatives.
5.	Write the equation of a tangent plane at a point.
6.	Determine differentiability.
7.	Find local extrema and test for saddle points.
8.	Solve constraint problems using Lagrange multipliers.
9.	Compute arc length.
10.	Find the divergence and curl of a vector field.
11.	Evaluate two and three dimensional integrals.
12.	Apply Green's, Stokes', and divergence theorems.

Course Content

1. Vectors and vector operations in two and three dimensions.
2. Vector and parametric equations of lines and planes; rectangular equation of a plane.
3. Dot, cross, and triple products and projections.
4. Differentiability and differentiation including partial derivatives, chain rule, higher-order derivatives, directional derivatives, and the gradient.
5. Arc length and curvature; tangent, normal, binormal vectors.
6. Vector-valued functions and their derivatives and integrals; finding velocity and acceleration.
7. Real-valued functions of several variables, level curves and surfaces.
8. Limits, continuity, and properties of limits and continuity.
9. Local and global maxima and minima extrema, saddle points, and Lagrange multipliers.
10. Vector fields including the gradient vector field and conservative fields.
11. Double and triple integrals.
12. Applications of multiple integration such as area, volume, center of mass, or moments of inertia.
13. Change of variables theorem.
14. Integrals in polar, cylindrical, and spherical coordinates.
15. Line and surface integrals including parametrically defined surfaces.
16. Integrals of real-valued functions over surfaces.
17. Divergence and curl.
18. Green's, Stokes', and divergence theorems.

Methods of Instruction

Methods of Instruction

Types	Examples of learning activities
Lecture	A class lecture that introduces the concept of partial derivatives, illustrating how functions change with respect to one variable while holding others constant.
Discussion	In a guided classroom discussion, students compare the geometric interpretations of partial derivatives and gradients, debating how each describes change in multivariable functions and when each is most useful in real-world contexts.
Activity	Students work in small groups using 3D models and gradient vector fields to explore how functions of two variables behave over surfaces.

Online Adaptation

Types	Examples of learning activities
Lecture	A lecture on Zoom that introduces the concept of partial derivatives, illustrating how functions change with respect to one variable while holding others constant.
Discussion	In a discussion post online, students compare the geometric interpretations of partial derivatives and gradients, debating how each describes change in multivariable functions and when each is most useful in real-world contexts.
Activity	Students work in small groups in breakout rooms using 3D models and gradient vector fields to explore how functions of two variables behave over surfaces.

Instructor-Initiated Online Contact Types

Announcements/Bulletin Boards
 Chat Rooms
 Discussion Boards
 E-mail Communication
 Telephone Conversations
 Video or Teleconferencing

Student-Initiated Online Contact Types

Chat Rooms
 Discussions
 Group Work

Course design is accessible

Yes

Methods of Evaluation

Methods of Evaluation

Types	Examples of classroom assessments
Quizzes	A quiz including multiple integrals where the student would be expected to calculate double integrals over a variety of different regions (rectangular, general, and polar) and calculate triple integrals for a variety of different coordinate systems (rectangular, cylindrical, and spherical).
Homework	A typical homework assignment might include a selection of problems from the corresponding section of the book, or a worksheet or project to be completed outside of class.
Exams/Tests	An exam including partial derivatives where the student would be expected to calculate the partial derivatives of a variety of different functions, find the directional derivative of a function for a given vector direction, calculate the gradient of a function and interpret its meaning, find the local max/min of a function, and use LaGrange Multipliers to find the maximum or minimum of a function given a constraint.
Oral Presentations	Students may be asked to present problems, solutions, graphs, or proofs to the class.

Other

The Mathematics Department maintains a commitment to diverse teaching methods in courses emphasizing vital quantitative skills and qualitative reasoning ability. To that end, it is expected that sufficient formative assessments will be given to students that in frequency, length and rigor adequately assess both quantitative skills and qualitative reasoning.

Sample assessment questions:

Let F be a vector field in \mathbb{R}^3 with continuous components. Show $\operatorname{div}(\operatorname{curl}(F))=0$.

Let $r(t)$ be a parametric space curve. Suppose $\|r'(t)\|=C$ a constant. Show $r'(t) \perp r(t)$.

Assignments

Reading Assignments

Read textbook, for example:

1. Read section on directional derivative
2. Read section on multiple integrals

Writing Assignments

Daily homework assignments from the text, for example:

1. Maximize $f(x,y) = x^2 + 2xy + y^2$
2. Find the volume above the x - y plane enclosed by the paraboloid $z = 1 - x^2 - y^2$.

Outside-of-Class Assignments

Other assignments such as research into applications or group projects assigned at instructors' discretion.

SECTION F - Textbooks and Instructional Materials

Material Type

Textbook

Author

Stewart, Clegg, Watson

Title

Calculus: Early Transcendentals

Edition/Version

9th

Publisher

Cengage

Year

2021

ISBN

9780357687901

SECTION G - Diversity, Equity and Inclusivity

How does your course and/or course outline of record reflect strategies for accommodating and engaging diverse student populations, advancing equitable outcomes, and fostering inclusion for all students?

This course advances equitable outcomes and inclusion by using open educational resources (OER), eliminating cost barriers to high-quality materials for all students. Instruction emphasizes multiple approaches to key concepts—such as graphical, numerical, analytical, and applied perspectives on vector-valued functions, partial derivatives, and multiple integration—so that students with different learning styles and levels of preparation can engage meaningfully. Real-world applications in science and engineering

highlight the relevance of calculus to diverse academic and career pathways, fostering engagement among a broad student population.

Course Codes (Admin Only)

CB00 State ID

CCC000522978

CB10 Cooperative Work Experience Status

N - Is Not Part of a Cooperative Work Experience Education Program

CB11 Course Classification Status

Y - Credit Course

CB13 Special Class Status

N - The Course is Not an Approved Special Class

CB23 Funding Agency Category

Y - Not Applicable (Funding Not Used)

CB24 Program Course Status

Program Applicable

Allow Pass/No Pass

No

Only Pass/No Pass

No