



## MA 345 Calculus III: Multivariable (4)

**Semester / Term / Year:** Fall 2024

**Class Meeting Times / Location / Delivery Modality:** MR, 2:00 to 3:40 PM / Miega 102 / In-Person

**Seat Time:** Our seat time for this 4-credit hour lecture course is four (4) hours per week. Even more, students are strongly encouraged to spend at least eight (8) hours per week reviewing their course materials, practicing problems, working on assignments, and preparing for quizzes and examinations.

**Instructor Information:** Dr. Dylan C. Beck, Assistant Professor of Mathematics

### Contact Information:

- **Discord:** <https://discord.gg/9DBS2WXcfr>
- **email:** [Dylan.Beck@StMary.edu](mailto:Dylan.Beck@StMary.edu)
- **Engage:** <https://engage.stmary.edu/learn/course/view.php?id=8868>
- **pronouns:** he / him / his
- **web page:** <https://dylan-c-beck.github.io>

**Office / Office Hours / Virtual Office:** Miega 102A / MR, 9:00 to 11:30 AM / [Microsoft Teams](#)

### University Academic and Classroom Policies:

Refer to Engage and the USM Catalog for the University Mission, Values, and Learning Objectives, ADA Academic Accommodations, and other University Academic and Classroom Policies. Particularly, students should become familiar with the following University policies. Course-specific policies are provided below.

- [Academic Catalog](#)
  - University Mission and Values Statements and Learning Outcomes
  - Academic Honesty Policy
  - University Attendance Policy
  - Disability Services (or Academic Accommodations) Policy and Requesting Accommodations
- [Academic Calendar](#)
- [Final Exam Schedule](#)
- [Student Handbook](#)
  - Disability and Accommodations Services
  - Student Code of Conduct
  - Alcohol, Drugs, and Tobacco Policies
  - Campus Offices Information

## Course Description

We will study functions of two and more variables, graphs of functions in space, derivatives and partial derivatives, vectors, optimization, integration of functions of several variables, numerical methods, cylindrical and spherical coordinates, parametric curves and surfaces, line integrals, and Green's Theorem.

## University Learning Outcomes

ULO 1.a Quantitative Literacy: The University of Saint Mary graduate will effectively access, evaluate, and apply information appropriately for a specific purpose.

## Program Learning Outcomes

1. Develop problem solving and reasoning skills and analyze conceptual relationships. ULO 1.a
2. Apply disparate knowledge to solve complex problems in various disciplines and interpret the results in practical terms. ULO 1.a
3. Use mathematical abstraction and symbolism to create generalizations from observed patterns and develop specific examples from general statements. ULO 1.a
4. Read mathematical literature with increasing confidence, collaborate with others to solve problems, and effectively communicate mathematical concepts and processes. ULO 1.a
5. Appropriately use technological tools, such as graphing calculators and computers, as aids in solving problems, and correctly interpret the results that technology produces. ULO 1.a
6. Develop quantitative literacy by collecting, organizing and interpreting data, and create models for drawing trustworthy conclusions based on that data. ULO 1.a

## Course Learning Outcomes

1. Use vectors and the geometry of space: vectors in the plane and in space, dot and cross product, lines and planes and surfaces in space. MPLO 1, 2, 6
2. Use vector-valued functions, including curvature, tangent and normal vectors, and parametric surfaces. MPLO 1, 2, 6
3. Understand and use partial differentiation. MPLO 2, 3
4. Evaluate and use multiple integrals. MPLO 2, 3
5. Understand and use vector calculus: vector fields, line integrals, Green's Theorem, curl, and divergence. MPLO 1, 2, 6

## Course Materials

*Calculus: Early Transcendentals* (3<sup>rd</sup> Edition) by Briggs, Cochran, Gillett, and Schulz

## Course Policies

Class meetings will typically consist of an instructor-led lecture during which students will take notes, ask questions, and participate in discussion. Each student should be prepared to interact with the instructor, their classmates, and the course materials during each class meeting; the instructor may call on students to facilitate learning. Often, a short quiz with no more than ten questions pertaining to materials already introduced will be administered in class. Explicitly, on a quiz, students must be able to provide definitions of key terms, answer true-false and multiple-choice questions, and compute examples. Exam reviews will be hosted during class prior to assessments. Consult the course schedule below for specific dates.

Each student must **place their phone screen-side down on their desk** at the beginning of each class period, and the device must be left in that position for the duration of the course meeting (barring extenuating circumstances that merit phone usage and must be communicated to the instructor). Each failure to comply with this policy will result in **a deduction of one percentage point from the student's overall grade**.

Regular and punctual attendance is vital to understanding the information presented in this course; however, in the event of an unavoidable absence, it is the responsibility of the student to inform the instructor by filling out the [Excused Absence Request Form](#) and to make arrangements with the instructor to make up any materials or assignments missed during class. Particularly, student-athletes should take care to maintain proactive and timely communication with the instructor to remain in good academic standing.

Even more, in view of the instructor's obligation to provide timely feedback on assignments, unless granted explicit permission from the instructor, **students may not submit work more than 72 hours (or one class period) past the due date**; toward this end, the instructor reserves the right to deny any student of comments or credit on any assignment submitted 72 hours (or one class period) past the due date or any assignment submitted after the rubric is posted. Crucially, unless granted explicit permission from the instructor, it is the responsibility of any student that misses class (due to athletics, illness, or other extenuating circumstances) to submit their own homework on time; it is strictly prohibited for students to submit work that is not their own. **Exam make-ups must be completed within one week (or five business days) of the original exam date**.

Conversely, the instructor reserves the right to deny any student comments or feedback on any assignment submitted in advance of the due date. Explicitly, the instructor may refuse to review, revise, or otherwise provide feedback on an assignment that has not been submitted to be graded by the instructor.

Communication between students and the instructor will occur primarily in the classroom and during the instructor's (virtual) office hours; however, each student should check their university email and [Engage](#) regularly for class announcements and supplementary materials. Even more, students are encouraged to join the [MA 345 Discord](#) for homework assistance and to discuss course materials, policies, and due dates with their classmates and the instructor. Crucially, engagement on Discord is optional: concretely,

- participation on Discord is not required as part of the MA 345 coursework;
- interactions on Discord will not influence a student's grade in the course; and
- Discord should not be viewed as an official medium of communication between the instructor and the students at the University of Saint Mary. Explicitly, Saint Mary email remains the official mode of communication between the students at the University of Saint Mary and their instructor.

Even more, students are forbidden from directly messaging the instructor via Discord, and any comments made by students on the MA 345 Discord may be viewed by their classmates. Bearing this in mind, confidential information must not be shared on Discord. Critically, the instructor is obligated to report any illegal, unethical, or improper activities on the Discord server to the appropriate authorities.

Generally, the instructor will adhere to the University of Saint Mary's [Hours of Operation](#) as it pertains to attending office hours, conducting make-up exams, and responding to emails or other correspondence from students; therefore, students should be conscientious and cognizant of this time frame when seeking assistance with assignments or scheduling appointments with the instructor. Even more, the instructor reserves the right to at least 48 hours (or two business days) to respond to any correspondence sent during the business week (Monday through Friday, excluding holidays) and more time on weekends.

Collaboration with classmates on homework is encouraged; however, each student is expected to submit their own work on all assignments, and each student will be graded on their work as it appears. Consequently, for students working together, it is critical that no party completes any work on behalf of another party and that each party determines their own solutions. Explicitly, students should write original solutions rather than copy from one another; however, students may discuss relevant techniques or strategies for their work. Ultimately, **students must clearly indicate their collaborators for each assignment.**

Outside of class, students should expect to spend at least two hours preparing materials and studying for every hour spent in class. Unlike in high school, students that do not understand coursework should not assume the instructor will repeat material until it is mastered; rather, each student is expected and encouraged to ask questions as they arise. Each student should certainly devote time to studying course materials outside of class, but in the event of confusion or difficulty, students should consider visiting the instructor during his office hours. **Do not hesitate to ask questions, as this course is cumulative.**

Crucially, it should be noted that the instructor reserves the right to refuse any accommodations requested by the student after the last day of classes of the semester, especially if these arrangements are negotiated to improve the student's course average or to achieve a desired letter grade in the class. Consequently, **it is imperative that students communicate early and often any difficulty or concern to the instructor.**

## Course Prerequisites

Enrolled students must have a grade of C or higher in MA 244 (Calculus II) or obtain instructor consent.

## Course Assignment Points and Percentages

type	quantity	weight	total
exam	5	10%	50%
final exam	1	26%	26%
homework	45	0.2%	9%
quiz	15	1%	15%

Once during the semester, students can earn up to one percent toward their overall grade by completing the [MA 345 Syllabus Quiz](#). Each student that completes all homework assignments with an average homework score of 67% may drop their lowest five homework scores. Each student that completes all quizzes with an average quiz score of 67% and passes the Gateway Exam may drop their lowest three quiz scores.

## Course Grade

<b>A</b>	90%	100%
<b>B</b>	80%	89.99%
<b>C</b>	70%	79.99%
<b>D</b>	60%	69.99%
<b>F</b>	0%	59.99%

Our final examination will be administered on **Monday, December 9** from **1:00 to 2:50 PM** in **Miege 102**. Each of the five units will account for about 20% of the exam. Completion of each of the five unit exams is required in addition to the final exam. Explicitly, any student that fails to complete any unit exam or the final exam fails the course. Even more, **any student that fails the final exam automatically fails the course**.

## Coursework, Examinations, and Quizzes

Each week, at the instructor's discretion, relevant written homework will be issued to be completed outside of class. Consult the course schedule below for specific due dates regarding assignments. Late work may not be accepted unless proper documentation is provided. Even more, **late work that is accepted may be subject to a deduction of one letter grade for each class period beyond the due date**; however, if the student anticipates and communicates an issue to the instructor at least one calendar week prior to the assignment due date, the student may be allowed to submit their work after the due date with no deduction in points.

Every Monday and Thursday of the semester, if an exam is not administered, a brief quiz will be administered in the last ten minutes of the class meeting. Unless otherwise specified, quiz questions will include definitions of key terms and formulas, true-false statements, multiple-choice questions, and computational short response related to the material covered in class during an earlier course meeting.

Exams will be administered five times during the semester. Like with quizzes, students will use definitions and formulas to evaluate true-false and multiple-choice questions and compute examples. Credit for true-false and multiple-choice questions is awarded on an all-or-nothing basis. Credit for computations is earned primarily by citing relevant definitions and theorems, demonstrating a command of appropriate techniques, and showing work: when the relevant work is provided and a problem is answered correctly, full credit will be awarded. Partial credit may be awarded if some pertinent details are supplied; in this case, the instructor will typically mark the student's work with the phrase "work follows." Rubrics will typically be provided for the students' convenience. Each student must comply with the following exam regulations and guidelines.

- Each student is allowed a writing utensil and a non-graphing, non-programmable scientific calculator without computer algebra capabilities during exams. **Graphing calculators are prohibited.**
- Other papers and electronic devices must be stored in the student's backpack and placed under or next to their desk. **Cell phones, smart watches, notes, and textbooks are prohibited during exams.**

Once all students have cleared their workspaces, the assessment will begin. Each student will then have the full duration of the scheduled course meeting to complete the examination. Once the student has finished the assessment (or time has expired), the check-out procedure must be initiated by the student submitting their work to the instructor; the student may then be dismissed with the instructor's permission.

Below is a brief list of authorized handheld calculators for use on quizzes and exams.

TI-30XIIS	TI-34
TI-30XA	Casio fx-300ESPLUS

Calculators other than those listed above may be used with the instructor's explicit permission.

## Update Clause

Ultimately, the instructor reserves the right at any point in the semester to alter this syllabus to reflect changes in policy or schedule due to extenuating or unforeseen circumstances. Consequently, it is the responsibility of the students to remain up to date with this syllabus; however, the instructor will inform students of any such changes to this document, and the syllabus will be maintained and updated.

## Course Schedule

### Week 1: Vectors in Two and Three Dimensions and the Dot Product

Monday, August 26 — Quiz 1: Calculus Review

Thursday, August 29 — Quiz 2: Vectors in Euclidean Space

Friday, August 30 — Last Day to Add a Course

date	section	topic(s)
Monday, August 26	13.1: Vectors in the Plane 13.2: Vectors in Three Dimensions	<ul style="list-style-type: none"><li>Distance Formula</li><li>Parallelogram Rule</li><li>parallel vectors</li><li>vector magnitude</li><li>vector operations</li></ul>
Thursday, August 29	13.3: Dot Products 13.4: Cross Products	<ul style="list-style-type: none"><li>Cross Product</li><li>Dot Product</li><li>geometric interpretations</li><li>orthogonality</li><li>projection</li></ul>

### Week 2: Cross Product, Lines, and Planes in Euclidean Space

Monday, September 2 — Labor Day Holiday

Thursday, September 5 — Quiz 3: Dot Products and Cross Products

Friday, September 6 — Last Day to Drop a Course with 100% Refund

date	section	topic(s)
Thursday, September 5	13.5: Lines and Planes in Space 13.6: Cylinders, Quadric Surfaces	<ul style="list-style-type: none"><li>common quadric surfaces</li><li>equations of lines and planes</li><li>normal vector</li><li>orthogonal planes</li><li>parallel planes</li><li>parametrization</li></ul>

### Week 3: Cylinders, Quadric Surfaces, and Exam 1

Monday, September 9 — First Day of Withdraw Period

Monday, September 9 — Quiz 4: Lines, Planes, Cylinders, and Quadric Surfaces

Wednesday, September 11 — Fall 2024 Convocation

date	section	topic(s)
Monday, September 9	Chapter 13 Review	
Thursday, September 12	Exam 1	

## Week 4: Calculus of Vector-Valued Functions

Thursday, September 19 — Quiz 5: Calculus of Vector-Valued Functions

date	section	topic(s)
Monday, September 16	14.1: Vector-Valued Functions 14.2: Calculus, Vector-Valued F'ns	<ul style="list-style-type: none"> <li>derivatives of vector-valued f'ns</li> <li>integration of vector-valued f'ns</li> <li>limits of vector-valued functions</li> <li>orientation (of a curve)</li> <li>tangent vector</li> </ul>
Thursday, September 19	14.3: Motion in Space 14.4: Length of Curves	<ul style="list-style-type: none"> <li>acceleration</li> <li>arc length</li> <li>arc length parametrization</li> <li>circular motion</li> <li>position</li> <li>straight-line motion</li> <li>velocity</li> </ul>

## Week 5: Curvature, Normal Vectors, and Exam 2

Monday, September 23 — Last Day to Drop a Course with 50% Refund

Monday, September 23 — Quiz 6: Curves and Motion in Euclidean Space

date	section	topic(s)
Monday, September 23	14.5: Curvature, Normal Vectors Chapter 14 Review	<ul style="list-style-type: none"> <li>Curvature Formula</li> <li>Principal Unit Normal Vector</li> <li>torsion</li> <li>Unit Binormal Vector</li> </ul>
Thursday, September 26	Exam 2	

## Week 6: Limits, Continuity, and Derivatives in Several Variables

Thursday, October 3 — Quiz 7: Limits and Continuity

date	section	topic(s)
Monday, September 30	15.1: Graphs and Level Curves 15.2: Limits and Continuity	<ul style="list-style-type: none"> <li>boundary and interior</li> <li>continuity</li> <li>level curve</li> <li>Limit Laws</li> <li>multivariate function</li> </ul>
Thursday, October 3	15.3: Partial Derivatives 15.4: the Chain Rule	<ul style="list-style-type: none"> <li>Chain Rule</li> <li>Clairaut's Theorem</li> <li>differentiability</li> <li>implicit differentiation</li> <li>partial differentiation</li> </ul>



## Week 7: Gateway Exam, Directional Derivatives, Gradient, and Approximation

Monday, October 7 — Graduation Application Deadline for Spring or Summer 2025 Graduates

Thursday, October 10 — Quiz 8: Partial Derivatives

date	section	topic(s)
Monday, October 7	Gateway Exam	
Thursday, October 10	15.5: Direct'l Derivatives, Gradient 15.6: Tangent Planes, Lin' Approx'	<ul style="list-style-type: none"><li>• differential</li><li>• Directional Derivative Formula</li><li>• Directions of Change Theorem</li><li>• equation of the tangent plane</li><li>• gradient</li><li>• Gradient and Level Curve Th'm</li><li>• Linear Approximation Formula</li></ul>

## Week 8: Lagrange Multipliers and Optimization

Monday, October 14 — Quiz 9: Directional Derivatives and Tangent Planes

Thursday, October 17 to Sunday, October 20 — Fall Break

date	section	topic(s)
Monday, October 14	15.7: Maxima and Minima 15.8: Lagrange Multipliers	<ul style="list-style-type: none"><li>• absolute extrema</li><li>• critical point</li><li>• Lagrange Multipliers</li><li>• local extrema</li><li>• saddle point</li><li>• Second Derivative Test</li></ul>

## Week 9: Exam 3 and Double Integration

Monday, October 21 — Spring Priority Registration Opens for Current Juniors and Seniors

date	section	topic(s)
Monday, October 21	Exam 3	
Thursday, October 24	16.1: Double Integrals, Rectangles 16.2: Double Integrals, General	<ul style="list-style-type: none"><li>• Average Value Formula</li><li>• double integration</li><li>• Fubini's Theorem</li><li>• regions bounded by surfaces</li><li>• Riemann sum</li><li>• simplicity (of a region)</li></ul>

## Week 10: Triple Integration in Polar, Cylindrical, and Spherical Coordinates

Monday, October 28 — Last Day to Withdraw and Receive a Grade of W

Monday, October 28 — Spring Priority Registration Opens for Current Freshmen and Sophomores

Monday, October 28 — Quiz 10: Double Integration

Thursday, October 31 — Quiz 11: Triple Integration

date	section	topic(s)
Monday, October 28	16.3: Double Integrals, Polar 16.4: Triple Integrals	<ul style="list-style-type: none"> <li>Change of Variables Formula</li> <li>order of integration</li> <li>polar coordinates</li> <li>triple integration</li> </ul>
Thursday, October 31	16.5: Triple Int', Cyl' and Spherical 16.6: Integrals for Mass Calc'	<ul style="list-style-type: none"> <li>Center of Mass Formulas</li> <li>Change of Variables Formula</li> <li>cylindrical coordinates</li> <li>spherical coordinates</li> <li>Transformation Formulas</li> </ul>

## Week 11: Change of Variables and Exam 4

Monday, November 4 — Spring Registration Opens for New Registering Students

Monday, November 4 — Quiz 12: Cylindrical and Spherical Coordinates

date	section	topic(s)
Monday, November 4	16.7: Change of Variables Chapter 16 Review	<ul style="list-style-type: none"> <li>Change of Variables Formula</li> <li>Jacobian</li> <li>transformation in Euclidean space</li> </ul>
Thursday, November 7	Exam 4	

## Week 12: Vector Fields, Line Integrals, and Green's Theorem

Thursday, November 14 — Quiz 13: Vector Fields and Line Integrals

date	section	topic(s)
Monday, November 11	17.1: Vector Fields 17.2: Line Integrals	<ul style="list-style-type: none"> <li>flux</li> <li>potential function</li> <li>scalar line integral</li> <li>vector field</li> <li>vector line integral</li> <li>work</li> </ul>
Thursday, November 14	17.3: Conservative Vector Fields 17.4: Green's Theorem	<ul style="list-style-type: none"> <li>curl</li> <li>divergence</li> <li>Fundamental Theorem of Conservative Vector Fields</li> <li>Fund'l Th'm of Line Integrals</li> <li>Green's Theorem</li> <li>Potential Function Algorithm</li> </ul>

## Week 13: Divergence, Curl, Surface Integrals, and Fundamental Theorems

Monday, November 18 — Quiz 14: Green's Theorem

Thursday, November 21 — Quiz 15: Surface Integrals

date	section	topic(s)
Monday, November 18	17.5: Divergence and Curl 17.6: Surface Integrals	<ul style="list-style-type: none"><li>• Curl of Conservative Vector Field</li><li>• Divergence of the Curl</li><li>• parametrization</li><li>• Product Rule for Divergence</li><li>• surface integral</li><li>• tangent vector</li></ul>
Thursday, November 21	17.7: Stokes's Theorem 17.8: Divergence Theorem	<ul style="list-style-type: none"><li>• circulation</li><li>• Divergence Theorem</li><li>• Fundamental Theorem of Calculus</li><li>• Stokes's Theorem</li><li>• Zero Curl Implies Conservativity</li></ul>

## Week 14: Exam 5 and Thanksgiving Break

Wednesday, November 27 to Sunday, December 1 — Thanksgiving Break

date	section	topic(s)
Monday, November 25	Exam 5	

## Week 15: Final Exam Review

Monday, December 2 — Last Day to Withdraw and Receive a Grade of WP or WF

date	section	topic(s)
Monday, December 2	Final Exam Review	
Thursday, December 5	Final Exam Review	

## Week 16: Finals Week

Monday, December 9 — MA 345 Final Examination (1:00 to 2:50 PM), Miega 102

Thursday, December 12 — Last Day of Fall 2024 Semester

Friday, December 13 — Final Grades Due to Registrar by 5:00 PM

Saturday, December 14 — Fall 2024 Commencement

date	section	topic(s)
Monday, December 9	Final Examination	