MATH 005C–Multivariable Calculus Spring 2026
34993 Online with In-Person Final Exam 5 units

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Office: V-216F **Office Hours:** M-Th 9-9:30 in V-216F; MW 1-2:45 Zoom ID 310 291 0470

Communication: Preferred methods of communication are email or Canvas Inbox. Phone works as well, though if I'm not in my office, you'll have to leave a message. Non-personal class-related questions can be posted to the Q&A Discussion in Canvas. I typically respond to emails/Canvas Inbox messages within 2 days during the work week.

Text: "Calculus," 9th ed. by Stewart, Clegg, and Watson with WebAssign ISBN 978-1-337-62418-3. Available at the PCC bookstore or through Cengage.

Course description: Parametric equations, polar coordinates, vectors and vector calculus, partial differentiation, multiple integration, Green's theorem, divergence theorem of Gauss, Stokes' theorem.

Prerequisite: Math 005B or Math 005BH.

Student Learning Outcomes: Upon successful completion of this course you will be able to:
1. Apply vector operations to find equations of lines and planes and analyze the motion of a particle in space.
2. Explain limits, partial derivatives, directional derivatives, gradient vectors, and differentials and linear approximations of functions of two or more variables.
3. Compute local and absolute extrema of functions of two variables.
4. Compute integrals over a region, curve, solid and surface, of both scalar and vector fields, and use them to solve application problems.
5. Apply the Fundamental Theorem for Line Integrals, Green's Theorem, Stokes' Theorem and the Divergence Theorem.

Course Content: Lectures, assignments, and assessments will be based on most of chapters 12-16.

Required Materials:
- Pencils
- Eraser(s)
- Lined paper
- Graph paper
- 1 ½" (or larger) binder with dividers
- OR in lieu of the above, a tablet device
- Scientific calculator

Homework (15% of your grade): The best way to learn math is to do it. Homework is your opportunity to practice working problems and learn the math you'll see in class. Homework for this course is assigned through WebAssign, so a WebAssign access code is required. This can be purchased from the PCC bookstore or directly through Cengage. Math tends to build on itself – so one of the best ways to be successful in this course is to do homework regularly and complete assignments on time. Though homework represents a relatively small portion of your overall grade, it is when most of your learning will happen; the time you spend on assignments each week is an investment toward ensuring success on exams. Your four lowest homework scores will be dropped (this is about 10 percent of the homework assignments for the course).

Exams (60% of your grade): Exams are your opportunity to show what you've learned in this course, so they account for the largest portion of your grade. In this class, we'll have four chapter exams that will be delivered via email. You'll receive an email with a link to an online exam. You'll submit your work for each problem by uploading a picture of your paper or a screen shot of your tablet device. Each chapter exam is scheduled on a Friday; the dates are 3/13, 4/3, 5/1, and 5/29. Please make a note of these dates. I have chosen not to use proctoring software (such as Proctorio). You are expected to complete exams without any reference material (such as notes or the textbook) and to complete exams without any assistance from anyone. You're on the honor system for chapter exams. Because exams are intended to reflect what you've learned, and because this course is intended to prepare you for future STEM classes, all exam scores will be included in your final grade.

Final Exam (25% of your grade): Thursday, June 11, 10:15am–12:15pm R-421 (PCC campus)
The final includes material from throughout the course, so when you prepare for the exam, you'll be able to reinforce the concepts you've learned throughout the term. To pass the class, you are required to earn a score of 60% or better on the final exam. In order to maintain standards I have for education and that we have here at PCC, I can't allow any exceptions to the minimum score or that the final must be taken in person. In addition, I'll need to check your photo ID during the final exam session. Examples of acceptable forms of ID are your PCC ID, a driver license, and a passport.

Academic Dishonesty: Academic integrity is important to ensure that the grades I submit are meaningful. Unfortunately, I need to address cheating. Any student caught cheating on an exam will receive a grade deduction for the exam and can possibly receive a score of zero for that exam. I am required to report the violation to the Office of Student Life for potential further action. According to PCC policy, any form of academic dishonesty can be grounds for receiving a grade of F and possibly dismissal from the college. Please make sure you have an official photo ID, as it will be checked during this class to verify that students in the class are those who are officially enrolled.

Calculators: Use of scientific calculators will be allowed on exams. Use of any other electronic device will be considered cheating.

Assigned grades are based on performance on exams and homework, not on extra credit or external factors such as GPA and transfer. Course grades will be no lower than those shown below.
A: 90-100% B: 80-89% C: 73-79% D: 60-72% F: below 60%

Canvas: Class notes and grades will be recorded on Canvas. Please let me know of any discrepancies or mistakes in posted scores within one week of being posted so I can correct them in a timely manner.

Attendance/Classroom Policies:
- Attend regularly
- Arrive on time
- Don't leave early
- Silence cell phone
- No food or drinks except bottled water
- No visitors (including children)

Additional Information: Tutoring is available at the Math Success Center (R-406), as well as the Zone for athletes (GM-112A). The office of Disabled Student Programs and Services (D-209) provides support for students with documented disabilities; please let me know of any accommodations for which you qualify.

Important Dates:
3/1 Last Day to Add or Drop Without a "W"
3/31 Cesar Chavez Day (no classes)
4/13-18 Spring Break (no classes)
5/15 Last Day to Drop With a "W"
5/25 Memorial Day (no classes)

Course Outline

Student Performance Objectives

1.1. Perform vector operations.
1.2. Find the unit tangent and normal vectors to two- and three-dimensional curves.
1.3. Find equations of lines and planes using vector and scalar products.
1.4. Find the arc length and curvature of two- and three-dimensional space curves.

2.1. State and use the definitions of limit of a function, partial derivatives, and continuity for functions of two or more variables.
2.2. Graph quadric surfaces from their equations.
2.3. Find the linear approximation at a point (which is the equation of a tangent plane at a point); determine the differentiability of a function.
2.4. Use partial derivatives to find gradients and directional derivatives (this includes evaluating those derivatives).

3.1. Use partial derivatives to find local extrema and test for saddle points.
3.2. Use Lagrange multipliers to solve constraint problems.

4.1. Evaluate double integrals (two dimensional) in rectangular and polar coordinates.
4.2. Evaluate triple integrals (three dimensional) in rectangular, cylindrical, and spherical coordinates.
4.3. Use double and triple integrals in application problems like volumes, surface area, and moments.
4.4. Vector fields, including curl and divergence.
4.5. Compute line integrals of scalar and vector fields.
4.6. Compute surface integrals of scalar and vector fields.
4.7. Use line and surface integrals in applications.

5.1. Use the Fundamental Theorem of Line Integrals to solve line integrals that are path independent.
5.2. Use Green's Theorem to solve line integrals over closed nonconservative vector fields.
5.3. Use Stokes' Theorem to relate a line integral to a surface integral.
5.4. Use the Divergence Theorem to relate a surface integral to the integral over the solid.

Course Content Outline

Vector Operations and Parametrizations

1.1 Definition of a vector quantity
1.2 Vector operations including addition, subtraction, and the length or norm of a vector
1.3 Dot product (including projections)
1.4 Cross product (including triple product)
1.5 Equations of lines (both vector and parametric form)
1.6 Equations of planes (both vector and parametric form)
1.7 Distance from a point to a plane
1.8 Parametrizations of curves (vector-valued function) in $\mathbb{R}^2$ and $\mathbb{R}^3$
1.9 Graphs of vector valued functions
1.10 Limits of vector valued functions
1.11 Derivatives of vector valued functions
1.12 Integrals of vector valued functions
1.13 Find tangent vectors to space curves
1.14 Arc length
1.15 Curvature
1.16 Unit tangent, unit normal, and binormal vectors
1.17 TNB-frame
1.18 Velocity and acceleration (including breaking acceleration into its vector components)
1.19 Applications of space curves

Partial Derivatives

2.1 Graphs of cylinders in $\mathbb{R}^3$
2.2 Graphs of quadric surfaces
2.3 Graphs of functions of several variables
2.4 Contour maps and level curves and surfaces
2.5 Limits of functions of several variables including properties of limits (and limits at a point)
2.6 Continuity of functions of several variables
2.7 Definition of a partial derivative
2.8 Computation of partial derivatives including higher-order derivatives
2.9 Clairaut's Theorem
2.10 Tangent plane and linear approximations
2.11 Definition of differentiability
2.12 Chain Rule (several cases)
2.13 Implicit differentiation
2.14 Directional derivative
2.15 Gradient vector and direction of steepest ascent

Local and Absolute Extrema

3.1 Identify critical points
3.2 Use the Second Derivatives Test to identify local and global minima, maxima, and saddle points.
3.3 Connect the characteristics of the contour map to local and global minima, maxima, and saddle points
3.4 Use the Extreme Value Theorem to find the minima and maxima on a closed and bounded set
3.5 Find the absolute extrema on an open set (application problem)
3.6 Use Lagrange multipliers to find the minima and maxima subject to a constraint equation

Integration

4.1 Double integrals over rectangles
4.2 Fubini's Theorem
4.3 Double Integrals over general regions
4.4 Changing the order of integration
4.5 Double integrals in polar coordinates
4.6 Triple integrals over a box
4.7 Triple integrals over general regions
4.8 Writing a triple integral in the 6 possible ways of integration
4.9 Sketching the domain of integration
4.10 Triple integrals in cylindrical coordinates
4.11 Triple integrals in spherical coordinates
4.12 Change of variables—for polar, cylindrical, spherical
4.13 Change of variables—general case, Jacobi's Theorem
4.14 Applications of multiple integrals including area, surface area, volume, center of mass, or moments of inertia.

Vector Analysis

5.1 Definition of vector field
5.2 Gradient (conservative) vector field
5.3 Line integrals over a scalar field
5.4 Line integrals over a vector field
5.5 Finding line integrals over conservative vector fields
5.6 Fundamental Theorem of Line Integrals
5.7 Potential functions
5.8 Green's Theorem
5.9 Green's Theorem over a multiply-connected region
5.10 Curl
5.11 Divergence
5.12 Interpreting curl and divergence from the graph of a vector field
5.13 Terminology of irrotational and incompressible
5.14 Parametrization of surfaces
5.15 Surface integral over a general surface
5.16 Surface integral over a parametrized surface
5.17 Stokes 'Theorem
5.18 Divergence or Gauss's Theorem
5.19 Analysis comparing the Fundamental Theorem of Line Integrals, Green's Theorem, Stokes 'Theorem, and the Divergence Theorem.