Virginia Western Community College
MTH 265
Calculus III

Prerequisites
Completion of MTH 264 or equivalent with a grade of C or better.

Course Description
Focuses on extending the concepts of function, limit, continuity, derivative, integral and vector from the plane to the three dimensional space. Covers topics including vector functions, multivariate functions, partial derivatives, multiple integrals and an introduction to vector calculus. Features instruction for mathematical, physical and engineering science programs.

Semester Credits: 4 **Lecture Hours: 4**

Required Materials
Textbook:
University Calculus. Hass, Weir & Thomas. 4th edition. Pearson/Addison-Wesley. ISBN: 9780134995540.

Other Required Materials:
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Course Outcomes
At the completion of this course, the student should be able to:
- Calculate the dot and cross products.
- Graph quadric surfaces.
- Use the rectangular, polar, cylindrical, and spherical coordinate systems.
- Analyze and apply vector-valued and parametrized functions, employing their related theorems to describe motion in space, based upon tangent and normal vectors and the principles of curvature.
- Find and interpret the rate of change of a function of several variables.
- Find and interpret gradients and directional derivatives of functions of several variables.
- Express and evaluate area using double integrals in either rectangular or polar coordinate systems.
- Express and evaluate the volume, mass, etc. of a surface using triple integrals.
- Convert and integrate in either the rectangular, spherical, or the cylindrical systems.
- Compute line integrals for both scalar and vector valued functions.
- Apply Green's Theorem and Stoke's Theorem
- Evaluate Surface Integrals and interpret flux of a vector field.
- Find and interpret the divergence and curl of a vector-valued function.

Course Objectives

- Vectors and the Geometry of Space
    - Identify and apply the parts of the three-dimensional coordinate system, distance formula and the equation of the sphere
    - Compute the magnitude, scalar multiple of a vector, and find a unit vector in the direction of a given vector
    - Calculate the sum, difference, and linear combination of vectors
    - Calculate the dot product and cross product of vectors, use the products to calculate the angle between two vectors, and to determine whether vectors are perpendicular or parallel
    - Determine the scalar and vector projections
    - Write the equations of lines and planes in space
    - Draw various quadric surfaces and cylinders using the concepts of trace and cross-section
- Vectors and the Geometry of Space
    - Sketch vector valued functions
    - Determine the relation between these functions and the parametric representations of space curves
    - Compute the limit, derivative, and integral of a vector valued function
    - Calculate the arc length of a curve and its curvature; identify the unit tangent, unit normal and binormal vectors
    - Calculate the tangential and normal components of a vector
    - Describe motion in space
- Partial Derivatives
    - Define functions of several variables and know the concepts of dependent variable, independent variables, domain and range.
    - Calculate limits of functions in two variables or prove that a limit does not exist;
    - Test the continuity of functions of several variables;
    - Calculate partial derivatives and interpret them geometrically, calculate higher partial derivatives
    - Determine the equation of a tangent plane to a surface; calculate the change in a function by linearization and by differentials,
    - Determine total and partial derivatives using chain rules,
    - Calculate directional derivatives and interpret the results
    - Identify the gradient, interpret the gradient, and use it to find directional derivative
    - Apply intuitive knowledge of concepts of extrema for functions of several variables, and apply them to mathematical and applied problems. Lagrange multipliers.
- Multiple Integrals
    - Define double integral, evaluate a double integral by the definition and the midpoint rule and describe the simplest properties of them.
    - Calculate iterated integrals by Fubini'sTheorem
    - Calculate double integrals over general regions and use geometric interpretation of double integral as a volume to calculate such volumes. Some applications of double integrals may include computing mass, electric charge, center of mass and moment of inertia
    - Evaluate double integrals in polar coordinates to calculate polar areas, evaluate Cartesian double integrals of a particular form by transforming to polar double integrals
    - Define triple integrals, evaluate triple integrals, and know the simplest properties of them. Calculate volumes by triple integrals

  - Transform between Cartesian, cylindrical, and spherical coordinate systems; evaluate triple integrals in all three coordinate systems; make a change of variables using the Jacobian
- Vector Calculus
  - Describe vector fields in two and three dimensions graphically; determine if vector fields are conservative, directly and using theorems
  - Identify the meaning and set-up of line integrals and evaluate line integrals
  - Apply the connection between the concepts of conservative force field, independence of path, the existence of potentials, and the fundamental theorem for line integrals. Calculate the work done by a force as a line integral
  - Apply Green's theorem to evaluate line integrals as double integrals and conversely
  - Calculate and interpret the curl, gradient, and the divergence of a vector field
  - Evaluate a surface integral. Understand the concept of flux of a vector field
  - State and use Stokes Theorem
  - State and use the Divergence Theorem

Textbook Topical Description

Sections	Topics
11	Vectors and the Geometry of Space
11.1	Three-Dimensional Coordinate Systems
11.2	Vectors
11.3	The Dot Product
11.4	The Cross Product
11.5	Lines and Planes in Space
11.6	Cylinders and Quadric Surfaces
12	Vector-Valued Functions and Motion in Space
12.1	Curves in Space and Their Tangents
12.2	Integrals of Vector Functions; Projectile Motion
12.3	Arc Length in Space
12.4	Curvature and Normal Vectors of a Curve
12.5	Tangential and Normal Components of Acceleration
13	Partial Derivatives
13.1	Functions of Several Variables
13.2	Limits and Continuity in Higher Dimensions
13.3	Partial Derivatives
13.4	The Chain Rule
13.5	Directional Derivatives and Gradient Vectors
13.6	Tangent Planes and Differentials
13.7	Extreme Values and Saddle Points
13.8	Lagrange Multipliers
14	Multiple Integrals
14.1	Double and Iterated Integrals over Rectangles
14.2	Double Integrals over General Regions
14.3	Area by Double Integration
14.4	Double Integrals in Polar Form
14.5	Triple Integrals in Rectangular Coordinates
14.6	Moments and Centers of Mass
14.7	Triple Integrals in Cylindrical and Spherical Coordinates
14.8	Substitutions in Multiple Integrals
15	Integrals and Vector Fields
15.1	Line Integrals
15.2	Vector Fields and Line Integrals: Work, Circulation, and Flux
15. 3	Path Independence, Conservative Fields, and Potential Functions
15.4	Green's Theorem in the Plane
15.5	Surfaces and Area
15.6	Surface Integrals
15.7	Stoke's Theorem
15.8	The Divergence Theorem and a Unified Theory

Notes to Instructors

A comprehensive final exam will be given.

ADA Statement (PDF)
Title IX Statement (PDF)