Math 241: Calculus III (4 credit hours)

Course Description

This is a third course in Calculus and Analytical Geometry. Topics for this course include vector analysis, Euclidean space, partial differentiation, multiple integrals, line and surface integrals, and the integral theorems of vector calculus.

Prerequisite: Calculus II

Course Objectives

After completing this course a successful student will be able to understand and apply the topics listed above. He/she will also be able to apply numerical, computational, and estimation techniques as well as the process of measurement. Through exploration, a successful student will be able to use vector analysis and integration to describe and model mathematical ideas. He/she will also have the necessary tools to formulate and solve problems in both mathematical and everyday situations, and connect concepts to other disciplines. Most importantly, a student completing this course will be able to communicate ideas through descriptive language as well as mathematical symbols.

### Course Content and Format

Content

A brief outline of topics for this course appears below:

- Parametric Plotting
    - Plotting ellipses, curves, and surfaces
    - Applications of parametric plotting
- Vectors
    - Tangent and velocity vectors
    - Length of a vector, dot product, and cross product
    - Velocity and acceleration applications
- Perpendicularity
    - Planes in three dimensions
    - Plotting curves on planes
- The Gradient
    - The gradient as a normal vector
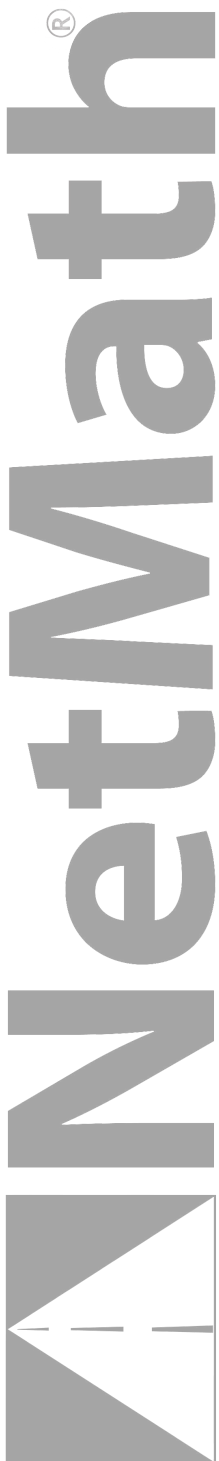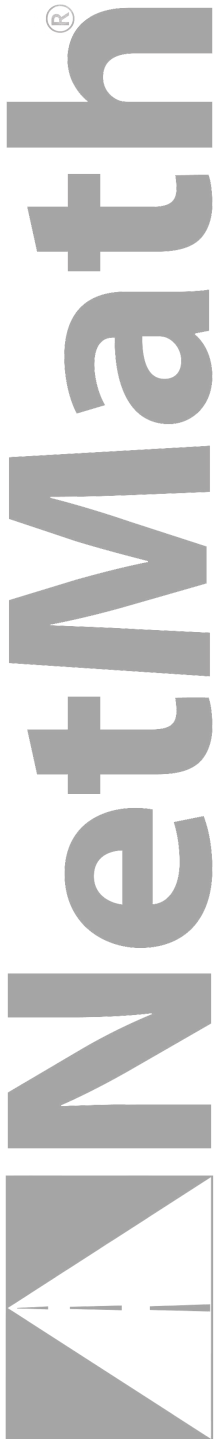
- o Maximization and minimization

- Gauss-Green Formula
  - o 2D integrals for area and volume measurements
  - o Correct parameterization in non-ideal situations

- Vector fields and their trajectories
  - o Flow along and flow across
  - o The gradient test in 2D and 3D
  - o Line integrals and path integrals
  - o Sources, sinks, divergence, and rotation of a vector field

- Transforming 2D and 3D integrals
  - o Area and volume conversion factors
  - o Measurements of volume, mass, and density
  - o Integrating on cylinders, spheres, and tubes

- Spherical Coordinates
  - o Integrating with spherical coordinates
  - o Applications including ice cream cones and a flower

- 3D Surface Measurements
  - o Sources, sinks and Gauss's formula in 3D
  - o Measuring area on surfaces
  - o Surface integrals and applications
  - o Stokes' formula

- 3D Flow Along Measurements
  - o Curl of a 3D vector field
  - o Applying Stokes' formula to measure the swirl
  - o Path dependence and independence

Format

Course content is drawn from *Vector Calculus* written by Bill Davis, Horacio Porta and Jerry Uhl ©2006-2010.

Math 241 utilizes the CAS-ILE system. *See https://cas-ile.illinois.edu/ for more information.* This online system helps students learn math topics through dynamic exploration and visualization.

Exams for Math 241 are taken online.