Course Outline for MATH 3

MULTIVARIABLE CALCULUS

Effective: Fall 2011

I. CATALOG DESCRIPTION:
   MATH 3 — MULTIVARIABLE CALCULUS — 5.00 units

   Vector valued functions, functions of several variables, partial differentiation, multiple integration, change of variables theorem, scalar and vector fields, gradient, divergence, curl, line integral, surface integral, Green's Stokes' and divergence theorem, applications.

   5.00 Units Lecture

   Prerequisite
   MATH 2 - Calculus II
   with a minimum grade of C

   Grading Methods:
   Letter Grade

   Discipline:

	MIN
Lecture Hours:	90.00
Total Hours:	90.00

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

III. PREREQUISITE AND/OR ADVISORY SKILLS:
   Before entering the course a student should be able to:

   A. MATH2
      1. Evaluate limits by applying L'Hospital's rule and techniques appropriate to limits of indeterminate forms;
      2. Evaluate definite and indefinite integrals by a variety of integration techniques;
      3. Evaluate improper integrals;
      4. Find arc length and the surface area of a solid of revolution;
      5. Solve separable first order differential equations;
      6. Apply the techniques of calculus to parametric curves;
      7. Sketch curves defined by polar equations;
      8. Apply the techniques of calculus to polar curves;
      9. Perform basic vector algebra in two-space and three-space and interpret the results geometrically;
      10. Find dot product and cross product of vectors.

IV. MEASURABLE OBJECTIVES:
   Upon completion of this course, the student should be able to:

   A. Perform vector algebra in two and three space and interpret the results geometrically especially the dot and cross products and apply them to problems in space geometry (e.g., orthogonal projection, vector equations of lines and planes);
   B. Transform points and equations among rectangular, cylindrical, and spherical coordinates and sketch their graphs as well as quadric surfaces;
   C. Parameterize curves using vector functions of one variable and analyze them (e.g., find unit tangent, unit normal, curvature);
   D. Sketch the graphs of functions of two variables using level curves, traces in coordinate planes, symmetry, etc.;
   E. Extend the concepts of limits, continuity, differentiability and differential of single variable functions to functions of two or more variables;
   F. Compute limits, partial derivatives, total differential, gradient, directional derivatives and interpret them geometrically and in terms of rate of change;
   G. Apply partial derivatives and/or gradients to problems involving tangent planes and linear approximation, and optimization, especially using Lagrange multipliers;
   H. Compute double and triple integrals directly or using change of variables and explain the geometric interpretation of Jacobians;
   I. Apply differential operators, gradient, divergence, curl and Laplacian to scalar and vector field and interpret the results;
   J. Compute line integrals using parameterizations for curves;
   K. Parameterize surfaces using vector functions of two variables, and compute their areas;
   L. Compute surface integrals of scalar functions and vector functions using parameterization for surfaces;
   M. Interpret the theorems of Green, Stokes and divergence physically as well as mathematically (as the generalizations of the Fundamental Theorem of Calculus), and use them to compute line and surface integrals;
   N. Find scalar potentials for conservative vector fields.

V. CONTENT:

- A. Vector Algebra
    1. vector addition, scalar multiplication, standard basis vectors
    2. the dot product
    3. Cauchy-Schwarz Inequality
    4. orthogonal projection
    5. vector equations of lines and plane
    6. cross-product, matrices, determinants, triple product
    7. vector functions and parameterized lines, curves and surfaces
    8. arc length and curvature
- B. Space Analytic Geometry
    1. rectangular, cylindrical and spherical coordinate systems
    2. surfaces (cylinders, quadric surfaces and surfaces of revolution)
    3. level sets, curves and surfaces
- C. Partial Differentiation
    1. scalar functions of two or more variables
    2. limits, continuity, partial derivatives, Chain Rule
    3. differentiability
    4. gradient
    5. directional derivative
    6. vector field
    7. tangent planes and linear approximation
    8. optimization, local and global maxima and minima and saddle points
    9. Lagrange multipliers;
- D. Multiple Integration
    1. double and triple integrals and their evaluations in rectangular, polar, cylindrical and spherical coordinates
    2. change of variables and Jacobians
    3. area, volume, surface area, center of mass and moments of inertia
- E. Scalar and Vector Fields
    1. scalar and vector fields
    2. vector differential operators (gradient, divergence, curl and Laplacian) and identities involving them
- F. Integrals over Paths and Surfaces
    1. integral of scalar functions along a path and line integrals
    2. path independence
    3. parameterized surface and its area
    4. surface integral
- G. Vector Analysis
    1. vector fields
    2. Divergence and curl
    3. Green's and Stokes' Theorems
    4. scalar potentials and conservative fields
    5. divergence Theorem

VI. METHODS OF INSTRUCTION:

- A. **Lecture** -
- B. **Discussion** -
- C. Web or CD-Rom based tutorials
- D. Student presentations
- E. Collaborative learning

VII. TYPICAL ASSIGNMENTS:

- A. Homework
    1. Homework should be assigned from the text and should include a sufficient number and variety of problems to develop both skill and conceptual understanding. Problems should range in level of difficulty from introductory level to challenging. A typical assignment should take an average student 1 to 2 hours for each hour in class.
- B. Collaborative learning
    1. Collaborative learning, done in small groups of 2-4 students, can be used to introduce new concepts, build skills, or teach problem solving. Students may be asked to present their results on the board.
    2. Example collaborative learning assignment: Have each group solve an optimization problem in two variables and present the results to the rest of the class.

VIII. EVALUATION:

- A. **Methods**
    1. Other:
        - a. Examinations
        - b. Comprehensive final examination
        - c. Any of all of the following at the discretion of the instructor
            1. Homework
            2. Quizzes (announced or unannounced, in-class or take home)
            3. Collaborative group activities
            4. Projects
- B. **Frequency**
    1. Recommend minimum of four exams plus the final
    2. Homework should be assigned for each section covered
    3. Number of quizzes and collaborative activities are at the discretion of the instructor

IX. TYPICAL TEXTS:

1. Stewart, James (2003). *Calculus* (5th ed.). Belmont, CA: Brooks/Cole – Thompson Learning.
2. Howard, A., Bivens, I., Davis, S. (2005). *Calculus: Early Transcendentals, Single and Multivariable* (8th ed.). New York, NY: John Wiley & Sons, Inc.
3. Larson, R., Hostetler, R. , Edwards, B. (2006). *Calculus* (8th ed.). Boston, MA: Houghton Mifflin Company.

X. OTHER MATERIALS REQUIRED OF STUDENTS:

- A. Graphing calculator