Prefix, Number and Name of Course: MAT 127 Applied Calculus II

Credit Hours: 4
In Class Instructional Hours: 4 **Labs**: 0 **Field Work**: 0

Catalog Description:
*Prerequisite***:** MAT 126 with a minimum grade of C or equivalent.

Continuation of MAT 126. Techniques of integration; applications of integration; introduction to differential equations including separation of variables, first order linear equations, and their applications; Taylor polynomials; Newton's method; partial derivatives; and optimization of functions of two and three variables. Graphical, symbolic, numerical, and verbal representations are used for all topics. Designed for students majoring in disciplines which use calculus as a tool. No credit given to students who have previously completed MAT 162 or equivalent.

Reasons for Revision:

The Mathematics Department's calculus sequences are being revised for several reasons. The current course description for MAT 127 is approximately 20 years old and needs to be up-dated. We also want to make the distinctions between MAT 162 and MAT 127 clearer both for students and instructors.

This course revision takes into account current best practices in the teaching of calculus, current undergraduate mathematics program guidelines, and the appropriate use of technology as recommended by the Mathematical Association of America's (MAA) Committee on the Undergraduate Program in Mathematics. Currently MAT 127 is a 3-credit, lecture-based course; increasing the credit hours earned to 4 hours will keep us in line with our sister schools in the SUNY system since approximately half of them with a course equivalent to our MAT 127 schedule it as a 4-credit hour course that meets for 200 instruction minutes/week.

The main goal in adding the fourth-credit hour to MAT 127 is to increase class time so that we can incorporate best pedagogical practices that focus on student-centered learning into this course. During the fourth-hour, a problem-solving session, students will work in small groups on challenging problems designed to give them hands-on experience working multi-step problems that require them to make sense of both the concepts and computational algorithms, as well as see connections between the mathematics they are studying and the applications of calculus in a wide range of disciplines such as economics, chemistry, physics, technology, etc.

The revised content of MAT 127 reflects current scholarship in calculus reform practices. The revised course aims to connect symbolic representations and operations directly and concretely to graphical and numerical representations—a goal made more attainable by technology that handles numbers, pictures, and symbols. This broader view of calculus is driven partly by computing possibilities and partly by different uses our students majoring in partner disciplines will make of calculus. Thus, this revised calculus course is characterized by such things as more writing and verbal presentations of student reasoning; more open-ended, investigative activities; and more challenging applications.

Finally, in consultation with client departments whose students are expected to enroll in MAT 126-127 instead of MAT 161-162, the trigonometric content has been dropped from MAT 127 in order to provide time for students to focus on differential equations and certain important numerical techniques for approximating solutions when exact solutions are impossible or difficult to obtain symbolically.

Student Learning Outcomes: Students will:	**Content Reference**	**Assessment**:
1. select and apply appropriate integration techniques for finding and evaluating integrals of algebraic, exponential, and logarithmic functions;	I-II	1. group work and classroom activities, individual assignments, quizzes, exams, projects
2. analyze applied integration problems from related disciplines and describe results using appropriate mathematical language and notations;	II	2. group work and classroom activities, individual assignments, quizzes, exams, projects
3. explain the concept of a differential equation and interpret the solutions to an applied differential equation in the context of the appropriate discipline;	III	3. group work and classroom activities, individual assignments, quizzes, exams, projects
4. solve elementary separable differential and first order linear differential equations using symbolic techniques;	III.A-D	4. group work and classroom activities, individual assignments, quizzes, exams, projects
5. derive approximate geometric and numerical solutions to differential equations with initial conditions using appropriate technology;	III.D-E	5. group work and classroom activities, individual assignments, quizzes, exams, projects
6. explain the concept of partial differentiation and compute partial derivatives of simple algebraic, exponential, and logarithmic multivariable functions using appropriate techniques of differentiation;	V.A-B	6. group work and classroom activities, individual assignments, quizzes, exams, projects
7. analyze applied optimization problems of multivariable functions and describe the results using appropriate mathematical language and notations;	V.C-E	7. group work and classroom activities, individual assignments, quizzes, exams, projects
8. use appropriate technology and numerical techniques such as Newton's Method and Taylor polynomial approximations to solve applied problems and as a tool to provide insight into significant concepts of calculus;	I-V	8. group work and classroom activities, individual assignments, quizzes, exams
9. solve problems from related disciplines individually and in small groups within a Socratic environment during weekly problem solving sessions.	I-V	9. group work and classroom activities, individual assignments

Course Content: Note: MAT 127 is a course designed for students majoring in disciplines that use calculus as a tool; the emphasis in this course is on the positive aspects of calculus—stressing things work well for functions that are continuous, except at a few, well-determined points. Furthermore, concepts, algorithms, and problems should be explored and developed following the "rule of 4"—graphic, numeric, symbolic and verbal representations.

While formal proof need not be stressed in this course, the development of good mathematical intuition and the need for at least heuristic justifications for important techniques is expected. Formal theoretical attention should be reserved for results that are clearly counterintuitive. For example, the integration by parts formula should be formally developed (and proved) from a symbolic point of view since many students seem to initially believe (incorrectly) that the integral of a product is the product of the integrals.

I. Techniques of integration
   A. Review of the definition of the definite integral and the fundamental theorem of calculus
   B. u-substitution
   C. Integration by parts
   D. Numerical techniques (optional)

II. Applications of integration
   A. Areas
   B. Average value of a function over a closed interval
   C. Applications to economics such as future and present values of income streams and consumer surplus problems
   D. Improper integrals

III. Introduction to differential equations
   A. Definition of differential equation and their solutions
   B. Separation of variables
   C. First order linear differential equations
   D. Applications
   E. Euler's method

IV. Additional applications of the derivative
   A. Taylor polynomials and approximating functions
   B. Newton's Method

V. Differential calculus of functions of two and three variables
   A. Functions of several variables and graphs of functions of two variables
   B. Partial derivatives
   C. Optimization of functions of two and three variables
   D. Lagrange Multipliers (optional)
   E. Least squares approximations

Resources

Scholarship:

Adams, C., Thompson, A., and Hass, J., *How to Ace Calculus*. W. H. Freeman, New York, 1998.

Apostol, T., *Calculus Volumes, I, II*. Blaisdell Pub. Co., Massachusetts, 1967.

Bressoud, D., *Launchings from the CUPM Curriculum Guide: Keeping the Gates Open*. The Mathematical Association of America (MAA), 2006.

Bouldin, R., *Calculus with Applications to Business Economics and the Social Sciences*. New York, NY, Saunders College Publishing Co., 1985.

Buck, C., *Advanced Calculus*. Waveland Press, Illinois, 2003.

Courant, R. and John, F., *Calculus and Analysis*. Interscience Publishers, New York, 1965.

Fraga, R., *Calculus Problems for a New Century*. The Mathematical Association of America (MAA), 1993.

Ganter, S., *Changing Calculus: A Report on Evaluation Efforts and National Impact from 1988-1998.* The Mathematical Association of America (MAA), 2001.

Goldstein, L., Lay, D., and Schneider, D., *Calculus and Its Applications*. 3rd ed., Englewood Cliffs, NJ, Prentice Hall, 1984.

Hughes-Hallett, D., Gleason A., McCallum W., et al., *Calculus.* 4th ed., Wiley, New York, 2005.

Kaplan, W., *Advanced Calculus.* 5th ed., Addison-Wesley, New York, 2002.

Kline, M., *Calculus: An Intuitive and Physical Approach*. John Wiley & Sons, New York, 1977.

Krantz, S. G., *Calculus Demystified*. McGraw-Hill, New York, 2003.

Lee, B., *Forgotten Calculus*. Hauppauge, NY, Barron's Educational Series, 2002.

Ostebee, A. and Zorn, P., *Calculus from Graphical, Numerical, and Symbolic Points of View*. 2nd ed., Houghton-Mifflin, 2002.

Roberts, W., *Calculus, the Dynamics of Change*. The Mathematical Association of America (MAA), 1995.

Steen, L. A. (Ed.), *Calculus for a New Century: A Pump, Not a Filter*. Papers Presented at a Colloquium, The Mathematical Association of America (MAA) Notes Number 8, 1987.

Stewart, J., *Calculus*, 6th ed., Brooks-Cole, 2007.

Thomas, G., *Calculus and Analytic Geometry*. Addison-Wesley, New York, 1952.

Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide 2004. The Mathematical Association of America (MAA), 2005.

Periodicals:

American Mathematics Monthly
College Mathematics Journal
Math Horizons
Mathematics Magazine

Electronic or Audiovisual Resources:

Buffalo State Calculus Revision: http://www.bsccalculus.info

Calculus & *Mathematica*: http://cm.math.uiuc.edu/

Calculus on the Web: http://www.math.temple.edu/~cow/

The Calculus Page: http://www.calculus.org/

Carnegie Mellon's Open Learning Initiative (OLI): http://www.cmu.edu/oli/courses/enter_calculus.html#aboutCalculus

Math Forum at Drexel: http://mathforum.org/library/topics/svcalc/

Project Calc: http://www.math.duke.edu/education/calculustext/

SUNY Stony Brook: Resources from their calculus reform efforts: http://www.math.sunysb.edu/~tony/calc/index.html

Tools for Enriching Calculus Video CD-ROM, (iLrn Homework, and vMentor), Brooks-Cole, 2002.

Visual Calculus: http://archives.math.utk.edu/visual.calculus/