Prefix, Number and Name of Course: MAT 162 Calculus II

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

Catalog Description: A continuation of MAT 161. Area accumulation functions; definition of the definite integral; fundamental theorem of calculus; integration techniques; applications of integrals; improper integrals; sequences and series; function approximation. Graphic, symbolic, and numeric representations are used throughout the course. Appropriate for math majors and students in partner disciplines requiring understanding of fundamental principles of calculus with emphasis on deductive reasoning and proof.

Prerequisite: MAT 161 with a minimum grade of C, or equivalent.
Corequisite: MAT 164

Reasons for Revision: This revision is based on current best practices in the teaching of calculus, current undergraduate mathematics program guidelines, and the appropriate use of technology. The department proposes to revise both the course content and increase the credit hours earned through successful completion of the course; the fourth credit hour will allow us to incorporate a highly desired problem-solving session officially into this course. Moreover, the idea of a 4-credit calculus course is not new: Traditionally calculus courses have involved a recitation meeting or a problem-solving session for which students receive credit, and we are currently one of only two SUNY schools that attempt to teach our calculus courses for mathematics majors in a three-hour format. [The rest of the SUNY schools teach calculus courses as 4-credit courses that meet four hours per week.]

The problem-solving session (fourth credit hour) is designed to provide students with a student-centered learning environment and is directly tied to Student Learning Outcomes #8 and #9, which are based on the new recommendations from the Mathematical Association of America's (MAA) Committee on the Undergraduate Program in Mathematics (CUPM). During the problem solving sessions students work in small groups on challenging problems designed to give them hands-on experience working multi-step problems that require them to make clear sense of both the concepts and computational algorithms. The problems are chosen from department-written pedagogical guides that direct instructors to use this hour specifically for students to work on the problems with guidance from the instructor. Ideally students and the instructor get instant feedback during these sessions; by working with the students and observing their work, the instructor can tell when certain central concepts and important algorithms need additional instruction time. By working in small groups with the guidance of the instructor, students can identify both their strengths and weaknesses and get timely help where necessary. The department expectation is that instructors use student participation and achievement in the problem solving sessions as a formal part of the student's semester grade. The department has experimented with this kind of problem-solving session through funding provided by the STEP grant for the past 5 semesters. Early indications are that our students benefit from these problem solving sessions and the department wants to insure that they continue to benefit from this type of instruction long after the STEP grant's funding runs out.

The revised content reflects current scholarship in calculus reform practices and is driven partly by computing possibilities and partly by the different uses our students will make of calculus. Thus, the revised course is characterized by studying critically important concepts from multiple representations; more and deeper modeling problems (where students build, not just use, calculus-based models); more writing and verbal presentations of student reasoning; more open-ended, investigative activities; and more challenging applications. Furthermore, to address the needs of partner disciplines, sequences and series and related topics have been moved from the third course (MAT 263) into the second course (MAT 162).

Student Learning Outcomes: Students will:	**Content Reference**	**Assessment**:
1. compare and contrast the concepts of indefinite integrals and definite integrals.	I, II, IV	1. Group work and classroom activities, individual assignments, quizzes, exams, projects
2. explain the meaning of the fundamental theorem of calculus and use the fundamental theorem to evaluate definite integrals of simple algebraic, trigonometric, exponential, and logarithmic functions.	II-IV	2. Group work and classroom activities, individual assignments, quizzes, exams, projects
3. compute both definite and indefinite integrals of algebraic, trigonometric, exponential, and logarithmic functions using appropriate techniques of integration.	II-IV	3. Group work and classroom activities, individual assignments, quizzes, exams, projects
4. analyze applied problems from related disciplines, including integration problems and selected differential equations, and describe results using appropriate mathematical language and notations.	IV	4. Group work and classroom activities, individual assignments, quizzes, exams, projects
5. explain the concepts of sequence and series and accurately describe the connections and differences between these two closely related concepts.	V, VI	5. Group work and classroom activities, individual assignments, quizzes, exams, projects
6. determine whether individual series converge, converge absolutely, or diverge; and compute intervals of convergence for power series; and compute and use series approximations of selected functions.	V.C-D, VI	6. Group work and classroom activities, individual assignments, quizzes, exams, projects
7. use technology to solve problems and as a tool to provide insight into significant concepts of calculus.	I-VI	7. Group work and classroom activities, individual assignments, projects
8. use deductive reasoning and proof as tools to generate mathematical knowledge and provide insight into significant concepts of calculus.	I-VI	8. Group work and classroom activities, individual assignments, quizzes, exams, projects
9. solve problems from related disciplines individually and in small groups within a Socratic environment during weekly problem solving sessions.	I-VI	9. Group work and classroom activities, individual assignments, projects

Course Content: Note: Proof and deductive reasoning are an integral part of the course that should be woven into the development of content knowledge and conceptual understanding at every opportunity. Furthermore, concepts should be explored and developed following the "rule of 4"– graphic, numeric, symbolic and verbal representations.

I. Anti-derivatives and differential equations (direct continuation from MAT 161)
   A. Slope fields *
   B. Selected classes of differential equations *
   C. Exponential growth and decay *
   * These topics are included in MAT 161 or 162 depending on placement in the adopted text.

II. Area accumulation functions and the definite integral
   A. Area accumulation functions
   B. Definition of the definite integral as signed area
   C. Fundamental theorem of calculus (graphic, numeric, symbolic and verbal representations)
   D. Riemann sums

III. Techniques of Integration
   A. u-substitution
   B. Integration by parts
   C. Partial Fractions
   D. Trigonometric Substitutions
   E. Graphical techniques for error checking
   F. Improper Integrals

IV. Applications of the Definite Integral
   A. Area
   B. Volume
   C. Arc length
   D. Introduction to separable differential equations (optional – depending on text)

V. Sequences and series
   A. Definition of sequence and definition of convergence of a sequence
   B. Definition of series and definition of convergence of a series
   C. Convergence tests
   D. Absolute convergence and alternating series

VI. Function approximation
   A. Taylor polynomials and Taylor series
   B. Power series
   C. Fourier polynomials and Fourier series (optional – depending on text)

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.

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.

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

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

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

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

Larson, H., *Calculus: Early Transcendental Functions.* 4th edition. Houghton-Mifflin, 2007.

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 edition, 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 edition. 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/