MTH 211 CALCULUS II (revised February 2009)

Students will be expected to demonstrate an understanding of Calculus beyond the manipulation of symbols, apply Calculus to practical problems and use current technology throughout the course. They will demonstrate their understanding of Calculus using four approaches—geometric, numerical, algebraic and verbal. A comprehensive departmental final exam testing the degree of mastery of the following course objectives is required.

1. General Objectives
   - 1.1 Recognize and manipulate functions given in numerical, graphical, and analytical forms.
   - 1.2 Give reasonable approximations for values of functions, their limits, derivatives, and integrals and express the error involved.
   - 1.3 Use graphing calculator technology to explore the behavior of functions, limits, derivatives, integrals and series; to find numerical approximations for limits, derivatives, integrals and intervals of convergence for power series; and to aid in solving problems and verifying solutions.
   - 1.4 Express Calculus concepts, and explain and interpret results in well-written sentences.
   - 1.5 Interpret the derivative as the limit of a difference quotient that gives the slope of a linear approximation to a graph at a point, and as instantaneous rate of change.
   - 1.6 Interpret a definite integral both as a limit of a Riemann Sum that is the difference in areas above and below the *x*-axis, and as the net amount of change in the function whose rate of change is the integrand.
   - 1.7 Explain the relationship between the derivative and the definite integral as it is expressed in both parts of the Fundamental Theorem of Calculus.
   - 1.8 Use derivatives and integrals to model and solve applied problems.
   - 1.9 Use the sign, magnitude, and units of measurement of a solution to an applied problem to assess its reasonableness.

2. Calculus I Review
   - 2.1 Review finding derivatives of functions that are sums, differences, products, quotients, or compositions of powers of *x*, sines and cosines, logarithmic and exponential functions.
   - 2.2 Review finding indefinite integrals of linear combinations of powers of *x*, sine, cosine, and the natural exponential function and check the results by taking the derivative.

3. Integration Techniques
   - 3.1 Review finding indefinite and definite integrals of sums and differences of constant multiples of powers of *x*, sines, cosines, and exponential functions.
   - 3.2 Review finding derivatives of inverse sine and tangent.
   - 3.3 Find antiderivatives for derivatives of inverse sine and tangent.
   - 3.4 Use the following integration techniques:
     - 3.4.1 Integration by substitution (Review)
     - 3.4.2 Integration by parts
     - 3.4.3 Integration by partial fractions
     - 3.4.4 Integrate functions involving products of powers of sine and powers of cosine. Recommended if time allows: Integrate functions involving products of powers of secant and powers of tangent.
     - 3.4.5 Integrate using trigonometric substitutions of the form: $u = a\sin\theta$ and $u = a\tan\theta$. Recommended if time allows: Integrate using trigonometric substitutions of the form $u = a\sec\theta$.

3.5 Use the following numerical techniques of integration to approximate an integral for a function given algebraically, graphically, or as a table of values; sketch the geometric representation of the approximation, and discuss the error involved:
- 3.5.1 LEFT-HAND and RIGHT-HAND rules (Review).
- 3.5.2 MIDPOINT rule
- 3.5.3 TRAPEZOID rule
- 3.5.4 Use concavity to determine whether the Midpoint and Trapezoid rules are over or under estimates.
- 3.5.5 SIMPSON's rule

4. Applications of Integration
   - 4.1 Set up an approximating Reimann sum and represent its limit as a definite integral in a variety of applications, then evaluate or approximate the integral. The following applications are required; however, students should be able to adapt this technique to application problems that are similar to, but not exactly the same as, the specific applications listed.
     - 4.1.1 Find or approximate the area between two curves. Sketch and label the i^{th} rectangle with its width and height, express the area of the i^{th} rectangle, express the total area as the limit of a Riemann sum of these areas, write the Riemann sum as a definite integral and find or approximate its value.
     - 4.1.2 Find or approximate volumes by slicing. Sketch and label the i^{th} volume element, express the volume of the i^{th} element, express the total volume as the limit of a Riemann sum of these volumes, write the Riemann sum as a definite integral and find or approximate its value.
     - 4.1.3 Find or approximate work done in moving an object along a straight line by a force in the direction of the motion. Identify the i^{th} force element, i^{th} distance element and i^{th} work element; express the total work as the limit of a Riemann sum; write the limit of the Riemann sum as a definite integral and evaluate or estimate it. Express the total work done using correct units.
   - 4.2 Find or approximate arc length using the definite integral formula for arc length.

5. First order differential equations
   - 5.1 Translate verbal descriptions of rates of change into differential equations.
   - 5.2 Solve differential equations by:
     - 5.2.1 the separation of variables technique,
     - 5.2.2 using slope fields,
     - 5.2.3 using Euler's method.
   - 5.3 Model exponential and logistic growth and decay by formulating and solving differential equations with initial conditions. Use the models to answer questions about amounts and times at which they occur.

6. Limits with Indeterminate Forms
   - 6.1 Use L'Hopital's Rule to evaluate $\infty/\infty, 0/0$, and $0 \cdot \infty$ forms.
   - 6.2 Use logarithmic techniques to reduce the indeterminate forms 0^0 and ∞^0 to forms for which L'Hopital's Rule applies.
   - 6.3 Use graphical and numerical techniques to approximate limits with indeterminate forms.

7. Improper Integrals
   - 7.1 Evaluate improper integrals with infinite limits of integration.
   - 7.2 Evaluate improper integrals with integrands containing infinite discontinuities.
   - 7.3 Use a comparison test to determine convergence or divergence of an improper integral. If the integral converges, find its value, give an upper bound on its value, or give an approximation of its value.

8. Infinite Series

- 8.1 Use the definition of an infinite series as the sum of an infinite sequence to construct the series.
- 8.2 Calculate and graph a sequence of partial sums. Construct an expression for the n^{th} partial sum when possible.
- 8.3 Determine convergence or divergence of an infinite series by evaluating the limit of the n^{th} partial sum for geometric and telescoping series.
- 8.4 Use the n^{th} term test for divergence.
- 8.5 Recognize geometric series, determine their convergence or divergence, and find their sum if convergent.
- 8.6 Recognize the harmonic series and know that it diverges.
- 8.7 Recognize an alternating series. Use the first n terms of an alternating series whose terms decrease in magnitude and whose n^{th} term goes to 0 to approximate the sum of the series. Give the magnitude of the first neglected term as a bound in the error of the approximation.
- 8.8 Interpret the terms of a series as areas of rectangles of width one and height equal to the value of the term. Interpret the Integral Test as a comparison of an infinite integral to its upper or lower sum. Use the integral test to determine the convergence or divergence of p-series. Use an appropriate integral to give an upper bound for the value of the series.
- 8.9 Use the Ratio Test to determine the convergence or divergence of series.
- 8.10 Calculate Taylor polynomial approximations. Discuss the accuracy of the approximations by comparing graphs and by constructing the Lagrange form of the Taylor Remainder**.**
- 8.11 Determine the radius and interval of convergence for a power series.
- 8.12 Perform substitution**,** algebraic manipulation, and term by term differentiation and integration of known power series to form new series.
- 8.13 Construct Taylor Series expansions of functions and examine their intervals of convergence graphically and/or numerically.
- 8.14 Construct and use the first several terms of a series to approximate an integral.

Adopted February 2009