WINONA STATE UNIVERSITY

COLLEGE OF SCIENCE AND ENGINEERING

DEPARTMENT OF MATHEMATICS AND STATISTICS

**Course Outline – MATH 413**

**Course Title:** Advanced Applied Mathematics

**Number of Credits**: 3

**Catalog Description:** A thorough treatment of advanced applied mathematics, including partial differential equations, Fourier series, Fourier transforms, Laplace transforms, Sturm-Liouville theory. Grading Method: Grade and P/NC Option. Prerequisites: MATH 312, MATH 313, and MATH 314 or MATH 242. Offered fall semesters of even numbered years (e.g. Fall 2012, Fall 2014, etc).

**Possible Textbooks:**

* Advanced Engineering Mathematics by Greenberg
* Advanced Engineering Mathematics by Kreyszig
* Mathematics for Physicists by Lea

**Topics Covered:**

1. Fourier Series
   1. Even, Odd, and Periodic Functions
   2. Aperiodic Functions
   3. Manipulation of Fourier Series (optional)
   4. Vector Space Approach (optional)
   5. Sturm-Liouville Theory
2. Fourier Integral, Fourier Transform
   1. Heaviside and Dirac Functions
   2. Fourier Integral
   3. Fourier Transform
   4. Derivation of Laplace Transform from Fourier Integral
3. Laplace Transform
   1. Singular Integrals
   2. Calculation of the Transform
   3. Properties of the Transform and its Inverse
   4. Applications to Differential Equations
   5. Additional Properties
4. Miscellaneous Topics
   1. Curvilinear Coordinates
   2. Helmholtz Theorem
5. Partial Differential Equations
   1. Preliminary Concepts and Second Order Linear Equations
   2. Diffusion Equation
      1. Separation of Variables
      2. Sturm—Liouville Theory
      3. Infinite and Semi-Infinite Regions (optional)
      4. Numerical Solution
   3. Laplace Equation
      1. Separation of Variables
      2. Polar Coordinates (Sturm-Liouville Theory)
      3. Fourier Transform (optional)
      4. Numerical Solution
   4. Wave Equation
      1. Separation of Variables
      2. D’Alembert’s Solution (optional)
   5. Special Functions
      1. Bessel Functions & Spherical Harmonics
      2. Legendre Functions
      3. Gamma Function
      4. Green’s Function
      5. Laplace’s Equation

**Remarks:** This course is aimed at physics majors though the course is open to mathematics and engineering students. It is understood that any prerequisite Complex Variable Theory will be taught as needed.

**Method of Instruction:** Lecture-presentation, discussion, question-answer sessions, use of calculators/computers, group work.

**Evaluation Procedure:** Homework, quizzes, projects, midterm exams, and a final exam.

**Minnesota Transfer Curriculum:** Not Applicable

**MNSCU Learning Outcomes:**

* Students will be able to define vector and scalar functions and perform operations on them in Cartesian, spherical, and cylindrical coordinated system.
* Students will be able to manipulate vectors in curvilinear coordinates.
* Students will be able to perform calculus operations on complex variables.
* Students will be able to use the gamma function.
* Students will be able to solve linear ordinary differential equations.
* Students will be able to use numerical method to solve ordinary differential equation.
* Students will be able separate the variables in a partial differential equation.
* Students will be able to expand a function in a Fourier series.
* Students will be able to use Fourier series to solve differential equations.
* Students will be able to use Laplace transform to solve differential equation.
* Student will be able to use the delta function to represent physical quantities.
* Students will be able to use the Fourier Transforms to solve partial differential equations.
* Students will be able to apply Sturm-Liouville theory to solve problems.

**Last Revised:** Spring 2016 by the Mathematics Subgroup