WINONA STATE UNIVERSITY

COLLEGE OF SCIENCE AND ENGINEERING

DEPARTMENT OF MATHEMATICS AND STATISTICS

**Course Outline – MATH 317**

**Title:** Theory of Functions of a Complex Variable

**Number of Credits**: 3

**Catalog Description:** The calculus of functions of a complex variable including differentiability, analyticity, and integration. Additional topics include the residue theorem. Prerequisites: MATH 312 - Multivariable Calculus. Grade or P/NC. Offered periodically spring semester every third year.

**Possible Textbooks:**

* Suggested Text: A First Course in Complex Analysis with Applications by Zill and Shanahan. Jones and Bartlett Publishers
* Possible Texts:
  + Complex Variables, 2nd edition by Stephen Fisher
  + Fundamentals of Complex Analysis, 3rd edition, by E. B. Saff and A. D. Snider
  + Complex Variables by Norman Levinson and Raymond M. Redheffer
  + Complex Variables and Applications, 8th edition by Brown and Churchill

**Topics Covered:**

1. Complex Numbers and Complex Plane
   1. Algebraic Forms
   2. Geometric Representation
   3. Polar Forms
   4. De Moivre’s Formula
   5. Roots and Powers of a Complex Number
2. Complex Functions and Mappings
   1. Domains in Complex Plane
   2. Algebraic Form for a function of a Complex Variable
   3. Exponential and Logarithmic Functions
   4. Trig and Inverse Trig Functions
   5. Hyperbolic and Inverse Hyperbolic Functions
3. Analytic Functions and Elementary Functions
   1. Limits and Continuity
   2. Derivation
   3. Cauchy-Riemann Equations
   4. Harmonic Functions
   5. Analyticity of the Logarithmic Functions
   6. Complex Exponentials
4. Integration in the Complex Plane
   1. Line Integral
   2. Cauchy’s Theorems
   3. Cauchy’s Integral Formula
   4. Generalization of Cauchy’s Integral Formula
   5. Maximum Principle and Minimum Principle
   6. Liouville’s Theorem
   7. The Fundamental Theorem of Algebra
   8. Weierstrass’ Theorem
5. Series, Residues and Conformal Mappings
   1. Convergence and Divergence
   2. Taylor Series
   3. Laurent Series
   4. Isolated Singularities
   5. Application of Residues to Integrals
   6. Definition and Characterization of Conformal Mappings
   7. Examples

**Listing of Sections in Departmental Text to be Covered (Name and Author of Text Here):** No Departmental Text required for this Course

**Remarks:** This is an introductory course to Complex Analysis at an undergraduate level. Complex Analysis, in a nutshell, is the theory of differentiation and integration of functions with complex-valued arguments *z = x +* ***i****y*, where ***i*** *= (-1)1/2*. While the course will try to include rigorous proofs for many - but not all - of the material covered, emphasize will be placed on applications and examples. Complex Analysis is a topic that is extremely useful in many applied topics such as numerical analysis, electrical engineering, physics, chaos theory, and much more, and students will see some of these applications throughout the course.

**Approximate Pace of Coverage:** About 2-3 weeks per topic

**Method of Instruction:** Lecture-presentation, discussion, question-answer sessions,

use of calculators/computers, group work and/or paper presentations.

**Evaluation Procedure:** Homework, quizzes, projects, midterm exams, and a final exam and/or paper presentations.

**Minnesota Transfer Curriculum:** Not Applicable

**MnSCU Learning Outcomes:**

* Students will have a working knowledge of the basic definitions and theorems of the differential and integral calculus of functions of a complex variable.
* Students will learn how to use the basic tools of complex methods.
* Students will learn the principal techniques and methods of analytic function theory.
* Students will learn the difference between real analysis and complex analysis via examples and geometrical views.
* Students will see and become familiarize with significant applications of complex analysis to other fields.
* Students will develop a clear mathematical writing style.

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