KOTEBE METROPOLITAN UNIVERSITY
COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES
DEPARTMENT OF MATHEMATICS
Course outline for the course 'Functions of Complex Variables' (Math 2072)

Course title: Functions of complex variable
Course code: Math 2072
Program: B.Sc. degree in Mathematics (Ext.)
Credit hours: 4 cr.hr
Course type: Compulsory
Instructor's name: Fufa Beyene **Email:** fbbeyenefufa1@gmail.com
Course description: The course mainly covers the complex number system, complex differentiability, analytic functions, conformal mappings, complex integration Cauchy's theorem, Cauchy integral formula, power series representations of analytic functions, Laurent series, residue theorem, evaluation of definite integrals, and Mobius transformation.
Course objective and competency acquired
On the successful completion of this course students will expected to:

- understand the significance of differentiability of complex functions,
- define analytic function, distinguish between differentiable functions and analytic functions,
- apply Cauchy-Riemann equations, evaluate integrals along a path in the complex plane,
- understand the statement of Cauchy's Theorem,
- understand Cauchy integral formula,
- apply Cauchy integral formula to evaluate line integrals,
- represent analytic functions by a power series,
- prove Fundamental Theorem of Algebra,
- distinguish the singularities of a function,
- write the Laurent series of a function,
- calculate the residue,
- apply the Residue theorem,
- understand the properties of Mobius transformation and its action on circles.

Course outline
Chapter 1: Complex numbers
1.1 Definition of the complex numbers and their operations
1.2 Geometric representation and polar form of complex numbers
1.3 De-Moiver's formula
1.4 Root extraction
1.5 The Riemmann and the extended complex plane

Chapter 2: Analytic functions
2.1 Elementary functions
2.2 Open and closed sets, connected sets and regions in complex plane
2.3 Definitions of limit and continuity
2.4 Limit theorem
2.5 Definition of derivative and its properties
2.6 Analytic function and their algebraic properties
2.7 Conformal mappings
2.5 The Cauchy Riemann equations and harmonic conjugates
Chapter 3: Cauchy's Theorem
3.1 Definition and basic properties of line integrals
3.2 Intuitive version of Cauchy's theorem
3.3 Cauchy's theorem on simply connected regions
3.4 Cauchy - Goursat theorem for a rectangle
3.5 The Cauchy integral formula
3.6 The Maximum Principle
Chapter 4: Series representation of analytic functions
4.1 Basic definitions and properties of sequence and series
4.2 Taylor's theorem
4.3 Liouville's theorem
4.4 Laurent series and classification of singularities
Chapter 5: Calculus of residues
5.1 Calculation of residues
5.2 The Residue theorem and its application
5.3 Evaluation of definite integrals
Chapter 6: The Mobius transformation
6.1 Examples of mapping by functions
6.2 Magnification, translation, and rotation
6.3 The map $w = \frac{1}{z}$
6.4 Definition of Mobius transformation and basic properties
6.5 The cross ratios

Method of teaching: The following active teaching-learning methods will be employed:Gap lecture, Question and answering, Tutorial classes where students will discuss and solve problems, Group work, and Discussion and presentation in group.

Class attendance: At least 85% of class attendance is mandatory to be seated for final exam.

Assessment: Assignments(30%), Tests(30%) and Final Exam(40%).

References:

Robert B. Ash, Complex variables, Academic press, 1971

R. E. Greene and S. G. Krantz, Functions of one complex varaiable, John Wiley & Sons, INC., 1997

N. Levinson & R. M. Redheffer, Complex variables, The McGram-Hill publishing company Ltd, 1980

I. Markushevich, Theory of functions of complex variable, Prentice-Hall INC., 1965