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**Department of Mathematics**

**College of Basic Education**

**Salahaddin University-Erbil**

**Subject: Complex analysis**

**Course Book – *4*th Stage –Second semester**

**Lecturer's name. Dr. Azad Ibrahim Amen**

**Academic Year: 2022/2023**

**Course Book**

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| **1. Course name** | **Complex analysis** | | |
| **2. Lecturer in charge** | **Dr.Azad Ibrahim Amen** | | |
| **3. Department/ College** | **Mathematics / Basic Education** | | |
| **4. Contact** | **e-mail:** [**azad.amen@su.edu.krd**](mailto:azad.amen@su.edu.krd) | | |
| **5. Time (in hours) per week** | **Theory: 3 hours in week**  **Practical: 0** | | |
| **6. Office hours** | **3 hours in the week** | | |
| **7. Course code** |  | | |
| **8. Teacher's academic profile** | Specialization  Applied Mathematics /differential eqatios  Bsc –Salahaddin University1988  Msc-Baghdad university-1991  PhD-Salahaddin university-2011   * Scientific Rank: Professor**, Calculus** | | |
| **9. Keywords** | Complex functions,analytic functions, Elementary functions: exponential function and properties**....etc** | | |
| **10. Course overview:**  **The history of the complex numbers is very interesting. By the 16th Century, although no-one understood exactly what a complex number was, it was found that complex numbers were a useful tool for solving problems. Later, mathematicians tried to**  **Understand the complex numbers. This led in turn to investigations of the real numbers, the rational numbers, the integers and finally the natural numbers. So historically there was a reverse development: the more complicated system was found to be useful early on, and the study of the simplest systems was left till later.**  **In the first chapter the basic ideas about complex numbers and analytic functions arc**  **introduced. In addition to becoming familiar with the theory, the student should strive to**  **gain facility with the standard (or "elementary'") functions such as polynomials,**  **e£, log z, sin z—as in calculus. These functions arc studied in §1.3 and appear**  **frequently throughout the text.** | | | |
| **11. Course objective:**  **Complex numbers are defined as ordered pairs z = (x, y) of real numbers x and y. We shall define addition and multiplication of these numbers shortly.**  **Let D be a subset of C. A function f : D C is a rule that associates with each z in D**  **a unique complex number w. We write w = f ( z ) .**  **Notes**  **1. The set D of numbers that are mapped is called the domain of f. Notice that we now have a double use of this word. Where the domain is unspecified, we assume it to be the largest subset of C for which f ( z ) is defined.**  **2. The set of image elements {w | w = f (z) } is called the range or image of the function.**  **3. The above definition specifies a unique image for each z D. Later we shall extend this definition to include multivalued functions.**  **In practice, this expression in terms of real and imaginary parts may be easier said than done! In theory, it allows us to deduce properties of complex functions from our knowledge of the real numbers.**  **The first part, , includes the basic properties of analytic functions, essentially what cannot be left out of, say, a one- semester course.**  **The second and third parts of the course deal with further assorted analytic aspects of functions in many directions, which may lead to many other branches of analysis. I have**  **emphasized the possibility of defining analytic functions by an integral involving a parameter and differentiating under the integral sign. Some classical functions are given to work out as exercises,**  **Definitions Function f ( z ) is analytic at z 0 if ( z ) exists not only at z 0 but for all z in some neighborhood of z 0. f ( z ) is analytic in a domain of the z -plane if it is analytic at every point of the domain. f ( z ) is entire if it is analytic everywhere.**  **Examples**  **1. f ( z ) = is not analytic anywhere. (It is in fact differentiable only at z = 0).**  **2. f ( z ) = 1/z is analytic (except at z = 0).**  **3. f ( z ) = a0 + a1z + ... + an is entire.**  **Cauchy's Theorem:**  **An attractive feature of complex analysis is that it is based on a few simple, yet**  **powerful theorems from which most of the results or the subject follow. Foremost**  **among these theorems is a. remarkable result called Cauchy's Theorem, which is**  **of the keys to the development of the rest of the subject and its applications.** | | | |
| **12. Student's obligation**  1) Schedule changes may occur during the semester any changes will be announced in class.  2) The student is responsible for all assignments, changes in assignments, or other verbal information given in the class, whether in attendance or not.. | | | |
| **13. Forms of teaching**  **White board and Presentation slides in Power point , Lecture notes** | | | |
| **14. Assessment scheme**  The students are required to do two exams before the final exam. There will be final exam on 60 marks . So that the final grade will be based upon the following criteria:  Mid-semester Exam: (20+20)% and ,  Final exam 60%  Total: 100%  ‌ | | | |
| **15. Student learning outcome:** | | | |
| **16. Course Reading List and References‌:**  1.R.V .Churchil, J.W.Brown and R.F.Verhey. Complex variables and applications(1996).  2. R.Shakarchi. Problems and solutions for complex analysis (1999).  3. S. Lang. Complex analysis (1999). | | | |
| **17. The Topics:** | | |  |
| Subject | | | Week |
| Introduction and basic concepts of complex numbers, Cartesian product, triangle inequality ,polar coordinates, | | | 1 |
| Analytic functions, mapping, limits and derivative of complex function | | | 2 |
| Cauchy –Riemann equation, Analytic functions and harmonic functions | | | 3 |
| Elementary functions: exponential function and properties | | | 4 |
| Trigonometric functions | | | 5 |
| The Logarithmic function, properties | | | 6 |
| Integrals, line integral | | | 7 |
| Cauchy Goursat theorem | | | 8 |
| The Cauchy integral formula | | | 9 |
| Derivative of Analytic function | | | 10 |
| Moreas theorem | | | 11 |
| Fundamental theorem of algebra | | | 12 |
| Series ,convergence of series | | | 13 |
| Taylor series | | | 14 |
| Laurent series | | | 15 |
| **21. Peer review**  **Assistant Professor Dr. Sami Ali** | | .‌‌ | |