Program Cover Document --- MAT 320: Complex Analysis

I. Basic Course Information

MAT 320: Complex Analysis will be scheduled for two lecture periods each of length 80 minutes.

Prerequisite: MAT 229 Multivariable Calculus

II. Learning Goals

The Complex Analysis (MAT 320) course is typically taken by students in their junior year. The subject matter builds on the material students have learned in the three semester calculus sequence, and connects with many other math options a student might take. During this course students learn not only how to perform simple calculations with complex numbers, but should also gain a good understanding of the geometry of the complex plane, and are introduced to the basics of the field of mathematical analysis through the study of analytic functions. The students are exposed to some surprising results that they can contrast with their earlier calculus experience. For instance early in the course the class will learn that a complex function that is differentiable is infinitely differentiable. Through the study of residues students will be able to easily calculate integrals that were impossible in the calculus class.

Students will improve their proof writing skills in this course and will be expected to prove results that they used in the real case in the calculus course. For instance students will be expected to prove derivative rules and integration theorems. The class will also discover the ways in which the subject of complex analysis can be applied to other types of problems and see relationships to other topics in mathematics. For instance when studying harmonic functions students are exposed to partial differential equations, and when studying Liouville's Theorem students can easily make the connection to the fundamental theorem of algebra. Students may also be easily exposed to the connection between complex analysis and differential equations, topology, and linear algebra during the course.

At the end of this course we expect our students will be able to construct proofs and write proofs in a logical manner, and to understand well the complex number system and analytic function theory as a basic part of mathematical analysis. We expect that this course will further the mathematical maturity of our majors.

A typical list of the topics studied in this course include the geometry of complex numbers, DeMoivre's theorem, analytic functions, elementary functions, limits, continuity, differentiation and integration of functions of complex variable, Cauchy-Goursat Theorem, Cauchy integral formula, fundamental theorem of algebra, harmonic functions, Taylor and Laurent Series, uniform convergence, essential, removable, and isolated singularities, residue calculus, conformal mapping.

III. Student Assessment

Students will receive feedback on their work via homework assignments and examinations. The performance of students in future mathematics courses will be used to evaluate the success

of Complex Analysis in achieving its learning goals and its contribution to the fulfillment of the MATA, MATT, and MATC program goals. Peer reviews and student evaluations will also be used to evaluate the course.

IV. Learning Activities

Learning activities will consist of a combination of lectures, group work, and student presentations. The specific choice will depend upon the individual instructor. Outside of class, students are expected to do a significant amount of individual and group homework to achieve the learning goals. These learning activities are typical of the learning activities in the MATA, MATT, MATC programs.

Course Syllabus Guide -- MAT 320: Complex Analysis

Introduction: A sample syllabus for Complex Analysis follows this sheet. Any syllabus for Complex Analysis should include the points listed below (the required course requirement sections) however course content will be at the discretion of the instructor.

I. Basic information on course and instructor
   A. Purpose statement: Complex Analysis introduces the student to an important and useful branch of mathematics with applications to many other areas.
   B. Course description: An introduction to the study of Complex Analysis designed for mathematics and statistics majors and minors.
   C. Course prerequisites: Multivariable Calculus.

II. Learning goals
   A. Content goals: Students should understand the geometry of complex numbers, the theory of differentiation and integration applied to complex functions, and should be familiar with series expansions and residue theory.
   B. Performance goals: At the completion of the course, students should be able to calculate complex integrals and derivatives, derive a series form of a function of a complex variable, and recognize connections between Complex Analysis theory and applications in other branches of mathematics. Students should be able to prove statements concerning functions of complex variables. Students should have improved their ability to write and explain mathematics.

III. Student assessment
   A. Assessment plan: Students will receive regular feedback on their work through the assignment of homework and examinations. A syllabus should clearly describe the schedule for these assessment tools and how they will be used to calculate grades.
   B. Rationale: Students understand mathematics concepts by doing mathematics. Feedback on problems assigned allows students to correct mistakes and better understand the material at hand.
   C. Methods and criteria: We will use the assessment of homework and examinations to evaluate student accomplishment of the course learning goals.

IV. Learning activities
   A. Summary of learning activities: Learning activities will consist of a combination of lectures, group work, and student presentations. The specific choice will depend upon the individual instructor. Outside of class, students are expected to do a significant amount of individual and group homework to achieve the learning goals.
   B. Calendar or outline: A guide to the organization of the course, a schedule of assessment tools, and a plan for the coverage of topics should be provided to the students. Homework and examinations should be spaced at appropriate intervals throughout the semester.
   C. Rationale: A regular spacing of assessment tools insures that students receive continual regular feedback on their work.

MAT 320
Complex Analysis

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Office Hours: Tuesdays & Fridays 10:00-11:00 and by appointment
Text: "Complex Variables and Applications", 6th Edition, by Brown & Churchill

Learning Goals:

During this course you will learn not only how to perform simple calculations with complex numbers, but you should also gain a good understanding of the geometry of the complex plane, and you will be introduced to the basics of the field of mathematical analysis through the study of analytic functions. We will see some surprising results that you can contrast with your earlier calculus experience. For instance early in the course the class will learn that a complex function that is differentiable is infinitely differentiable. Through the study of residues we will be able to easily calculate integrals that were impossible in the calculus class. We will be doing proofs of many results and students will be expected to prove results used in the course.

Assessment and Course Requirements:

Homework = 30%
Exams = 40%
Final = 30%

Homework: There will be weekly homework assignments which will usually be assigned each Tuesday and will be due the following Tuesday. The homework will be posted on SOCS. These assignments will fall into two categories –

Non hand in homework: part of the assignment will consist of problems which will not be collected. Students will be required to present some of these homework problems at the board during Tuesday's class. You will be given advance notice when it is your turn to put homework on the board. If you are unable to attend class on the day that you are assigned to put up homework, you should notify me of the absence before the start of class. If this happens more than once it will affect your grade.

Hand in homework: part of the assignment will consist of problems to be graded. You may work on these in groups of two or three people if you wish. If you do work in a group, you should acknowledge whom you worked with on the top of your homework paper. Each member of the group should hand in a copy of the assignment, and these should be written up separately (i.e. I do not want to see homework papers that are identical).

The homework assignments are due at the beginning of class. I will deduct 10 percent for each day that the homework is late, and will not accept it more than three days late. The lowest homework score will be dropped in computing the homework average at the end of the semester.

Exams: There will be two in-class exams. The first exam will occur during the 6th week of class and the second exam will occur during the 12th week of class. If you are ill and unable to attend the exam a makeup can be arranged only if you call my office or email me before the start of the exam, and if you get a doctor's note. Makeup exams will be more difficult than the original.

Final: There will be a cumulative final exam at the end of the semester.

Learning Activites:

Students are expected to keep current with the homework assignments, to review material in groups as much as possible, and to consult tests from the library to supplement the course text. The homework assignments are meant to provide a means to practice writing proofs and calculations and to solve problems based on the material discussed in lecture. I may periodically break the class up into groups during lecture time to work on problems to be presented to the class.

Other Information:

Class participation: I will consider class participation in computing your final grade if your grade is borderline. By "class participation" I include putting homework on the board on Tuesdays.
Extra Credit: I do not give extra credit assignments, so you need to make sure that you are keeping up with the classwork as it is assigned.
Email: I might periodically send messages to the class so you should get in the habit of checking your email. I will respond to email sent to me as soon as possible.
Snow: In the event of inclement weather you should check the snow hotline 609-637-6000 or the home page for the College to see if classes have been delayed or cancelled. If classes are held but I am unable to travel in, I will email the class.

Syllabus:

This course will cover the following topics as time permits:
The Geometry of Complex Numbers
Analytic Functions
Limits and Continuity
Derivatives and the Cauchy-Riemann equations
Analytic Functions and Harmonic Functions
Elementary Functions
Integrals, the Cauchy-Goursat Theorem, Cauchy integral formula
Taylor and Laurent Series, uniform convergence
Residues and poles
Applications of residues
Conformal Mapping