MAT 342 APPLIED COMPLEX ANALYSIS

SPRING 2018

1.

Instructor: Lisa Berger
Office: Math 4-100A
Email: lisa.berger@stonybrook.edu
Web page: `http://www.math.sunysb.edu/~lbrgr/`
Current Office Hours:

> Tuesdays: 2:30-4:00 in 4-100A
> Thursdays: 2:30-4:00 in P-143
> By appointment. Please send email to schedule.

Office hours may be adjusted to accommodate the instructor's schedule and/or student needs. Students unable to meet during scheduled office hours are encouraged to schedule an appointment with the instructor.

Grader: Jiasheng Teh
Email: jiasheng.teh@stonybrook.edu

2.

General Information. This is an introductory course in functions of a complex variable. Complex analysis is a requisite tool in many fields of advanced mathematics and a beautiful theory of its own. We will cover as much as possible of the first nine chapters of the course textbook, to include material on Riemann surfaces if possible. This course will involve a balance of computational and theoretical work, and the course MAT 200, an introduction to mathematical proof, is a recommended pre-requisite. You should be prepared to work through a lot of problems, prove your results and write your work clearly and accurately. Course information will be posted regularly to the course web page:

`http://www.math.sunysb.edu/~lbrgr/MAT342Spring2018.html`.

Students are expected to attend class regularly and are responsible for all announcements made in class or posted to the course page.

Pre-requisites. A *minimum* pre-requisite for this course is completion of multi-variable calculus and differential equations. Math 200 is recommended.

2.1. Textbook.

We will be using a Stony Brook version of the ninth edition of *Complex Variables and Applications* by James Brown and Ruel Churchill.

Homework/Class Work/Quizzes.

Homework is an essential component of the course. Homework will be assigned and collected regularly, and selected problems will be graded. Homework is due at the beginning of the class period, and late homework will not be accepted. Announced and/or unannounced quizzes may be given, and there may be assignments completed and collected during class. Students are expected to be present for class, and missed quizzes or classwork may not be completed for credit. The lowest 2 scores in the homework/classwork/quiz category will be dropped.

Homework is due at the beginning of class and is to be submitted to the course instructor; homework is not to be submitted to the course grader.

A significant part of doing mathematics is *communicating* mathematics. Homework is expected to be clear and grammatically correct, in addition to mathematically accurate. Homework not meeting this criteria may be returned ungraded.

You are encouraged to work together, but submitted written assignments must be your own work and represent your own understanding. If you consult any outside sources, these must be cited. If you need clarification on these statements, please ask.

Exams.

There will be two midterms exams and a final exam. Exam 1 is *tentatively* scheduled for Tuesday, February 27. Exam 2 is *tentatively* scheduled for Thursday, April 12. The **final exam** is as scheduled by the University: Tuesday, May 15, 2:15 - 5:00 p.m.

Final Grades. Your final grades will be based on the following:

(1) Exam 1: 20%
(2) Exam 2: 20%
(3) Homework/Quizzes/Classwork: 30%
(4) Final Exam: 30%

Academic Integrity.

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instance of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at `http://www.stonybrook.edu/commcms/academic_integrity/index.html`.

If you do not understand the policy on academic integrity, please ask for clarification.

Disability Support Services. If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room 128, (631) 632 − 6748 or `http://studentaffairs.stonybrook.edu/dss/`. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go the the following website: `http://www.stonybrook.edu/ehs/fire/disabilities/`

Critical Incident Management. Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, and/or inhibits students' ability to learn.

Student Learning Outcomes. Students should be able to do the following:

- Implement the basic arithmetic of complex numbers: addition, subtraction, multiplication, division, conjugates, moduli, exponential form, roots, absolute value and agrument, including Arg;
- Recall and use the triangle inequality; use Euler's formula to convert between cartesian and polar notation for complex numbers.
- Apply the concepts of ϵ-neighborhood, open set, boundary, closed set, connected set, accumulation point;
- For $w = f(z)$, a complex function, with $w = u + iv$ and $z = x + iy$, write w in terms of the two real-valued functions of two variables: $u(x, y)$, and $v(x, y)$;
- Work with multi-valued functions;
- Given $w = f(z)$, sketch images in the w-plane of regions in the z-plane.
- Demonstrate that $f(z) = z^2$ has a derivative for every $z \in \mathbb{C}$, but that $f(z) = \bar{z}$ never has a derivative, and $f(z) = |z|^2$ has a derivative only at 0;
- Use differentiation rules, such as the chain rule, to compute derivatives of complex functions;
- Derive the Cauchy-Riemann equations for $f = u + iv$ at z from differentiability of f at z; derive and use the equation: $f'(z) = \partial u/\partial x + i\partial v/\partial x$;
- Prove and apply the Theorem: If $f'(z) = 0$ everywhere in a domain $\mathcal{D}$, then f must be constant throughout $\mathcal{D}$;
- Work with the exponential map; show that it takes each half-open horizontal strip of height 2π in a one-to-one fashion onto the complement of 0; demonstrate understanding that, since the exponential map covers the plane infinitely often, every non-zero z has infinitely many possible logarithms, and that the differ by multiples of $2\pi i$;
- Compute Log z, the principal value of the logarithm function, and explain why it is discontinuous at every point of the negative x-axis;
- Implement complex exponentiation $z^c = e^{c \log z}$, and explain why this function is multi-valued in general;
- Use the Euler formula: $e^{iz} = \cos z + i \sin z$ for complex z to define sine and cosine in terms of the exponential function; define tangent, cotangent, secant, and cosecant as usual, and show that the derivatives of these functions satisfy the usual differentiation formulas;
- Calculate line integrals of a complex function by separately integrating the real and imaginary parts;
- Evaluate contour integrals by choosing a parametrization and carrying out the real integration with respect to the parameter;
- Use the inequality bounding the absolute value of a contour integral by the product of the length of the contour by the maximum absolute value of the integrand;
- Apply the Cauchy-Goursat Theorem: If f is analytic on and inside of a simple closed contour, then the integral of f along that contour is 0;
- Show that the integral $\int_\gamma \frac{1}{z} dz$ about any simple closed contour γ traversed counterclockwise about the origin is $2\pi i$;
- Use the Cauchy Integral formula; use the Extended CIF to calculate derivatives of f by contour integrals;
- Determine convergence of a complex series by examining the separate convergence of its real and imaginary parts; analyze remainders to show, for example, that a geometric series converges if the multiplier has absolute value less than 1;
- Apply Taylor's Theorem to compute derivatives from series coefficients, and vice-versa;
- Work with examples of Laurent series;
- Apply the Residue Theorem to calculate contour integrals; apply the Residue Theorem to calculating appropriate real integrals from negative infinity to infinity.