Project for Complex Variables and Applications

PLEASE READ THIS INFORMATION CAREFULLY

Abstract: Project title, all names of group participants, their affiliations and a short abstract of approximately 100 words must be submitted via Gradescope by 11:59pm March 11. One title/abstract is sufficient for each group.

Overview: The project will consist of a written report and a presentation of 20 minutes plus 5 minutes for questions. The project's written report is due on April 29 and the presentation will be scheduled during the last week of the course: April 29–May 3. Specific times will be announced later in the course. All students are required to attend all oral presentations.

APPM 4360 students are to work together in groups of three. APPM 5360 students do the project independently or work in groups of two.

Below is a list of possible projects; others are possible. The instructor must approve your project.

Possible projects: Remember: this is a mathematics course. It is not a physics/engineering course or numerical course or probability course, etc. Mathematical ideas/concepts/methods in complex analysis must be central in each project.

- Applications of complex variables to fluid dynamics/electrostatics/heat conduction etc. Include applications beyond what was covered in class. Many books on fluid dynamics/electromagnetics, etc. cover this topic;
- Infinite product and Mittag-Leffler expansions–section 3.6; other references can be found in the literature. Supplement with examples.
- Differential equations in the complex plane–Painlevé type equations–section 3.7; applications: possible reference: Ablowitz & Clarkson CUP 1991.
- Computational methods in the complex plane–section 3.8. Supplement with examples, applications, use other references from the literature. **Make sure complex analysis leading to the computational method is an important component.**
- Conformal mapping: polygons–Schwarz-Christoffel transformation section 5.6; fundamental mapping of a rectangle and elliptic functions–supplement with other applications, references.
- Numerical Conformal mapping: polygons: numerical implementation of the Schwarz-Christoffel transformation; possible reference: Driscoll-Trefethen, CUP 2002; others can be found in the literature; applications include fluid dynamics, electrostatics, etc; **Make sure complex analysis leading to this computational method is an important component**
- Special functions in the complex plane: Airy functions, the Riemann Zeta function, Gamma function, elliptic functions, etc; describe analytic/singularity properties, visualization, solutions of ODEs and integral representations, applications.
- Asymptotic evaluation of integrals: Laplace, stationary phase, steepest descent, WKB methods, Stokes phenomenon: see Chapter 6 of Ablowitz & Fokas 2003. Supplement with other references. There are numerous potential projects within this subtopic.

- Wiener-Hopf and Riemann-Hilbert (RH) problems: scalar RH problems: closed/open contours, relate to singular integral equations; matrix RH problems: see Chapter 7 of Ablowitz & Fokas 2003. Supplement with application examples. There are many possible projects within this subtopic; e.g. nonlinear waves: integrable equations, Inverse Scattering Transform; Ref. MJ Ablowitz, CUP 2011.
- Generalized Cauchy Integral Formula (GCIF)–Sect. 2.6.3. Derivation and applications of GCIF include nonlinear waves 'KP' equation: reference: Ablowitz & Clarkson, CUP 1991.