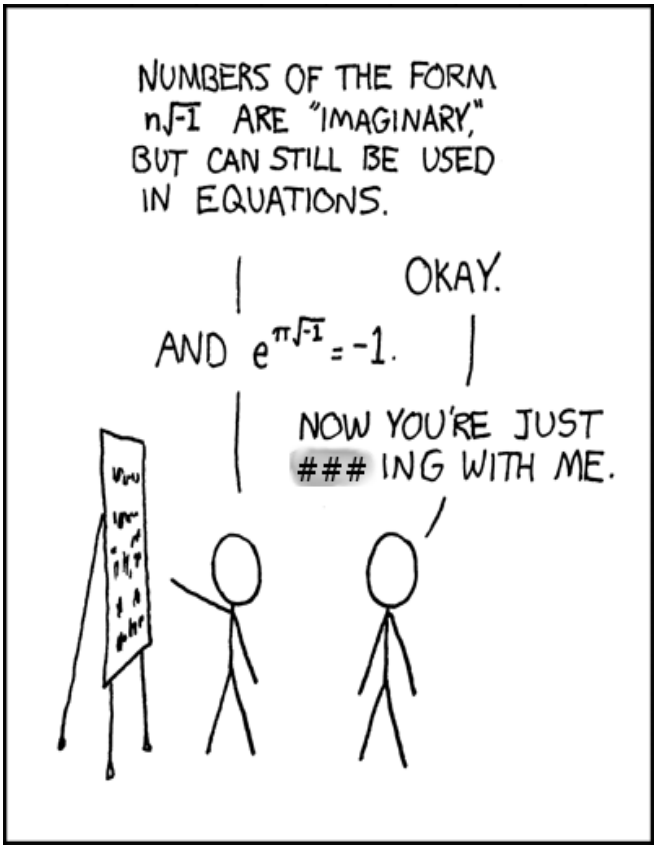
AM104:

Complex and Fourier Analysis with Applications to Art, Science and Engineering

Prof. L. Mahadevan
MW 10:30 – 11:45 am
North West B103



(credit: xkcd.com)

POSTER link

Course Information

Course Description

Complex analysis: complex numbers, functions, mappings, Laurent series, differentiation, integration, contour integration and residue theory, conformal mappings and circle mappings. Applications to visualization, art (especially M.C. Escher) and photography. Fourier Analysis: orthogonality, Fourier Series, Fourier transforms. Signal processing: sampling theorems (Nyquist, Shannon), fast Fourier and other discrete transforms and wavelets. Applications to image and audio filtering; cleaning images and sound. Inverse problems.

Reading

The course will follow the class notes. Occasionally, we will assign extra readings from the literature. Some readings we recommend are:

E. Saff, A. Snider. *Fundamentals of Complex Analysis*, Pearson
T. Needham. *Visual complex analysis*, Oxford University Press.
P. Nahin *An imaginary tale: the story of i,* Princeton University Press.

Course Staff

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Lectures

Lectures are 10:30-11:45am on Mondays and Wednesdays in NW B103. They are not recorded.

Office Hours and Sections

All students are expected to attend sections. Sections are mandatory, and attendance will be

recorded. There will be short **in-section quizzes** on a regular basis at the end of sections. The quizzes are graded based on completion. In addition, course staff will hold weekly office hours. Specific times and locations will be posted on the course website.

Course Website

Announcements, resources, and homeworks are available on the course website via http://canvas.harvard.edu.

Ed

Students can ask questions and participate in discussions via the course Ed, which can be reached via Canvas.

Grading

Grades will be assigned based on a curve. Gaps in the scoring distribution will be favored as locations for breakpoints between grades. Final scores will be determined using the following weights:

Homework	55%
Short **section** quizzes	5%
In-class midterm exam	15%
Take-home final exam	25%

Homework

There will be 8 homeworks, which will include math problems and small computational exercises (programming experience not required). Homeworks will be assigned approximately weekly, with a week off for the midterm exam and around Thanksgiving break.

HW will be **due Wednesdays at midnight in Gradescope.** Working in groups, whether in person or over the forums, is ***permitted*** and ***encouraged***, as studies show that this aids retention. However, each person must turn in their own copy of the work, and work must be shown on each problem. You are expected to write neatly (or use LaTeX) – this makes your graders happy, and happy graders are generous graders. All homeworks must be written up individually even if the work is done collectively. Please include names of all collaborators on all HWs.

Late Days

Each student will have **four late days** which can be used as 24-hour extensions on homework assignments. You do not need to ask to use a late day. Submitting a homework shortly after the midnight deadline still counts as using an entire late day. You can use at most two late days on an assignment. We expect you to use your late days first to cover homework delays due to being sick,

etc. However, please reach out to the course staff if you have extenuating life circumstances for which the late days are not sufficient.

Exams

There will be short **in-section quizzes** on a regular basis (completion graded and worth 5% of the overall grade), an **in-class midterm exam on 10/30/2024**, and a **24 hour take-home final during reading period**. The final will be handed out at noon, Monday 12/9/2024, and due at noon on Tuesday 12/10/2024.

Quiz questions will resemble homework questions, the midterm exam questions will resemble quiz questions, and the final exam will be a comprehensive exam resembling your homeworks. You can bring a one-page **handwritten** note sheet (front and back) to the in-class midterm. On the take-home final, the only resources you will be permitted to use are course materials (lecture notes, previous homeworks, other resources posted to the course website, no AI tutor/ChatGPT).

AI Policy

Using the AI ChatGPT Tutor is allowed to help enhance understanding. All such use must be appropriately acknowledged and cited. It is each student's responsibility to assess the validity and applicability of any GAI output that is submitted; you bear the final responsibility. Violations of this policy will be considered academic misconduct.

Rough distribution of lectures

Unit 1: Complex Analysis
8 weeks - Complex algebra. Elementary functions. Complex differentiation. Complex integration. Series. Residue calculus. Conformal mappings. Riemann sphere -> Moebius transform. Applications to Anamorphosis, Morphometry.

Unit 2: Fourier Analysis and Signal Processing
5 weeks - Fourier series. Orthogonality, completeness. Fourier/Laplace transforms. Convolution and correlation. Fast Fourier Transform and its cousins. Applications to music and image analysis. Filtering and cleaning images and sound.