California Institute of Technology
Department of Computing + Mathematical Sciences

ACM 95a/100a Introductory Methods of Applied Mathematics for the Physical Sciences

Winter 2026

Lectures: Mon, Wed, Fri, at 11:00am-12:15pm in Kerckhoff 125
Instructor: Konstantin (Kostia) Zuev
Office: Annenberg 114
Email: kostia@caltech.edu (please include "95a" or "100a" in the subject line)
Office Hour: Wed 1pm-2pm, or by appointment (please, send an email to schedule)
Head TA: Harsh Gandhi (hgandhi@caltech.edu)
TAs and OHs: https://piazza.com/caltech/winter2026/acm95a100a/staff
You are welcome to attend as many office hours as you like.

Course Description

This course introduces students to the fundamental concepts and methods of applied mathematics. The course consists of two parts: complex analysis and ordinary differential equations (initial value problems). The list of topics includes:

- Complex Analysis: complex numbers, complex plane, Euler's formula, regions in the complex plane, functions of complex variable, limits and continuity, stereographic projection, complex derivative, the Cauchy-Riemann equations, analytic functions, complex exponential, trigonometric functions, logarithmic function, branches, branch cuts, brunch points, power function, roots of unity, contour integrals, equivalence theorem, the Cauchy-Goursat theorem, deformation of paths, Cauchy's integral formula, derivatives of analytic functions, Morera's theorem, sequences and series, Taylor series, power series, circle of convergence, ratio test, Cauchy-Hadamard formula, continuity, integration, and analyticity of power series, Laurent series, zeros and singularities of analytic functions, residues, Cauchy's residue theorem, improper integrals, Jordan's lemma, analytic continuation.
- Ordinary Differential Equations (initial value problems): differential equations, general terminology, 1st order liners ODEs, 2nd order linear ODEs, existence and uniqueness, superposition principle, Wronskian, fundamental set of solutions, Abel's theorem, reduction of order, variation of parameters, Green's functions, the Laplace transform, applications to initial value problems, shifting theorems, initial value problems with discontinuous and impulsive forcing, convolution integral, the Mellin inversion formula, linear vs nonlinear ODEs, numerical methods for 1st order nonlinear IVPs, Euler's method, backward Euler's method, approximation errors, Heun's method, Runge-Kutta methods, Adams methods, nst order nonlinear IVPs, power series solutions, Airy's equations, ordinary and singular points, Fuchs' theorem, Euler's equations, the method of Frobenius.

Prerequisites

- Ma 1 abc, Ma 2 or equivalents.
- Some familiarity with MATLAB, e.g. ACM 11, is desired.

Textbooks

- Comprehensive Lecture Notes (will be posted on Piazza after each lecture)
- Complex Analysis:
  - E.B. Saaf and A.D. Snider, *Fundamental of Complex Analysis with Applications to Engineering and Science*
  - J.W. Brown and R.V. Churchill, *Complex Variables and Applications*
  - M.J. Ablowitz and A.S. Fokas, *Complex Variables: Introduction and Applications*
- Ordinary Differential Equations:
  - W.E. Boyce and R.C. DiPrima, *Elementary Differential Equations and Boundary Value Problems*
  - E.A. Coddington, *An Introduction to Ordinary Differential Equations*

Practice Problems

Each lecture will be accompanied by two practice problems: a somewhat easier, more practical Problem A, and a more difficult, more conceptual Problem B. The main goal of the practice problems is threefold: to help you better understand the material covered in the corresponding lecture, to help you prepare to solve problems in problem sets and exams, and to accommodate the diversity of students' math backgrounds by providing both easier and more challenging problems. These problems are for self-practice: they will not be graded, and the solutions (posted on Piazza) also illustrate the expected level of rigor for problem sets and exams.

Grading

Your final grade will be based on your Total Score. Your Total Score is a weighted average of Problem Sets (60%), First-Half Exam (10%), Second-Half Exam (10%), and the Final Exam (20%). You can increase your total score by up to 5% if you participate actively in Piazza discussions in the Q&A section[1]. Every answer submitted before TAs or instructor answer, which is later endorsed as a "good answer" by TAs or instructor, gets 1% of the total score. There are no fixed thresholds for grades, but if your total score is 90% (80%, 70%, 60%), you are guaranteed at least "A" ("B", "C", "D").

Problem Sets

There will be seven Problem Sets. Problems (and solutions) will be posted on Piazza. For assignment and due dates see "Important Dates" below. Late submissions will not be accepted, but the Problem Set with the lowest score will be dropped and not counted toward your total score. Submitting wrong files or files in a wrong format is considered as a late submission. Extensions may be granted for academic, personal, or medical reasons. For extensions, please email the Head TA.

Exams

There will be three exams:

1. First-Half Exam (midterm): based on Lectures 1-13, **take-home**, 4h 10 min long, timed on Gradescope.
2. Second-Half Exam: based on Lectures 14-25, **take-home**, 4h 10 min long, timed on Gradescope.
3. Final Exam: based on Lectures 1-25, **in-person**, 1h long, paper-based (no electronic devices).

The Head TA will provide a review session before the first and second exams. All exams are closed-book but open-notes (*your* notes): only material written or typed by you may be used during exams. Electronic devices may be used only for typing and for arithmetic operations on the take-home exams. The final exam is paper-based: no electronic devices are permitted.

Ethical Use of AI

You can use AI tools (e.g., ChatGPT) to support your learning in this course, but only in ethical and responsible ways. For example, it is fine to use AI to generate a practice exam based on the topics covered in the course. However, using AI to directly solve your problem sets or exams, to give you hints, or check your solutions for correctness is not allowed, as it undermines your learning and violates Caltech's Honor Code. When in doubt, ask yourself: would it be acceptable for a tutor to do this for you? If not, then it is also not appropriate to ask an AI to do it. Most importantly, keep in mind that you are here to train your own neural network, not the artificial one.

Collaboration Policy

A detailed collaboration policy is given on the course website at:
http://www.its.caltech.edu/~zuev/teaching/2026Winter/CollaborationACM95a100a.pdf
In general, collaboration is encouraged everywhere except for the exams. Let's help each other and learn together!
If you get stuck with a homework problem, I encourage you to discuss it with other students (offline or online on Piazza). But remember that you will have to prepare and submit your solution by yourself. No collaboration is allowed on the exams.

Important Dates (All times are Pacific Times)

	Available	Due
Problem Set 1	1pm Fri, Jan 09	9pm Fri, Jan 16
Problem Set 2	1pm Fri, Jan 16	9pm Fri, Jan 23
Problem Set 3	1pm Fri, Jan 24	9pm Fri, Jan 30
Problem Set 4	1pm Fri, Jan 30	9pm Fri, Feb 06
Head TA Review	11am Fri, Feb 06	
First-Half Exam	1pm Fri, Feb 06	9pm Tue, Feb 10
Problem Set 5	1pm Fri, Feb 13	9pm Fri, Feb 20
Problem Set 6	1pm Fri, Feb 20	9pm Fri, Feb 27
Problem Set 7	1pm Fri, Feb 27	9pm Fri, Mar 06
Head TA Review	11am Wed, Mar 11	
Second-Half Exam	1pm Wed, Mar 11	9pm Wed, Mar 18
Final Exam (in-person[2]) Location: ANB 105/104[3]	Start: 1pm Mon, Mar 16 Start: 10:45am Tue, Mar 17 Start: 1pm Wed, Mar 18	End: 2pm Mon, Mar 16 End: 11:45am Tue, Mar 17 End: 2pm Wed, Mar 18

[1] If you are interested in being a TA next year, try to be active on Piazza and help other students by answering their questions.
[2] Each student must sign up for 1 of the 3 available time slots by January 23 (add day), on a first-come, first-served basis, via a Google Form.
[3] Room ANB 104 is reserved for students with CASS accommodations.

Websites

- Course website:
  http://www.its.caltech.edu/~zuev/teaching/2026Winter/ACM95a100a.htm
- Lecture notes, practice problems, problem sets, solutions, announcements, and class discussions will be managed via Piazza, which is designed such that you can get a quick help from your classmates, TA(s), and instructor. Instead of emailing questions to the teaching staff, I encourage you to post your questions on Piazza because
  - You will get the answers faster
  - Your classmates may also benefit from seeing the answers to your questions.

  Here is the Piazza page:
  http://www.piazza.com/caltech/winter2026/acm95a100a/home
- Problem sets and exams will be graded via Gradescope.
  - If you are a **registered student**, you will be enrolled on Gradescope by the end of the 1st week of classes, and you will receive a notification from Gradescope about your enrollment.
    - Please make sure that the email that you use on Gradescope is your official Caltech email.
  - If you are a **registered student** but have not been enrolled on Gradescope by the end of the 1st week of classes, please email the Head TA as soon as possible and ask to enroll you to Gradescope. Your absence on Gradescope means that, according to my records, you are not registered for the course.
  - If you want just to **audit the course**, it is fine, you will have access to Piazza and all course materials there (please email me and I will enroll you on Piazza), but you will not have access to Gradescope and your submissions will not be graded. If you audit the course this year, you should not register for the course in the future.

  To submit your solution via Gradescope, you need to create a single PDF (not images) that contains the whole solution (for example, by scanning your solution), and then upload it to Gradescope. Here is a useful link:
  - How can I submit my homework as a PDF?
    https://guides.gradescope.com/hc/en-us/articles/21862105254413-How-can-I-submit-my-homework-as-a-PDF

  Should you have any questions regarding Gradescope, please ask on Piazza: we will have many experts there.

Suggested Study Process

To get the most out of ACM 95a/100a, here is my suggested study process[4]:

- **Have Enough Sleep**: Good sleep is an important prerequisite for learning.
- **Attend Lectures**: Focus on understanding the big picture of what is going on.
- **Review Lecture Notes**: Ideally on the same day they are released, make sure everything is clear.
- **Ask and Answer Questions**: If something is not clear, ask on Piazza; help your classmates by answering their questions.
- **Summarize in Your Own Notes**: After each lecture, very briefly summarize my notes, extract the essence.
- **Work on Practice Problems**: Attempt to solve the practice problems and review my solutions.
- **Attend Office Hours**: Interact with the instructor, TAs, and other students.
- **Start Early**: Begin each problem set on the day it is released (or as soon as possible after that).
- **Finish Early**: Aim to complete problem sets and exams at least one day before the deadline.
- **Stuck? Ask for Help**: If you get stuck on a problem set problem, ask for hints on Piazza

Keep in Mind

My goal is to help you understand and learn the material. Understanding is a creative process that takes time and effort. If you do not understand something, please ask me. If you are struggling to balance the workload, talk to me. If you have any concerns, let me know. Keep in mind that I am here to help.

Honor Code

"No member of the Caltech community shall take unfair advantage of any other member of the Caltech community."

[4] Based on Stanislav Dehaene, *How We Learn: The New Science of Education and the Brain*. 2020: Penguin Books Limited.