Efe Eroz

CURRICULUM VITAE

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EDUCATION

Princeton University **Sep. 2022 – May 2026**
Deg. Programs: Mechanical Eng., Aerospace Eng. – GPA: 3.94 *Princeton, NJ*
Minor: Computer Science

- MAT203: Adv. Multivariable Calc.
- MAT204: Adv. Linear Algebra
- MAE305: Differential Equations
- COS226: Algorithms/Data Struct.
- COS324: Intro ML (A+, 1st of 146)
- COS323: Comput. & Optim. (now)
- COS487: Theory Computation (now)
- MAE221: Thermodynamics
- MAE223: Solid Mechanics (A+)
- MAE222: Fluid Mechanics (A+)
- MAE335: Fluid Dynamics (A+)
- MAE423: Heat Transfer (now)
- MAE427: Energy Conversion (A+)
- MAE433: Automatic Control Systems
- MAE331/2: Aircraft Dyn. & Design
- MAE206: Intro Eng. Dynamics (A+)
- MAE324: Materials Science
- MAE321: Engineering Design
- PHY104: Elec./Magnetism (A+)
- PHY105: Adv. Mechanics
- CHM201: General Chemistry

Additional Selected (Non-Princeton) Courses: Multivariable Calculus & Differential Equations, Linear Algebra, Complex Analysis, Discrete Math, Quantum Physics, Thermodynamics, Optics, Analysis of Algorithms, Algorithms & Data Structures, Intro to Artificial Intelligence with LISP, Seminar in Statistical Research, Computational Methods, Spanish

MANUSCRIPT IN PREPARATION & CONFERENCES

- Journal paper in preparation for peer-reviewed Combustion Theory and Modeling journal.
- Conference talk at the 14th U.S. National Combustion Meeting (USNCM) in Boston (March, 2025): *paper link.*
- Upcoming conference talk at 78th APS Dep. of Fluid Dynamics conference in Houston (Nov. 2025)

RESEARCH EXPERIENCES

Research: Optimal Combustion Models | *w. Prof. Michael E. Mueller* **Summers ‘24, ‘25, IW, Thesis**

- **Description:** A priori assumptions made by practical combustion simulations can be leveraged to derive reduced-order, manifold-based combustion models governed by corresponding manifold equations. For three-stream, nonpremixed combustion, various assumptions about the mixing processes can be invoked to reduce the two-dimensional governing equations in Z_1 and Z_2 to one-dimensional equations in a mixture fraction-like variable, $\xi(Z_1, Z_2)$, parameterized by another mixing variable, $\eta(Z_1, Z_2)$. Asymptotic one-dimensional models – proposed previously in the literature – are shown to be a subset of a more general, continuous (infinite) class of one-dimensional models, and an “on-the-fly” LES simulation strategy is derived. This framework is also extended from three-stream combustion to combustion of arbitrarily many streams.
- **Condensed description:** Developed and implemented optimal, on-the-fly modeling approach for nonpremixed, n-stream combustion with my mentor, thereby relaxing the need to make asymptotic local mixing assumptions.
- **Skills:** Regular use of Python & Bash for data analysis; simulations were Fortran-based (used `Slurm` on University’s Tiger3 cluster). Learned distributed version control with `Git` and typesetting with LaTeX.
- **Research communication (external links):**
  - Journal paper under preparation for Combustion Theory and Modeling journal.
  - Presented this research via a conference talk at the 14th U.S. National Combustion Meeting (USNCM) in Boston (March, 2025): *paper link.*
  - Will present via a talk at the 78th APS Department of Fluid Dynamics conference in Houston, 2025.
  - Selected GitHub repos: *Repo 1 (general simulation analysis), Repo 2 (optimal model generalization).*
  - Princeton junior independent work (IW) course report: *paper link.*

Research Internship: Combustion Non-Monotonicities | *w. Prof. Michael E. Mueller (MAE)* **Summer ‘23**

- **Description:** By modeling nonpremixed, turbulent combustion with the fuel-side boundary condition varying linearly through composition space, non-monotonicities in the thermochemical state predicted by the group’s manifold solver, `PDRs`, were explored by means of measuring upstream and downstream reaction rates and by introducing dilution of the fuel boundary condition.
- **Skills:** Regular use of Python & Bash for data analysis and visualization; the simulations were Fortran-based.

Research Internship: Telecommunications | *Mentor: Prof. Tolga Duman (Bilkent EE Dept.)* **Summer ‘21**

- **Description:** We developed a telecommunications algorithm to incrementally improve the signal set (a collection of 2^k transmitted codewords, each with k information bits) for digital communication with $n \in \mathbb{Z}^+$ channel uses. Specifically, by empirically obtaining probabilities, p_{ij}, of confusing codeword $\vec{c}_i$ for codeword $\vec{c}_j$ for all $i, j \in \{1, \ldots, 2^k\}$, confusable pairs could be "pushed apart" in an n-dimensional hyperspace representation of the signal set. This greedy algorithm matched the performance of benchmark design codes on an additive white Gaussian noise (AWGN) channel as well as a more complex channel.
    - In designing this algorithm, I was inspired by the relatively basic idea of like-charge repulsion (Coulomb's Law) in the entirely different field of electrostatics. Because of this experience, I came to appreciate the notion that good ideas are often found at the intersection of different ways of thinking.
- **Condensed description:** Worked on the design/Python implementation of a new, geometry-inspired forward error correction technique for arbitrary channels; wrote paper.
- **Research poster link:** *link.*
- **Selected Honors & Awards (Telecommunications Research Internship):**
    - 2nd in nation among Engineering and Technology posters at National Junior Science & Humanities Symp. (JSHS) conference
    - Top 300 in nation: Regeneron STS Scholar (semifinalist)
    - American Institute of Aerodynamics & Astronautics (AIAA) YPSE Research Conference, High School Division: Honorable Mention (i.e., 2nd)

SELECTED HONORS & AWARDS

- Princeton Shapiro Prize for Academic Excellence (AY 23-24): Awarded to top ∼4% of Princeton class of 1,500
- Tau Beta Pi Engineering Honor Society: Awarded to top 1/8 of juniors in engineering majors
- National awards for algorithm developed in telecommunications research internship (high school):
    - 2nd in nation among Engineering and Technology posters at National Junior Science & Humanities Symp. (JSHS) conference
    - Top 300 in nation: Regeneron STS Scholar (semifinalist)
    - American Institute of Aerodynamics & Astronautics (AIAA) YPSE Research Conference, High School Division: Honorable Mention (i.e., 2nd)
- 3-time American Invitational Math Exam (AIME) qualifier: Scored 8 (top 0.7% of MAA participants)
- 1st place in the American Computer Science League (ACSL) All-Star Contest
- USA Physics Olympiad (USAPhO) Qualifier (in the top ∼400 F=ma contest scores)
- Other: Math Kangaroo 4th place nationally, UMD Math Comp. Hon. Mention (top 50/1,746)

EXTRACURRICULARS

- Previously, Princeton Undergrad. Research Journal (PURJ): Managing Editor of Peer Review for STEM Papers
    - PURJ is Princeton's 1st peer-reviewed undergrad journal. It focuses on communicating diverse research work carried out by undergrads of any major using non-specialist, accessible language.
    - As Managing Editor of Peer Review for STEM Papers, I helped coordinate a board of >30 undergrads and faculty, pairing manuscripts with the appropriate student/faculty reviewers, helping with peer review, selecting final manuscripts to be published, and helping authors improve their work. *Spring '24 Issue.*
- Princeton Rocketry IREC Team Avionics and, previously, Princeton High Power Rocketry Team
    - Helping design solid-fuel rocket to reach 30,000 ft. with CubeSat payload (launched in Midland, Texas). Proposed an approach for airbrake control to avoid overshooting target altitude.
- Princeton University Engineers without Borders Ecuador Team: Implementing safe, reliable water system
- Previously, Princeton Robotics Team (Drone Subteam) and Princeton Engineering Council Vice Publicity Chair
- Teaching: gave free, online math courses to interested students nationwide (probability theory, number theory).
    - With the transition to virtual learning due to the pandemic, I noticed many younger students (like my little brother) weren't getting as much instructional time or help with their questions. To do my small part to help out, I taught free basic math courses every week on probability theory and number theory to students nationwide via Zoom.
- Teaching: volunteered at Princeton SPLASH program for high schoolers, teaching introductory fluid mechanics.
    - I really enjoyed learning about fluid mechanics at Princeton, and I decided to teach a course on it at the one-day Princeton SPLASH program for local high schoolers. We discussed the governing relationships in a conceptual way (without using calculus), culminating in Bernoulli's equation and a justification of the "Magnus effect" which underlies curveballs in sports.

- Volunteered for more than 400 hours, including: food pantry for 5 years and volunteer assistant sports coach.
- Community Living Adviser (CLA) for 90-100 students/year at Princeton during junior and senior year.
  - Foster an inclusive community for upperclass students by holding study breaks, connecting students with University resources, and upholding community standards. Managed yearly activity budget of $\$1,000$.
- Princeton Beekeeping and, previously, Princeton Garden Project and Princeton Ultimate Frisbee Team

SELECTED COURSEWORK & PROJECTS

- **Complete Conceptual Design of Long-Range Aircraft:** Design of a long-range, mid-size (170 passenger) aircraft with `OpenVSP` software. MAE332 mid-semester assignment.
- **Brief Linearized Stability Analysis of Aircraft:** Linearizing the differential equations governing an aircraft's motion about an equilibrium state (in particular, steady, wings-level flight) allows for a decoupling of the longitudinal and lateral motions assuming the perturbations are sufficiently small. Using the eigenvectors of the corresponding state space matrices as initial conditions reveals well-known flight "modes," that are analyzed and tied back into flight control and safety. MAE331 assignment.
- **Static Longitudinal Stability Analysis of Aircraft:** After deriving criteria for static longitudinal stability from first principles reasoning, `VSPAero`'s vortex lattice and panel methods are used to assess the stability of the Macchi MB339 aircraft. MAE331 assignment.
- **API-Based Weather Software:** Pulls and interactively graphs short-term data for any location.

SOFTWARE & MISCELLANEOUS

- Software: Python, Java, MATLAB, Bash (Linux CLI), Fortran, distributed version control with Git, LaTeX typesetting, Lisp, Creo & Autodesk, Minitab (statistics), computing cluster use (workload managed by Slurm).
- Languages: English (native), Spanish (intermed.), Turkish (intermed.) | Other: US Citizen