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/146)
- COS323: Comput. & Optim. (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
- MAE345: Intro to Robotics (now)
- 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

RESEARCH EXPERIENCES

Research: Optimal Combustion Models | *w. Prof. Michael E. Mueller (MAE)* **Summers '24 & '25 & IW**

- **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.
- **Condensed description:** Developed and implemented optimal, on-the-fly modeling approach for nonpremixed, 3-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` to interact with University's computing cluster). Learned distributed version control with `Git` and typesetting with LaTeX.
- **Research communication (external links):**
  - Presented this research via a conference talk at the 14th U.S. National Combustion Meeting (USNCM) in Boston, 2025: *paper link.*
  - Journal paper under preparation for Combustion Theory and Modeling journal.
  - GitHub Repository Links: *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.
- **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:
  - 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 (in the 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 Selected Awards: Math Kangaroo 4th place nationally, UMD Math Comp. Hon. Mention (top 50/1,746)

EXTRACURRICULARS

- Princeton Rocketry IREC Team Avionics and, previously, Princeton High Power Rocketry Team
  - Building solid-fuel rocket to reach 30,000 ft. with CubeSat payload (launched in Midland, Texas)
- Princeton University Engineers without Borders Ecuador Team: Implementing safe, reliable water system
- Previously, Princeton Undergrad. Research Journal (PURJ): Managing Editor of Peer Review for STEM Papers
  - Princeton's 1st peer-reviewed undergrad. journal: Coordinated board of >30 undergrads and faculty
- 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). Founded Elegant Bees platform. Volunteered at Princeton SPLASH, teaching introductory fluid mechanics.
- Volunteered for more than 400 hours, including: food pantry for 5 years and volunteer assistant coach.
- Princeton Beekeeping and, previously, Princeton Garden Project and Princeton Ultimate Frisbee Team
- Community Living Adviser (CLA) for around 90 students at Princeton

SELECTED PROJECTS & COURSEWORK

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