Efe Eroz

——————————— CURRICULUM VITAE ———————————

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EDUCATION

Princeton University **September 2022 – May 2026 (expected)**
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

Optimal Modeling of 3-Stream Combustion | *Mentor: Prof. Michael E. Mueller (MAE)* **Summer ‘24 & IW**

- **Description:** To reduce the dimensionality of the thermochemical state-space required to describe turbulent combustion, practical simulations often make a priori assumptions about the nature of the combustion. These assumptions can be leveraged to derive manifold-based combustion models governed by corresponding manifold equations. This work explores such assumptions for three-stream turbulent nonpremixed combustion, which would be fully described by two-dimensional manifold equations in two mixture fractions, Z_1 and Z_2. To simplify further, various assumptions about the mixing processes can be invoked to reduce these two-dimensional equations 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” simulation strategy is derived for this more general class of models based on the relative gradient sizes of ξ and η.
- **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 3-day 14th U.S. National Combustion Meeting (USNCM) in Boston, MA from March 17th-19th, 2025: *paper link.*
  - Journal paper under preparation (not yet sent for peer review).
  - GitHub Repository Links: *Repo 1 (general simulation analysis), Repo 2 (optimal model generalization).*
  - Princeton junior independent work (IW) course report: *paper link.*

Non-Monotonicities in Combustion Simulation | *Mentor: Prof. Michael E. Mueller (MAE)* **Summer ‘23**

- **Description:** By simulating nonpremixed, turbulent combustion with the fuel boundary condition composed of various mixtures of toluene and n-heptane, non-monotonicities in the thermochemical state predicted by the group’s manifold solver, `PDRs`, were explored. Put concretely, the “profiles” for some of the chemical compounds’ mass fractions not only varied nonlinearly as the fuel composition changed from pure toluene to pure n-hetpane but also varied *non-monotonically.* These non-monotonicities were explored by means of measuring upstream and downstream reaction rates and investigating the effects of diluting 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:** To achieve reliable digital communication, a well-known technique is the controlled addition of redundant data to the information-carrying signal in a manner known by both the transmitter and the receiver. With recent technological advances, efficient analytical redundancy addition techniques exist when the transmit message size is large and when the transmission medium (i.e., the channel) has a mathematically tractable model. For more complex channels or shorter messages, however, there is still room for improvement. For this case, we developed an algorithm to incrementally improve the signal set instead of using analytical design methods. The approach can be explained by supposing k information bits must be transmitted with $n \in \mathbb{Z}^+$ channel uses, subject to some power constraint. By empirically obtaining probabilities, p_{ij}, of "confusing" codeword $\vec{c}_i$ for codeword $\vec{c}_j$ for all $i, j \in \{1, \ldots, 2^k\}$, each pair of codewords can be "pushed apart" in n-dimensional hyperspace. This greedy algorithm incrementally improves error rate and matched the performance of benchmark design codes on an additive white Gaussian noise (AWGN) channel and 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 4-day National Junior Science & Humanities Symp. (JSHS) conference held in Albuquerque, New Mexico
  - 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
- 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 4-day National Junior Science & Humanities Symp. (JSHS) conference held in Albuquerque, New Mexico
  - 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 (launch 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
  - Pton's 1st peer-reviewed undergrad. journal: Coordinated board of 20 Pton undergrads and dozen 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 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, 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

Last updated 05/24/25