HARICHARAN BALASUNDARAM

ep21b015@smail.iitm.ac.in · Website · GitHub

EDUCATION

Indian Institute of Technology, Madras **CGPA: 9.57/10.00, Department Rank 1**

B.Tech (Hons.) in Engineering Physics + M. Tech. in Electrical Engineering *Nov 2021 - Present*
Minor in Computer Science

ACCEPTED PUBLICATIONS

1. **Estimating Error in Natural Distribution Estimation** [LINK]
   H. Balasundaram, A. Thangaraj. *Annual Allerton Conference on Communication, Control, and Computing 2025.*
2. **Stability Notions for Hospital Residents with Sizes** [ARXIV]
   H. Balasundaram, Krishnashree J. B., G. Limaye, M. Nasre. *Foundations of Software Technology and Theoretical Computer Science 2025.*

ONGOING PUBLICATIONS

1. **Learning to Transmit Over Unknown Erasure Channels with Empirical Erasure Rate Feedback** [ARXIV]
   H. Balasundaram, K. Jagannathan.
2. **Generalized Capacity Planning for the Hospital-Residents Problem** [ARXIV]
   H. Balasundaram, G. Limaye, M. Nasre, and A. Raja. *Submitted to Elsevier Theoretical Computer Science.*

AWARDS AND ACHIEVEMENTS

- Presented research at *Allerton Conference* held at University of Illinois, Urbana–Champaign in the *Informational Characterization* Session
- Sole undergraduate recipient of **Teaching Assistant Recognition Award (TARA)** 2025 in the EE Dept for serving as **Head TA**.
- Recipient of *Ms. Latha and Sampath Srinath* prize for **Highest CGPA** in semesters 3 and 4 in the Engineering Physics program.
- Achieved an **JEE Advanced** All India Rank of **1153** and **JEE Mains** All India Rank of **2565** out of over 1 million candidates.
- Attained **Candidate Master** title on **Codeforces** Competitive Programming, securing Global Rank #59 in Round #886 among 25,000 participants.

RESEARCH EXPERIENCE

UNIFORMITY TESTING OF THE MISSING MASS
Guide: Prof. Andrew Thangaraj, Department of Electrical Engineering, IIT Madras *Feb 2025 - Present*

- Studied **distribution estimation** of an unknown discrete distribution over large a alphabet, where *natural estimators* incur large error
- Introduced a novel **error statistic** that captures the unavoidable estimation error at frequency l and proposed a *non-linear estimator* for this
- Proved low bias and consistency for the estimator and validated the approach using simulations on **synthetic and natural language datasets**

CONSTRAINED ONLINE CONVEX OPTIMIZATION WITH ADVERSARIAL CONSTRAINTS
Guide: Prof. Rahul Vaze, School of Technology and Computer Science, Tata Institute of Fundamental Research *May 2025 - Present*

- Addressed the problem of **constrained online convex optimization (COCO)**— simultaneous minimization of regret and constraint violation
- **Improved analysis** for the existing gradient descent method, thus breaking the long-standing $O(\sqrt{T})$–cumulative constraint violation bound
- Provided lower bound of $O(T^{\beta})$–regret and $O(T^{1-\beta})$–cumulative constraint violation, confirming the optimality of pre-existing algorithms

LEARNING TO TRANSMIT OVER UNKNOWN ERASURE CHANNELS [B. TECH. PROJECT]
Guide: Prof. Krishna Jagannathan, Department of Electrical Engineering, IIT Madras *Dec 2023 - May 2025*

- Developed algorithms for **transmission over erasure channels** with unknown erasure rates, using limited empirical erasure feedback
- Proposed and analyzed two strategies: **Estimate-then-Transmit** (1 query, $O(T^{2/3})$ regret) and **Windowing** (logarithmic queries, $O(\sqrt{T})$ regret)
- Established **theoretical regret guarantees** and validated performance through simulations, showing applicability to low-feedback IoT systems

APPROXIMATION ALGORITHMS FOR HOSPITAL-RESIDENT MATCHINGS
Guide: Prof. Meghana Nasre, Department of Computer Science, IIT Madras *Oct 2023 - Nov 2024*

- Developed **approximation algorithms** and **inapproximability results** for *capacity* and *quota augmentation* in the **Hospital–Residents** setting
- Analyzed **the Hospital–Residents problem with Sizes (HRS)**, studying *occupancy-stability* and designing efficient approximation algorithms

MANY-TO-ONENESS OF LATTICE FILTERS
Guide: Prof. C. S. Ramalingam, Department of Electrical Engineering, IIT Madras *Sep 2023 - Nov 2023*

- Utilized **MATLAB** to carry out **brute-force calculations** to determine the *oddness or evenness* of lattice coefficients
- Explored **conditions on one-oneness and many-oneness** of the mapping from *lattice coefficients to transfer functions*

CONTROL SYSTEMS FOR REHABILITATION [PYTHON PACKAGE]
Guide: Prof. Sourav Rakshit, Gait and Motion Analysis (GAMA) Lab, Machine Design Section, IIT Madras *Sep 2022 - Jan 2023*

- Applied **LQR**, **iLQR**, and **SAC** control systems for trajectory tracking in **gait training of paralyzed patients**, achieving 75% accuracy
- Created **Python package** and contributed to *open-source repository* for implementing **LQR** to achieve *multi-motor position control*

TEACHING EXPERIENCE

- **Head Teaching Assistant (TA)** for Signals and Systems (EE1101), oversaw 400+ students and coordinating with 6 faculty members– **TA award**
- **TA** for Multirate Digital Signal Processing, Probability Foundations– formulated assignments and conducted tutorial sessions
- **Shaastra 2023:** conducted workshop on Cryptography and **Shaastra 2024:** conducted workshop on Probability, Statistics and Finance
- Conducted information session on **Fundamentals of Mathematics and Programming** to incoming freshers in 2023

RELEVANT COURSEWORK

EE:	Information Theory	Estimation Theory	Detection Theory	Convex Optimization
	Multirate DSP	RF and Optical Communication	Communication Networks	Linear Algebra
	Probability and Statistics	Mathematical Physics	Advanced Topics in Communications (5G)	
Minor in CS:	Approximation Algorithms	Parameterized Algorithms	Advanced Graph Algorithms	Linear Programming

PROFESSIONAL EXPERIENCE

SOFTWARE DEVELOPER INTERN AT D. E. SHAW INDIA
Using LLMs to Automate Processing Vendor Emails *May 2024 - Jul 2024*

- Built **Python pipelines** to process and validate large-scale financial data, improving speed and accuracy of business operations
- Applied **LLMs** to automate vendor **email classification** and data extraction, reducing manual effort and streamlining workflows

SELECTED COURSE PROJECTS

EE5111: ESTIMATION THEORY [SLIDES]
Prof. Sheetal Kalyani, EE Department, IITM *May 2025*

- *Source Enumeration using Linear Shrinkage Coefficients*— addressed limitations of existing source enumeration methods in **low SNR** regimes
- Introduced a *running average–based filter* on the shrinkage coefficients to enhance detection accuracy
- Achieved better results than traditional methods for **source enumeration** under colored noise, with applications to wireless communications

EE5143: INFORMATION THEORY [SLIDES]
Prof. Andrew Thangaraj, EE Department, IITM *Feb 2024*

- Presented **Lempel-Ziv compression algorithms (LZ77 and LZ78)**, focusing on information-theoretic analysis and optimality
- Compared **advantages** of LZ compression over Huffman-coding, explained practical applications such as **'gzip'** and **'GIF'** formats

CS6130: ADVANCED GRAPH ALGORITHMS [SLIDES]
Prof. Meghana Nasre, CS Department, IIT Madras *Apr 2024*

- Presented '*Vital Edges for* (s,t)*–min-cut*': classification into tight and loose vital edges and a general **Maxflow-Mincut theorem**
- Explained utilization of **data structure** (*ancestor tree*) to compute all tight edges and **bounded** the number of **loose edges**

EE5121: CONVEX OPTIMIZATION [POSTER]
Prof. Uday Khankhoje, EE Department, IIT Madras *Nov 2023*

- Poster presentation on the paper '*Subsampled Hessian Newton methods for solving supervised learning problems*'
- Achieved **12% improvement** on overqualified constraint datasets by integrating approximate Hessian direction with the gradient

CS6841: APPROXIMATION ALGORITHMS [SLIDES]
Prof. Meghana Nasre, CS department, IIT Madras *Nov 2023*

- Presented an **approximation algorithm** for the '*Connected Dominating Set problem using only local information*' in graphs
- Proved that the algorithm achieved a H_n–approximation factor, **matching the theoretical lower bound** on approximation

POSITIONS OF RESPONSIBILITY

HEAD AND FOUNDER
Mathematics Club, Centre for Innovation, IITM *Nov 2022 - Mar 2024*

- **Co-founded and headed the Mathematics Club** at IIT Madras, building a community with a reach of 1000+ students
- **Conducted sessions** on number theory, probability, and linear algebra and **headed projects** on probability and group theory for **Open House**
- **Supervised a cohort of 76 members**, including 4 project leads, 15 coordinators, and 57 deputy coordinators during 2023–24

EXTRA-CURRICULAR ACTIVITIES

- Presented Mathematics Club achievements at the **G20 Global Summit** held at IIT Madras to national and international delegates
- **Bronze Medal** in the Inter-IIT Tech Meet Quant Competition (Dec 2023)
- Heading the **Communications Problem Statement** at Inter-IIT Tech Meet '25
- Member of the **Quiz Club IITM**, winner of Shaastra SciTech Quiz '25
- **Strategist** in the Programming and Cybersecurity clubs
- Selected for **ICPC Regionals** at Amritapuri
- **Press Correspondent** for *The Fifth Estate*, IITM's newsletter