# Haricharan Balasundaram

Email ◇ Website ◇ GitHub

## EDUCATION

Indian Institute of Technology Madras — Chennai, India

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

**CGPA: 9.50/10.00, Department Rank 1**

## AWARDS AND ACHIEVEMENTS

- Recipient of *Ms. Latha and Sampath Srinath* prize for **highest CGPA** in semesters 3 and 4 in the Engineering Physics department
- Presented achievements of Mathematics club at **G20 Global Summit** held at IIT Madras to international delegates

## RESEARCH EXPERIENCE

### Multi-Armed Bandits on Budgeted Erasure Channels

*Guide: Prof. Krishna Jagannathan, EE Department, IIT Madras* — *Dec 2023 - Present*

- Working on MAB formulation for **maximizing successful information** sent in erasure channels with **unknown erasure rates**
- Tested analogies of MAB strategies such as **$\epsilon$-first** and **Successive Arm Elimination (SAE)** to measure asymptotic performance
- Determined **sublinear** ($\sqrt{T}\log^2(T)$) dependence of exploration fraction on the budget $T$ (**exploration-exploitation strategy**)
- Attended **National Communications Conference (NCC '24)** organized by department of EE, IIT Madras

### Approximation Algorithms for Hospital-Resident Matchings

*Prof. Meghana Nasre, CSE Department, IIT Madras* — *Oct 2023 - Aug 2024*

- Worked on **approximation algorithms** for minimum-cost envy-free perfect matchings in bipartite graphs with two-sided preferences
- Formulated ***Integer Linear Program (ILP)*** formulations for cost-based envy-free perfect many-to-many bipartite matchings
- Proved **constant factor inapproximability** in the cost-based setting with envy penalties for bipartite matchings
- Proved that there is no $\ell_{\mathbf{a}} - \epsilon$ approximation algorithm, using a **reduction from vertex cover** under the unique games conjecture

### Many-to-oneness of Lattice Filters

*Prof. C. S. Ramalingam, Dept. of EE, IITM* — *Aug 2023 - Nov 2023*

- Used MATLAB for **brute-force calculations** to determine the oddness or evenness of lattice coefficients
- Explored conditions on lattice coefficients which lead to **many-one lattice filters** and discovered lattice filters without pre-images

### Control Systems for Rehabilitation [Repo]

*Prof. Sourav Rakshit, Gait and Motion Analysis (GAMA) Lab, Machine Design Section, IIT Madras* — *Nov 2022 - Jan 2023*

- Worked on **trajectory tracking** using advanced control systems including Linear-Quadratic Regulator (LQR), iterative LQR (iLQR), and Soft Actor-Critic (SAC) for **gait training of paralyzed patients**, with 75% accuracy
- Contributed to **Open Source Repository** in implementing LQR to achieve multiple-motor position control

## PROFESSIONAL EXPERIENCE

### Software Developer Intern at D. E. Shaw India

*Using LLMs to Automate Processing Vendor Emails* — *May 2024 - Jul 2024*

- Designed **Python pipelines** to assist operations teams in processing critical financial data for business systems
- Leveraged LLMs to **automate the classification** of vendor **emails**, streamlining communication and data extraction

## RELEVANT COURSEWORK

**Electrical Engineering:** Advanced Topics in Communication (5G), Information Theory, Convex Optimization, Multirate DSP

**Minor in CS:** Approximation Algorithms, Parameterized Algorithms, Advanced Graph Algorithms, Linear Programming

## COURSE PROJECTS

**CS6130: Advanced Graph Algorithms** [Slides]
*Prof. Meghana Nasre, CS Department, IIT Madras* *Apr 2024*

- Presented the paper '*Vital Edges for $(s,t)$–min-cut: Efficient Algorithms, Compact Structures, and Optimal Sensitivity Oracle*'
- Presented **classification of vital edges** into tight and loose vital edges and a generalization of the **Maxflow-Mincut theorem**
- Explained utilization of **data structure** (*ancestor tree*) to compute all tight edges and **bounded** the number of **loose edges**

**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

**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*'
- **Improved descent direction** by integrating approximate Hessian direction with gradient, leading to better optimization outcomes
- Achieved a **12% improvement** in optimizing **overqualified constraint datasets** using the improved descent technique

**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
- Improved bounds on the proof of the approximation guarantee to get a **smaller constant factor** in restricted cases

**EE6133: Multirate Digital Signal Processing**
*Prof. Aravind, EE Department, IIT Madras* *Oct 2023*

- Implemented a 2-channel Cosine Modulated Filter Bank (CMFB) for reconstructing music and speech signals without aliasing
- Additionally, reviewed audio compression techniques using the MP3 standard

## TEACHING EXPERIENCE

- **Head Teaching Assistant** for Signals and Systems (EE1101), overseeing 400+ students and coordinating with 6 faculty members
- **Teaching assistant** for Multirate Digital Signal Processing (EE6133), formulated assignments and conducted tutorial sessions
- **Shaastra 2023:** conducted workshop on Cryptography and **Shaastra 2024:** conducted workshop on Quantitative Finance
- Conducted information session on **Fundamentals of Mathematics and Programming** to incoming freshers in 2023

## POSITIONS OF RESPONSIBILITY

**Head and Founder**
*Mathematics Club, Centre for Innovation, IITM* *Nov 2022 - Mar 2024*

- **Co-founder** and **Head of Mathematics Club**, Centre for Innovation, IITM with a reach of 1000+ students
- **Led sessions and workshops** on number theory, quintic unsolvability, game theory, probability, and linear algebra
- **Directed and managed projects** on Probability and Stochastics, Nonlinear dynamics and Group Theory for **CFI Open House**
- Supervised a cohort of 4 project leads, 15 coordinators, and 57 deputy coordinators

**Core Team Member**
*Programming Club, Centre for Innovation, IITM* *Apr 2023 - Mar 2024*

- Conducted sessions on **Competitive Programming**, covering topics like Graphs and Dynamic Programming for students
- Created popular **video editorials** for Codeforces rounds and curated contests using Polygon platform

## EXTRA-CURRICULAR ACTIVITIES

- Secured **Bronze medal** in Inter-IIT Tech Meet Quant Competition held in December 2023 by producing alphas using stock data
- **Candidate Master** in Codeforces Competitive Programming, Global Rank #59 in Round #886 among 25000 participants
- Trained in **Carnatic Keyboard** for 5 years and performed Carnatic keyboard in two concerts (2012 and 2015)
- **Press Correspondent** for The Fifth Estate, IITM: the institute's *independent student media body*