Pursuing **Honours** in **Electrical Engineering** and **Minor** in **Artificial Intelligence & Data Science**

Scholastic Achievements

- **Department Rank 3** in a batch of 103 students
- Awarded **8 AP Grades** (Advanced Performer) for outstanding performance in courses including Control Systems, Electronic Devices and Circuits, Analog Circuits, Signal Processing, Calculus-I given to the **top 1%** of the batch
- Secured **All India Rank 277** in JEE Advanced 2020 among 1,50,000 candidates
- Secured **All India Rank 280** in JEE Mains 2020 among 6,00,000 candidates
- Awarded the prestigious **Kishore Vaigyanic Protsahan Yojana (KVPY)** fellowship
- Placed among the National **top 1%** in NSEP, NSEC and Maharashtra (State) **top 1%** in NSEA

Key Projects and Experience

Surrogate Optimization in QAOA | *Internship*

Guide: Dr. Paweł Gora, QWorld and the Quantum AI Foundation *(July '22 - Present)*

- Studying methods for the selection of relaxation parameters to solve **constrained binary optimisation problems**
- Working on extending approaches involving penalty modification based on **Spectral Decomposition** of constraint QUBO matrices to solve the **Travelling Salesman Problem** using stochastic solvers like **Simulated Annealing**
- Analysing the use of **Classically-inspired Warm-Starts** based on the **Burer-Monteiro** relaxation to outperform the seminal **Goemans-Williamson** algorithm on NP-Hard problems like Travelling Salesman and Max-Cut

Quantum Learning Theory | *Internship*

Guide: Prof. Rahul Jain, Centre for Quantum Technologies, NUS *(May '22 - July '22)*

- Explored the method of **Classical Shadows** which allows for efficient storage of unknown quantum states
- Reviewed the separation between Classical ML and Quantum ML pertaining to **Query Complexity** in tasks which involve learning an **unknown CPTP map**, using average prediction error and worst-case error as metrics
- Analysed the advantage in using classical ML over classical randomized algorithms to efficiently learn **classical representations of the ground state of Hamiltonians** which shows the power of data in Machine Learning

Particle Swarm Optimization on the IITB HPC | *Guided Project*

Guide: Prof. M. B. Patil, Department of Electrical Engineering, IIT Bombay *(May '22 - Present)*

- Utilised various **OpenMP primitives** by parallelising serial workloads like tensor product computations
- Working on implementing the **Particle Swarm Optimisation** algorithm on the IITB HPC and benchmarking the speedup gained using multithreading. Studying applications of the PSO algorithm in **Circuit Optimisation**

CISC and RISC Processor Design | *Course Project*

Guide: Prof. Virendra Singh, Department of Electrical Engineering, IIT Bombay *(March '22 - May '22)*

- Designed a micro-coded **8085-like CISC processor** using the Hardware Flowchart Method
- Designed a 16-bit multi-cycle **RISC processor** with a 17 instruction, Turing complete ISA and tested the design on the **Altera Cyclone IV E** FPGA by carrying out state reduction resulting in an FSM of **19** states
- Optimised the RISC design for performance by including **Forwarding** and **Branch Prediction** techniques

Predicting the RUL of EV Batteries | *Course Project* *November '21 - December '21*

- Designed a Machine Learning Pipeline to predict the **Remaining Useful Life** of Li-ion batteries for EV applications
- Performed a thorough EDA that suggested using indirect parameters like **Battery Temperature** and **Voltage**
- Trained multiple models like **Support Vector Regressors**, **Random Forests** achieving an **R2 score** of 0.98

Optical Quantum Computing | *Reading Project*

Guide: Prof. Alok Shukla, Department of Physics, IIT Bombay *(May '21 - July '21)*

- Studied **Quantum Mechanics** from *Modern Quantum Mechanics* by Sakurai and Napolitano and learned about **Photonic Quantum Computers** from *Five Lectures on Optical Quantum Computing* by Pieter Kok. Topics included the **KLM Protocol** and **Measurement-based Quantum Computing**

Other Projects

Digital Circuit Design | *Course Project*   *(July '21 - Present)*
Guide: Prof. Maryam Shojaei Baghini, Department of Electrical Engineering, IIT Bombay
- Studied **Structural** and **Behavioural modelling** by synthesising circuits in **Intel's Quartus** tool and testing the design on the **Altera MAX-V** CPLD breakout board. Implemented an **Arithmetic Logic Unit (ALU)**, **String Recognizer** and **ATM coin dispenser** in VHDL and tested the design using **urJTAG** and **Scanchain**

Prefix Adders & Logic Minimization | *Self Project*   *(November '21 - December '21)*
- Designed Parallel Prefix Adders like the **Kogge-Stone**, **Brent-Kung** and **Sklansky** Adders for 8-bit Addition using **Structural Modelling** in VHDL. Came up with a reusable design for any prefix adder configuration
- Implemented a SAT Solver in C++ using the **DPLL (Davis-Putnam-Logemann-Loveland) Algorithm** and improved its backtracking capabilities of the algorithm using **Unit Propagation** and **Pure Literal Elimination**
- Implemented the **Quine-McCluskey Algorithm** which is used for the minimisation of Boolean functions in C++

Brain-Computer Interface | *Institute Technical Summer Project*
Institute Technical Council, IIT Bombay   *(March '21 - July '21)*
- Part of a four-member team that built a Machine Learning pipeline to play **Atari's Breakout** game using a person's thoughts in the form of EEG data. Declared as one of the **top 6** projects out of 60 proposals in ITSP
- Developed a complete playable version of the game **Breakout** from scratch in Python using the **PyGame** library
- Used popular EEG data pre-processing schemes like the **FFT** and **Wavelet Transform** and implemented a **Convolutional Neural Network** with spatial and temporal filters from scratch, achieving an accuracy of **75%**

Snake Game | *Summer of Code Project*
Web and Coding Club, IIT Bombay   *(March '21 - July '21)*
- Studied **On-policy and Off-policy Reinforcement Learning methods** from *Reinforcement Learning - An Introduction* by Sutton and Barto, and notes by *Prof. Shivaram Kalyanakrishnan*
- Developed a complete playable version of the game **Snake** from scratch in Python using the **PyGame** library
- Utilised algorithms like **SARSA**, **Q-Learning**, **Expected-SARSA** to play the game achieving a **60+** score

The Lasso Game | *Course Project*   *(February '21 - March '21)*
Guide: Prof. Bhaskaran Raman, Department of Computer Science & Engineering, IIT Bombay
- Implemented the **Lasso Game** using IIT Bombay's C++ library, **Simplecpp**. Followed an OOP paradigm by adding classes for Bombs, Speedup Coins and Magnets bringing complexity to the basic game mechanism

Technical Skills

Programming	C, C++, Python, Java
Software	MATLAB, Octave, Git, Arduino, GNU Radio, Quartus
Machine Learning	TensorFlow, Keras, PyTorch, Scikit-Learn
Python Libraries	NumPy, Pandas, Matplotlib, Seaborn, SciPy
Miscellaneous	LaTeX, Qiskit, Q#, OpenMP

Courses Undertaken

Electrical Engineering	Introduction to Electrical Engineering Practice, Power Engineering, Analog Circuits, Digital Systems, Digital Systems Lab, Signals and Systems, Probability and Random Processes, Electronic Devices Lab*, Electromagnetic Waves*, Control Systems Lab*, Communications Lab*, Communications System-I*
Computer Science	Computer Programming and Utilization, Programming for Data Science, Introduction to Machine Learning, Image Processing*, Advances in Computer Architecture*, Foundations of Intelligent and Learning Agents*
Quantum Computing	Quantum Physics and Applications, Quantum Information and Computing
Mathematics	Calculus, Linear Algebra, Differential Equations, Complex Analysis
Online Courses	Mathematics for Machine Learning (Imperial College London), Machine Learning (Stanford University), Deep Learning (deeplearning.ai), Nand2Tetris (Hebrew University of Jerusalem)

Miscellaneous

- Completed a year-long course on **Quantum Computing** organized by **The Coding School & IBM**
- Participated in the **Fall 2020**, **Summer 2021** and **Fall 2021** editions of the **IBM Quantum Challenge**
- Completed an intensive 2 week course on **Quantum Machine Learning** organised by IBM
- One of the youngest out of nearly **60** participants in the **ACM 2021 Europe Summer School** on **HPC Computer Architectures for AI and Dedicated Applications**
- One of the **top 60** participants in the **QHack Coding Challenge** organised by Xanadu
- Mentored students in **Quantum Information** and **Computing** by curating resources and answering doubts