# Pulkit Bhardwaj

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## Academic Qualifications

| Year | Degree/Certificate | Institute | CPI/% |
|---|---|---|---|
| 2023-2027 | B.Tech-Chemical Engineering | Indian Institute of Technology Kanpur | 7/10 |
| 2023 | CBSE(XII) | Dev Samaj Vidya Niketan School, Gurgaon | 94.4% |
| 2021 | CBSE(X) | Dev Samaj Vidya Niketan School, Gurgaon | 93.2% |

## Scholastic Achievements

- Secured **All India Rank 5649** in JEE Advanced 2023 among the 1.9 Lakh shortlisted candidates. *2023*
- Secured the **First** rank in academics among 120+ students for **8 consecutive** years in School. *2016-2023*
- Earned **Bronze Level** recognition in the **WorldQuant Challenge** for applying predictive modeling techniques. *2024*

## Work Experience

**Optimizing DELM via Small-World** | Winter Intern
Mentor: **Prof. R.M. Hegde, Dept. of Electrical Engineering**, IIT Kanpur *(Nov'24 - Jan'25)*

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| **Objective** | • Developed a **high-speed** DELM model as an alternative to traditional backpropagation-based neural networks |
| **Approach** | • Implemented **small-world architecture** with randomized **inter-layer** connections to boost model efficiency<br>• Enhanced accuracy via **optimal node selection** using weight analysis and **activation value analysis**<br>• Experimented with **learning methods**, number of nodes and implemented **iterative weight storage** solution<br>• Enhanced DELM stability and accuracy using optimal node selection using different methods like weight analysis, activation value analysis, gradient based sensitivity analysis, etc., implemented small world with random inter-layer connections, regression-based training, tried other training models as well like, Moore-Penrose Pseudoinverse, QR Decomposition, etc., and iterative weight adjustments to enhance model performance. |
| **Impact** | • Achieved **100% stability** on Concrete dataset with **15x lower training time**( 7-8 seconds compared to 120 seconds in traditional backpropagation models) and reduced RMSE compared to backpropagation models( 4-5 in DELM compared to 6-6.5 in slow backpropagation models); delivered similar results on **Parkinson and Energy** datasets |

## Key Projects

**CycleGANs: Translating Images** | IITK Consulting Group | IIT Kanpur *(May'24 - Jul'24)*

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| **Objective** | • Built a **CycleGAN** model to perform **unpaired**, high-quality **image-to-image translation** across domains |
| **Approach** | • Used GAN architectures like **Pix2Pix, PatchGAN**, and **DCGAN** to improve translation quality and stability<br>• Applied ML techniques such as **PCA, k-means**, regression, **ANN**, and **CNN** to optimise model performance |
| **Results** | • Achieved **Realistic** image translation in domains like (day ↔night, horse↔ zebra, orange↔ apple), **without paired datasets** |

**Mutual Fund Return Prediction & Portfolio Suggestion System** | Self Project
(*May'25-Jul'25*)

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| **Objective** | • Developed a **TFT** model to predict **Mutual Fund returns** and **optimal investment distribution** |
| **Approach** | • Scraped and cleaned monthly and annual return data for **80+ Mutual Funds** from **ETmoney** and **AMFI**.<br>• Built a **TFT**, and implemented allocation strategy to suggest portfolio in **top-performing and stable** funds. |
| **Result** | • Achieved **8% return** on test data with portfolio suggestions balancing growth and risk stability |

**Forecasting using Time Series** | Stamatics Society, IIT Kanpur (*May'24 - Jul'24*)

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| **Objective** | • Developed robust **time series forecasting models** to predict short-term and long-term trends in real-world datasets using advanced **machine learning** and **statistical techniques**. |
| **Summary** | • Implemented classical models such as **ARIMA** and volatility-focused models like **GARCH** to capture trends, seasonality, and fluctuations in time-dependent data.<br>• Designed and trained **LSTM-based deep learning models** to capture complex temporal dependencies and improve long-range forecast accuracy.<br>• Conducted rigorous **data preprocessing, feature engineering,** and **hyperparameter tuning** to enhance prediction reliability across noisy, real-world datasets.<br>• Compared model performance through evaluation metrics (e.g., **MAE, RMSE**) and selected optimal models for deployment. |

## Course Project — Mass Transfer (CHE213) — Prof. Himanshu Sharma

**Title:** Charcoal Reuse for Cost-Effective Adsorption Applications
**Objectives:**

- Proposed an innovative approach to enable the reuse of charcoal used in adsorption processes, which is typically discarded after single use, leading to significant material wastage.

- Aimed to develop a practical method for regenerating used charcoal while maintaining its adsorption efficiency comparable to fresh charcoal.

**Approach:**

- Conducted multiple small-scale experimental trials using beaker setups to test different chemical treatments for effective regeneration of spent charcoal.
- Investigated the impact of various treatment methods, including:
  - Reaction with alkali solution (NaOH)
  - Acid treatment using hydrochloric acid (HCl)
  - Acid treatment using oxalic acid
  - Hot water treatment
- Identified that only the HCl treatment was effective, as it facilitated a redox reaction with the adsorbed chemical contaminants.
- Post-treatment, the charcoal was thoroughly washed with water to remove the resulting reaction products, ensuring the surface was ready for reuse.
- Upon successful small-scale trials, the HCl regeneration method was implemented on full-scale setups in the laboratory to validate its effectiveness.

**Results:**

- The regenerated charcoal, after HCl treatment and washing, demonstrated adsorption performance comparable to fresh charcoal, as verified through experimental readings and characteristic adsorption curves on full-scale trials.
- The approach was recognized as an innovative and practical solution by the laboratory staff.
- The developed method enables the reuse of charcoal 3-4 times, reducing the weekly requirement of fresh charcoal by up to 75%, resulting in significant material cost savings (typically, 10-15 kg of charcoal was used per week prior to this intervention).

## Course Project — Heat Transfer (CHE212) — Prof. Anurag Tripathi

**Title:** Error Minimization in Natural Convection Experimental Setup

**Objectives:**

- Investigated the significant errors observed in the standard Natural Convection experiment setup, where experimental results deviated by nearly 300% from theoretical predictions.
- Aimed to identify sources of error and implement modifications to reduce the overall experimental inaccuracies.

**Approach:**

- Conducted a systematic analysis of the experimental setup and calculation methodology to locate sources of error.
- Introduced multiple design and calculation improvements, including:
  - Reoriented the metal cylinder to a horizontal position to reduce air movement disturbances affecting heat transfer measurements.
  - Modified the power calculation approach by incorporating the $\cos\phi$ factor to account for the phase difference in the nichrome heating element, which was neglected in the original setup.
  - Considered heat losses to the surrounding air, previously unaccounted for, improving the accuracy of heat transfer calculations.
  - Integrated additional heat sensors within the rod and on the heating cylinder to precisely monitor temperature gradients and internal heat losses, addressing key oversights in the earlier experimental arrangement.

**Results:**

- The implemented setup modifications and refined calculation techniques reduced the experimental error from approximately 300% to nearly 100%.
- The project demonstrated that both setup design and theoretical calculations play critical roles in reducing deviations in heat transfer experiments.
- The improvements were validated through multiple trials and recognized by the laboratory staff as a significant enhancement to the existing experimental procedure.

**Industrial Waste Simulations and Analytics** | Chemineers Society | IIT Kanpur *(Jan'25 - Apr'25)*

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| **Objective** | • Developed an integrated **industrial waste management system** combining **analytics, predictive modeling, simulations**, and **optimization** to tackle challenges in waste generation, recycling, and valorization, ensuring environmental and economic sustainability. |
| **Approach** | • Performed data collection, cleaning, and **exploratory data analysis (EDA)** to understand waste generation patterns and trends using dashboards.<br>• Built predictive models to forecast industrial waste generation using Python and Power BI for visualization.<br>• Conducted **environmental impact assessments** such as **Life Cycle Analysis (LCA)** and carbon footprint evaluation.<br>• Performed **cost-benefit analyses** for waste recycling and valorization opportunities and optimized waste processes using **material and energy balances**. |
| **Results** | • Developed reliable predictive models to forecast waste trends, proposed optimized sustainable waste management solutions, and compiled a comprehensive report with insights, environmental assessments, and strategic recommendations. |
| **Tools** | • Python (Data Analytics), Power BI (Dashboards), MATLAB, Aspen, OpenLCA (Environmental Impact Assessment). |

**Stochastic Solutions: A Bayesian Approach** | Simutech Project | IIT Kanpur *(Jan'25 - Apr'25)*

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| **Objective** | • Addressed challenges of decision-making under uncertainty in engineering by leveraging **Bayesian inference**, **stochastic simulations**, and probabilistic modeling for process optimization and data-driven insights. |
| **Approach** | • Built a strong foundation in **Probability**, **Bayes' Theorem**, and parameter estimation techniques including **MLE**, **MAP**, confidence intervals, and credibility regions.<br>• Developed **Bayesian Regression Models** and applied **Monte Carlo simulations** to model complex systems under uncertainty.<br>• Explored **Bayesian Hierarchical Modeling** for improved model comparison and parameter estimation in multi-level systems.<br>• Applied Bayesian methods to real-world **chemical engineering problems** through research-based assignments and project work. |
| **Results** | • Gained hands-on expertise in stochastic modeling, Bayesian inference, and probabilistic reasoning, enabling informed decision-making and process optimization in uncertain engineering environments.<br>• Successfully connected Bayesian techniques to practical chemical engineering scenarios and delivered research-driven solutions. |
| **Tools** | • Python, R, SciPy, PyMC3, Arviz, PyStan, sklearn. |

**Stochastic Modelling of Financial Derivatives** | Stamatics Society, IIT Kanpur *(May'25 - Jun'25)*

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| **Objective** | • Gained a comprehensive understanding of **financial derivatives** and their mathematical modeling through **stochastic processes**, simulations, and real-world market data analysis. |
| **Approach** | • Explored **Brownian Motion**, **Geometric Brownian Motion (GBM)**, and **Itô's Calculus** to model asset price dynamics.<br>• Derived and implemented the **Black-Scholes-Merton (BSM)** model for option pricing under risk-neutral measures.<br>• Applied **Monte Carlo simulations** for pricing complex derivatives such as Asian Options, Barrier Options, incorporating techniques like **variance reduction**.<br>• Developed and calibrated the **Heston Stochastic Volatility Model** using **real-world market data** (NIFTY/S&P 500), estimating implied volatility and predicting option prices.<br>• Utilized **Machine Learning techniques** for parameter estimation in volatility modeling and improving prediction accuracy. |
| **Results** | • Successfully simulated complex financial derivatives using stochastic models and Monte Carlo techniques, bridging the gap between theoretical models and real-world market behavior.<br>• Calibrated advanced volatility models to actual financial market data, enabling accurate pricing and analysis of derivatives under uncertain market conditions. |

**LLM Fine-Tuning and AI Alignment** | Self Project | IIT Kanpur  *(May'25 - Jun'25)*

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| **Objective** | • Customized and fine-tuned an open-source **LLaMA-based Large Language Model (LLM)** to align its behavior, responses, and instruction-following capabilities for specific tasks and conversational use-cases. |
| **Approach** | • Integrated pre-trained LLaMA models and explored fine-tuning techniques including **parameter-efficient tuning** to modify model outputs without full retraining.<br>• Experimented with **instruction-tuning** datasets to improve task-specific reasoning, response coherence, and control over model behavior.<br>• Evaluated and tested **uncensored LLM variants** to analyze output control challenges, alignment risks, and content moderation limitations.<br>• Designed testing prompts and practical scenarios to benchmark AI alignment, behavioral consistency, and potential misuse mitigation. |
| **Results** | • Successfully fine-tuned LLaMA models for improved instruction following, task alignment, and controlled conversational responses tailored to intended use-cases.<br>• Identified inherent limitations in uncensored AI models regarding content filtering, and analyzed ethical and technical considerations in deploying such models. |

**Automated Remote Payload Delivery via Custom Web Server** | Self Project | IIT Kanpur 

*(May'25 - Jun'25)*

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| **Objective** | • Designed and deployed a custom web server to **automatically deliver executables** upon webpage interaction, simulating real-world payload delivery methods for controlled testing and research. |
| **Approach** | • Developed a Python-based server with embedded scripts to initiate **auto-download triggers** when clients accessed the hosted page.<br>• Integrated and tested the **Quasar Remote Administration Tool (RAT)** within a personal, sandboxed environment to study remote access behavior and payload delivery chains.<br>• Evaluated browser-level defenses, including download protection mechanisms, to analyze how modern systems intercept unsolicited executables.<br>• Ensured all experiments were strictly confined to personal devices for **educational and cybersecurity research** purposes only. |
| **Results** | • Successfully demonstrated automated payload delivery mechanisms and gained practical insights into web-based file distribution techniques and endpoint protection systems. |

**Machine Learning with Python** | Chemineers Society, IIT Kanpur *(Dec'23 - Jan'24)*

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| **Objective** | • Developed strong theoretical and practical understanding of **machine learning algorithms** and their application in solving complex problems in **chemical engineering** using Python. |
| **Approach** | • Implemented core **Supervised Learning** algorithms including **Linear Regression, Polynomial Regression**, and **Logistic Regression** for predictive modeling.<br>• Applied **K-Nearest Neighbors (KNN)** and **Support Vector Machines (SVM)** for classification tasks with real-world datasets.<br>• Utilized **data preprocessing techniques** and the **Scikit-Learn** library for efficient model development, validation, and performance enhancement.<br>• Gained proficiency in essential Python libraries: **Numpy, Pandas, Matplotlib** for data handling and visualization. |
| **Results** | • Acquired hands-on experience in building and evaluating machine learning models tailored to chemical engineering problems, strengthening algorithmic intuition and practical coding skills. |

**Connectify: Social Media Platform Development** | ACA, IIT Kanpur *(May'24 - Jun'24)*

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| **Objective** | • Designed and initiated development of a fully functional **social media website** focusing on core features such as user authentication, profile management, content posting, and real-time user interactions. |
| **Approach** | • Developed the frontend using **HTML** and **CSS**, emphasizing intuitive design principles to ensure a responsive, seamless, and user-friendly interface across devices.<br>• Incorporated interactive components and layout structures to support essential features like user profiles, posts, likes, and comment functionalities.<br>• Focused on building the foundation for scalable UI/UX design to enable further backend and database integration. |
| **Results** | • Successfully implemented the responsive frontend framework, establishing the base structure for a **real-world social media platform** with core interactive features. |

**Methanol Production via Steam Reforming of Natural Gas** | Course Project, CHE251, IIT Kanpur *(Sep'24 - Nov'24)*

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| **Objective** | • Simulated and optimized the production of **methanol from natural gas** through **steam reforming** and subsequent synthesis, analyzing process variables, catalyst performance, and energy efficiency using Aspen Plus. |
| **Approach** | • Modeled the conversion of methane to **syngas** ($H_2$, CO, $CO_2$) via steam reforming and subsequent conversion to methanol using **Cu/ZnO catalysts**.<br>• Performed detailed material balance and reactor simulations to evaluate CO and $CO_2$ conversions, methanol yield, and **hydrogen consumption**.<br>• Studied the influence of **temperature, pressure, and gas composition** on methanol yield, identifying optimal operating conditions to maximize production while avoiding catalyst degradation.<br>• Explored process improvements including **heat integration, recycling of unreacted gases**, and separation techniques to enhance overall process efficiency and product purity. |
| **Results** | • Achieved methanol production with **35% CO conversion**, **17% $CO_2$ conversion**, and identified energy savings through heat recovery systems.<br>• Optimized operating conditions at 55 atm and 220–280°C to balance methanol yield with catalyst longevity and process stability.<br>• Recommended further optimizations including advanced heat exchangers, purge stream management, and by-product control to improve methanol purity and reduce environmental impact. |

**Process Feasibility Research for Surfactant Manufacturing** | Course Project, CHE261, IIT Kanpur *(Jan'25 - Apr'25)*

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| **Objective** | • Conducted detailed process research and feasibility analysis for surfactant production as part of **QuantiVEX**, a virtual chemical company project under Prof. R. Ragipani, focusing on identifying optimal, sustainable manufacturing routes. |
| **Approach** | • Evaluated multiple industrial pathways for three surfactants — **Fatty Acid Ethoxylates (FAE)**, **Sodium Lauroyl Sarcosinate**, and **Linear Alkyl Benzene Sulfonate (LABS)** — based on process efficiency, environmental impact, and scalability.<br>• Recommended enzyme-catalyzed synthesis for FAEs utilizing **lipase catalysts** for high yield (92–95%), low energy use, and minimal waste over conventional acid-catalyzed routes.<br>• Analyzed direct amidation vs. acid chloride routes for Sodium Lauroyl Sarcosinate production; proposed **direct amidation** as a greener, safer, and higher-yielding (95%) alternative.<br>• Assessed LABS production pathways; recommended **zeolite-catalyzed alkylation** and $SO_3$ sulfonation for optimal selectivity (up to 90%), lower emissions, and improved plant safety. |
| **Results** | • Provided actionable production process recommendations for all three surfactants prioritizing **green chemistry**, industrial feasibility, and cost-performance balance, supporting QuantiVEX's sustainable business model. |

**Hack to Capture: CTF and Cybersecurity Training** | GDG, IIT Kanpur *(Dec'24 - Jan'25)*

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| **Objective** | • Developed practical skills in **cybersecurity, CTF problem-solving**, and offensive security techniques through a structured Capture the Flag (CTF) training program organized by GDG, IIT Kanpur. |
| **Approach** | • Completed foundational modules on **Linux commands, Bash scripting**, computer memory concepts, and Python for automation.<br>• Gained hands-on experience with **forensics**, file analysis, and **steganography** for uncovering hidden data in images and audio files.<br>• Applied **OSINT techniques** for information gathering, along with cryptography concepts such as XOR, Caesar Cipher, RSA, AES, and elliptic curve cryptography.<br>• Explored **reverse engineering**, debugging, assembly language basics, and binary exploitation techniques including buffer overflows and format string vulnerabilities. |
| **Results** | • Strengthened proficiency in CTF-style cybersecurity challenges, including cryptography, forensics, OSINT, and exploit development, laying a strong foundation for ethical hacking and information security. |

## Positions of Responsibility

**Core Team Member, Chemineers Society** | Dept. of Chemical Engineering, IIT Kanpur (*Apr'25-Present*)

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| **Leadership** | • Leading a **three-tier** team of **40+** to drive academic, skill-based and cultural growth for **700+ students** |
| **Management** | • Managing **INR 7.2 Lakh** budget, targeting **INR 10+ Lakh** this year ensuring efficient resource allocation<br>• Recruited **15 secretaries** out of multiple application received through **two-stage** elimination process |
| **Intiative** | • Led initiatives like **Intern Marathons**, **alumni talks**, and fresher sessions, enhancing career readiness<br>• Collaborated with **10 IITs** to organise ChemBlitz, an **inter-IIT** E-sports Tournament featuring 6 games |

**Secretary, Sponsorship** | EXERGY'25, IIT Kanpur (*Jun'24-Jan'25*)

- Raised **INR 5L+** in funds from alumni and industry partners like **Evonik**, **Kanopy Techno Solutions** and **Red FM**
- Organised talks with industry leaders including **founders** and **directors** from reputed firms like **HPCL** and **Vedanta**.
- Conducted **competitions** and technical **workshops** with global firms like **MathWorks** to enhance industry exposure.
- **Impact:** Propelled Exergy to **300k+ reach**, with about **140% growth** engaging **100+ colleges** in various events

**Trainee** | Google Developer Group (GDG), IIT Kanpur (*Nov'24 - Present*)

- Selected as a **GDG Trainee** to contribute towards building a vibrant, tech-driven student community at IIT Kanpur.
- Assisting in organizing **hackathons**, workshops, and technical events promoting **Web Development**, **Machine Learning**, **Cloud Computing**, and **Cybersecurity**.
- Supporting **community growth** initiatives inspired by the success of GDSC IITK with over **5000+ engagements** and active project contributions.
- Contributing to collaborative **real-world projects**, tech content creation, and fostering inclusivity within the GDG community.
- **Impact:** Developing leadership skills while driving technology-focused initiatives to empower students with practical, industry-relevant knowledge.

## Extra-Curriculars

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| **Managerial** | • Actively Helped in organizing events of EXERGY'25, served as POC of **M.B. Lal, former C&MD, HPCL** |
| **Volunteer** | • Volunteered in Antaragni'25 **Hospitality**; conducted outreach calls for participation for event fundraising. |
| **Leadership** | • Served as Head Boy in Class 12th, **leading 800+ students** and representing the school in competitions |
| **Cultural** | • Participated in **Wall painting** in Freshers'23 and in **Acrylic Painting** in Galaxy'24 reflecting **creativity**<br>• Participated in Galaxy'24 and **Mentored** Freshers for Galaxy'25 in events of **Hindi Sahitya Sabha** |

## Technical Skills

- **Programming Languages:** C, C++, Python, Advanced SQL, HTML, CSS, LaTeX, MATLAB
- **Software and Libraries:** Numpy, Pandas, Matplotlib, Scikit-learn, Seaborn, Tensorflow, MS Power BI, MS Excel, Git, Linux, AutoCAD, ASPEN, DWSM, Plotly, Statsmodels
- **Mathematics and Statistics:** Descriptive and Inferential Statistics, Probability, Linear Algebra, Calculus

## Relevant Courses

| Course ID | Course Name | Course ID | Course Name |
|---|---|---|---|
| ELC 112 | English Language & Communication (Intermediate) | PHY 111 | Physics Laboratory |
| CHM 112M | General Chemistry: Physical Chemistry | TA 111 | Engineering Graphics |
| PE 111 | Morning Exercise | MTH 111M | Single Variable Calculus |
| CHM 113M | General Chemistry: Inorganic & Organic Chemistry | PHY 112 | Classical Dynamics |
| MTH 112M | Application of Single Variable Calculus & Several Variable Calculus | PHY 113 | Classical Electrodynamics |
| MTH 114M | Ordinary Differential Equations | PE 112 | Evening Exercise |
| ESC 113M | Computer Methods for Engineers | LIF 111 | Introduction to Biology |
| MTH 113M | Linear Algebra | ETH 111 | Practical Ethics |
| CHM 111 | Chemistry Laboratory | ESC 111M | Fundamentals of Computing - I |
| ESO 204 | Fluid Mechanics and Rate Processes | ESC 201 | Introduction to Electronics |
| ART 103 | Introduction to Western Art | CHE 251 | Introduction to CHE and Process Calculation |
| ESO 201 | Thermodynamics | CHE 201 | Introduction to Chemical Engineering |
| CHE 212 | Heat Transfer | CHE 261 | Chemical Process Industries |
| ECO 111 | Economy, Society & Public Policy | CHE 213 | Mass Transfer and Separation Processes |
| CHE 221 | Chemical Engineering Thermodynamics | CHE 200 | Chemical Engineering Communication Skills |