# Deepak Kumar

New Delhi, India

chz228174@iitd.ac.in • kumar.deepak.iitd@gmail.com • (+91) 830 722 1667

## Education

**Ph.D. in Chemical Engineering**                    *[Aug 2022 – Present]*
Indian Institute of Technology (IIT) Delhi, India
 Thesis title: Adaptive and Interpretable Neural Network Frameworks for Process Modeling
 GPA: 8.9/10
 Fellowship: Prime Minister Research Fellowship (PMRF)

**M. Tech. in Chemical Engineering**                    *[Jul 2019 – Jun 2021]*
Indian Institute of Technology (IIT) Delhi, India
 Thesis title: Modelling and Optimization of Monoclonal Antibodies Production in Bioreactor
 GPA: 9.233/10

**B. Tech. in Chemical Engineering**                    *[Jul 2014 – May 2018]*
Indian Institute of Technology (IIT) (ISM) Dhanbad, India
 GPA: 7.25/10

## Research Experience

**Doctoral Researcher, IIT Delhi**                    *[Aug 2022 – Present]*
Supervisors: Prof. Hariprasad Kodamana & Prof. M.C. Ramteke
- Working in collaboration with Prof. Fengqi You, Cornell University, on greenhouse modeling using KAN-based PINNs to optimize crop production.
- Designed forward-forward algorithm based deep learning frameworks for real-time fault isolation and MPC.
- Developed SyNISM, a symbolic neural model for process modeling using data only.
- Applied SyNISM to nanofluid property prediction, uncovering interpretable physical insights.
- Extracted Koopman observables using equation learning (EQL) networks for nonlinear reactor modeling.

*Expertise Gained: Scientific ML, Interpretable AI, Process Monitoring and Control*

**Visiting Researcher, Khalifa University, UAE**                    *[Nov 2024 – Jan 2025]*
Supervisor: Prof. Ahmed Alhajaj
- Modeled and optimized $CO_2$-binding organic liquids using quantum descriptors and KANs.
- Optimized post combustion $CO_2$ capture plant using data-driven models.

*Expertise Gained: Aspen Plus Simulation, COSMO-RS, KANs*

**Research Assistant, Deeppro Pvt. Ltd., New Delhi**                    *[Feb 2022 – Aug 2022]*
- Designed and executed Bayesian Design of Experiments (DOE) methodologies to optimize cell culture.
- Developed hybrid models using Gaussian processes for bioreactors, reducing RMSE by 95%.
- Built LSTM autoencoders for anomaly detection.
- Employed DDPG-based Deep Reinforcement Learning for optimal bioreactor performance and trajectory tracking.

*Expertise Gained: Bayesian DOE, Deep Learning*

**Research Assistant, IIT Delhi**                    *[Jul 2021 – Jan 2022]*
Supervisors: Prof. A.S. Rathore & Prof. M.C. Ramteke
- Predicted acute decompensated heart failure using ML-based health analytics.
- Proposed and executed a novel Fast Feature Elimination algorithm, improving runtime by 90%.

*Expertise Gained: Machine Learning, Data Analysis*

**Masters Student, IIT Delhi** *[Jan 2020 – Jul 2021]*
Supervisors: Prof. A.S. Rathore & Prof. M.C. Ramteke
- Developed a kinetic model and estimated model parameters for protein production in bioreactors.
- Performed multi-objective optimization for continuous protein production simulation.
*Expertise Gained: Bioreactor Modeling, Evolutionary Algorithms*

## Publications

Google Scholar [Citations: **88**    *h*-index: **6**    i10-index: **4**]

1. **Kumar, D.**, Anwer, S., Alhajaj, A., Kodamana, H., & Ramteke, M. Integrating Quantum Descriptors and Kolmogorov Arnold Network (KAN) for Modeling and Optimization of $CO_2$-binding organic liquids ($CO_2$BOLs). *Industrial & Engineering Chemistry Research* (**Under Review**).

2. **Kumar, D.**, Dixit, V., Kodamana, H., & Ramteke, M. (2025). Learning System Physics using Symbolic Neural Integration (SyNISM) with Applications to Chemical Processes. *Industrial & Engineering Chemistry Research*.

3. **Kumar, D.**, Ramteke, M., & Kodamana, H. (2024). A framework for model maintenance using kernel-based forward propagating neural networks. *Chemical Engineering Research and Design*, 210, 352–364.

4. **Kumar, D.**, Goswami, U., Kodamana, H., Ramteke, M., & Tamboli, P. K. (2023). Variance-capturing forward-forward autoencoder (VFFAE): A forward learning neural network for fault detection and isolation of process data. *Process Safety and Environmental Protection*, 178, 176–194.

5. **Kumar, D.**, Gangwar, N., Rathore, A. S., & Ramteke, M. (2022). Multi-objective optimization of monoclonal antibody production in bioreactor. *Chemical Engineering and Processing - Process Intensification*, 180, 108720.

6. **Kumar, D.**, Balraj, K., Seth, S., Vashista, S., Ramteke, M., & Rathore, A. S. (2024). An improved machine learning-based prediction framework for early detection of events in heart failure patients using mHealth. *Health and Technology*, 14(3), 495–512.

7. **Kumar, D.**, Dixit, V., Ramteke, M., & Kodamana, H. (2024). Learning Interpretable Representation of Koopman Operator for Non-linear Dynamics. *Computer Aided Chemical Engineering*, Vol. 53, pp. 2773–2778. Elsevier.

8. Anto, A., **Kumar, D.**, Kodamana, H., & Ramteke, M. Adaptive Fault Detection via Machine Unlearning. *Computers and Chemical Engineering*.

9. Goswami, U., **Kumar, D.**, Kodamana, H., & Ramteke, M. (2025). Multi-objective Optimization of Hydrocracking Processes Using Graph Neural Differential Equations. *Chemical Engineering Research and Design*.

10. Goswami, U., **Kumar, D.**, Kodamana, H., & Ramteke, M. (2025). Change Point Detection of Processes using Graph Neural Differential Convolutional Network with Contrastive Loss. *Process Safety and Environmental Protection*.

11. Kaysfeld, M. W., **Kumar, D.**, Nielsen, M. K., & Jørgensen, J. B. (2023). Dynamic optimization for monoclonal antibody production. *IFAC-PapersOnLine*, 56(2), 6229–6234.

12. Gupta, N., Anand, S., **Kumar, D.**, Ramteke, M., Kandath, H., & Kodamana, H. (2024). A Twin Agent Reinforcement Learning Framework by Integrating Deterministic and Stochastic Policies. *Industrial & Engineering Chemistry Research*.

13. Gupta, N., Anand, S., **Kumar, D.**, Ramteke, M., & Kodamana, H. (2023). Proximal policy optimization for the control of mAB production. *Computer Aided Chemical Engineering*, Vol. 52, pp. 1903-1908. Elsevier.

14. Goswami, U., Rani, J., **Kumar, D.**, Kodamana, H., & Ramteke, M. (2023). Energy out-of-distribution based fault detection of multivariate time-series data. *Computer Aided Chemical Engineering*, Vol. 52, pp. 1885-1890. Elsevier.

15. Gupta, N., Anand, S., Joshi, T., **Kumar, D.**, Ramteke, M., & Kodamana, H. (2023). Process

control of mAb production using multi-actor proximal policy optimization. *Digital Chemical Engineering*, 8, 100108.

## Teaching Experience

- **Data Science for Chemical Engineers**
  *TKM College of Engineering, Kerala (Online)*
  Served as the primary instructor. Covered Python, chemical process simulation, and data-driven modeling, with an emphasis on practical coding exercises.
- **Computational Process Design**
  *NPTEL Course, IIT Delhi (Prof. Kodamana and Prof. Ramteke)*
  Assisted in preparing lectures, quizzes, and assignments. Participated in resolving student queries via online forums.
- **Data Science and Machine Learning**
  *CEP Course, IIT Delhi (Prof. Kodamana and Prof. Ramteke)*
  Recorded instructional content and helped lead practical Python sessions focused on machine learning tools.
- **Mass Transfer**
  *IIT Delhi (Prof. Anil Verma)*
  Conducted tutorials and helped undergraduate students with problem-solving sessions.

## Conferences and Poster Presentations

- Poster: Hybrid Modeling of Bioreactor, ECCE-ECAB 2024, Germany
- Poster: Interpretable Koopman Observable Estimation, PSE-ESCAPE 2024, Italy

## Industrial Training

**Indian Farmers Fertilizers Cooperative Limited, Phulpur, India**          [*May 2017 – Jun 2017*]
- Performed mass and energy balances for ammonia production units.

## Skills

- **Programming Languages:** Python, MATLAB, Java
- **Data Science & Machine Learning:** Machine Learning (ML), Deep Learning (DL), Reinforcement Learning (RL), Kolmogorov–Arnold Networks (KANs), Physics-Informed Neural Networks (PINNs)
- **Chemical Engineering Tools:** Aspen Plus, COSMO-RS (Conductor-like Screening Model for Real Solvents)
- **Core Applications:** Process Modeling, Model Predictive Control (MPC), Multiobjective Optimization, Fault Detection & Isolation, System Identification
- **Web & Mobile Development:** Developed a DOE (Design of Experiments) tool for process optimization; Built an mHealth monitoring app for patient data tracking

## Awards & Honors

- Prime Minister's Research Fellowship (PMRF) for PhD research at IIT Delhi
- Secured Top 1% rank in IIT-JEE 2014 (Joint Entrance Examination for admission to IITs)
- Secured Top 2% rank in GATE 2019 (Graduate Aptitude Test in Engineering)
- Best Sports Person Award at IIT (ISM) Annual Sports Meet (2016 & 2017)