

# Arsh Kumbhat

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## EDUCATION

### Eidgenössische Technische Hochschule (ETH) Zürich (GPA: 5.25/6)

*Master of Science, Computational Science and Engineering (Fluid Dynamics Specialization)*

*September '23 - Present*

- **Research Interests:** Scientific Machine Learning, Scientific Computing, Computational Fluid Dynamics

### Birla Institute of Technology and Science, Pilani (CGPA: 9.57/10)

*Bachelor of Engineering, Chemical and Minor in Data Science*

*August '19 - May '23*

- **Achievements:** Top 2% of students in Class of 2023, Department Rank 1, Merit Scholarship

## PUBLICATIONS (★ - UNDER REVIEW)

- **A. Kumbhat**, R. Goel, A. Madaan, S. Appari, A. S. Al-Fatesh, A. I. Osman, "Predicting Nickel Catalyst Deactivation in Biogas Steam and Dry Reforming for Hydrogen Production Using Machine Learning", *Process Safety and Environmental Protection*\*
- Daneker, M., Cai, S., Qian, Y., Myzelev, E., **Kumbhat, A.**, Li, H., Lu, L., [Transfer Learning on Physics-Informed Neural Networks for Tracking the Hemodynamics in the Evolving False Lumen of Dissected Aorta](#), *Nexus* (2024)
- G. Arora, **A. Kumbhat**, A. Bhatia and K. Tiwari, "CP-Net: Multi-Scale Core Point Localization in Fingerprints Using Hourglass Network", 2023 11th International Workshop on Biometrics and Forensics (IWBF), Barcelona, Spain, 2023

## PROJECTS

### Multi-GPU 3D Simulation of Fluid Flow Across a Stationary Sphere/Cylinder [[GitHub](#)]

*Course: Solving PDEs in Parallel on GPUs, ETH Zürich (Piz Daint GPU Nodes)*

- Implemented a finite-difference solver comprising of Chorin's projection method, and a semi-Lagrangian advection scheme.
- Utilised a pseudo-transient approach for iteratively solving the Poisson pressure equation.
- Scaled solver on multiple GPU nodes by exploiting seamless interoperability of [ImplicitGlobalGrid.jl](#) and [ParallelStencil.jl](#).

### Kinetics Informed Neural Networks (KINNs) for Reaction Rate Constant Prediction

*Mentor: [Dr. Srinivas Appari](#), Assistant Professor, BITS Pilani*

- Developed Forward KINNs for prediction of ammonia, hydrogen, and nitrogen flow rates in packed bed reactors.
- Estimated kinetic rate constants for ammonia decomposition detailed kinetic model (12 reactions) using Inverse KINNs.

### Physics Informed Neural Networks (PINNs) for Blood Flow Predictions [[Thesis](#)]

*Mentor: [Dr. Lu Lu](#), Assistant Professor, University of Pennsylvania*

- Developed PINNs informed by Navier Stokes Equations to model blood flow in stenosed arteries and aneurysms.
- Generated velocity profiles by optimizing the number of cross-sections of the thrombus for training the PINN.
- Estimated parameters: shear rate and wall shear stress using PINN outputs; essential for heart disease detection.

### Machine Learning for Predictive Analysis of Biomass Pyrolysis Yields

*Mentor: [Dr. Srinivas Appari](#), Assistant Professor, BITS Pilani*

- Built a dataset of 200+ biomasses through a literature survey of journal and review articles.
- Dataset was inclusive of biomass analysis data, pyrolysis yields (bio-oil, biochar, and gas), and pyrolysis process parameters.
- Predicted pyrolysis yields by tuning ANN and Random Forests hyperparameters. (ANN:  $R^2 > 0.9$ , RF:  $R^2 > 0.8$ )

### Heat Exchanger Design for Decay Heat Removal [[Certificate](#)]

*Research Intern, Indira Gandhi Centre for Atomic Research, Kalpakkam, Tamil Nadu*

- Designed and simulated heat exchanger for decay heat removal via natural convection from radioactive waste storage tanks.
- Incorporated a finned-tube design to increase surface area for 100 kilowatts of decay heat removal.
- Optimized fin spacing and thickness to reduce coolant water outlet temperature to the lowest possible value.

## SKILLS/COURSES

**Programming:** C++/C, Python, Julia, MATLAB, R Programming,  $\text{\LaTeX}$

**Libraries/Tools:** pandas, NumPy, Matplotlib, scikit-learn, JAX, OpenCV, TensorBoard, Git, GitHub

**AI Frameworks:** DeepXDE (Contributions - [1](#), [2](#)), PyTorch, TensorFlow 2.0

**Computational Software:** ANSYS Fluent, COMSOL Multiphysics, [LehrFEM++](#)

## RELEVANT COURSEWORK

**Partial Differential Equations:** [Numerical Methods for PDEs](#), [Solving PDEs in Parallel on GPUs](#)

**Artificial Intelligence:** AI in the Sciences and Engineering, SciML for Chemical Engineering Applications, Deep Learning

**Fluid Dynamics:** Advanced CFD Methods, Theory and Modeling of Reactive Flows, Fluid Mechanics

## WORK EXPERIENCE & LEADERSHIP

**Reviewer:** [Journal of Autonomous Intelligence](#)

**President:** Indian Institute of Chemical Engineers, BITS Pilani Chapter (October '20 - May '23)

**Teaching Assistant:** [MPBA G507 Programming for Analytics](#) (August '21 - December '21)