UMAIR HUSSAIN, PhD

Data Scientist | Physics-based Modeling | AI/ML for Energy

husain.umair2010@gmail.com +91 9560842249

umairhussaincmm.github.io **LinkedIn:** linkedin.com/in/umair-h-204191b4 **GitHub:** github.com/umairhussaincmm

PROFESSIONAL SUMMARY

Data Scientist at ChampionX, an SLB company, building AI, machine learning, and physics-based models for the oil & gas industry. PhD in Mechanical Engineering from IIT Madras with deep expertise in the finite element method (FEM), phase field modeling, and multiphysics simulation. Currently leading AI-on-Edge initiatives for ESP diagnostics and optimization, while integrating physics-informed modeling with modern ML to solve real-world problems across artificial lift systems, corrosion prediction, and equipment diagnostics.

TECHNICAL SKILLS

Machine Learning & AI: Supervised and Unsupervised Learning, Time-Series Forecasting, Time Series Foundation Models, Anomaly Detection, Deep Learning, Gaussian Process Regression, Small Language Models (SLMs), LLM fine-tuning, Physics-Informed ML

Physics-based Modeling: Finite Element Method (FEM), Phase Field Modeling, Multiphysics Simulation, Computational Mechanics, Plasticity, Electrochemical Modeling, Multi-phase Field Solvers, Parallel Computing

Programming: Python (NumPy, Pandas, Scikit-learn, PyTorch, TensorFlow), C++, MATLAB, LaTeX, Shell/Bash

Tools & Libraries: deal.II, TensorFlow, PyTorch, Abaqus, MicroSim, ParaView, GMSH, SageMath, PETSc, Git, Linux

AI Tools: Cursor, GitHub Copilot, ChatGPT, Claude

Domain Expertise: Artificial Lift Systems (Sucker Rod Pumps, ESPs), Corrosion Prediction, Equipment Diagnostics, Sensor Data Analytics, Li-ion Battery Modeling

Soft Skills: Cross-functional collaboration, Technical writing, Research mentoring, Presenting to technical and business audiences

PROFESSIONAL EXPERIENCE

Data Scientist, *ChampionX, an SLB company* May 2025 – Present

Chennai, India

- Led the **Autonomous ESP Optimizer** (AI-on-Edge initiative), a data-driven optimizer that automatically identifies the setpoint required to maximize production from an Electric Submersible Pump. The system is under testing, and a patent application has been submitted to the company's legal team.
- Led an **upgrade to the Smart Alarm model for ESP diagnostics** (AI-on-Edge initiative) by designing a substitute model for detecting ESP or well stabilization following a restart. The new model is set to replace the incumbent production model and is currently under deployment. Continuing to explore further improvements to other smart alarms in the suite.
- Supported the **SLM Agent for ESP diagnostics** (AI-on-Edge initiative) by building the underlying knowledge bank, curating test cases from the internal labelled dataset and other sources, and working with an SME to analyze results. Project is currently under testing.
- Built a **gas-interference anomaly detection model for ESPs** on high-fidelity sensor data. Partnered with an SME to test and validate the model across 16 ESPs over one month of operations, in the process creating a labelled ESP dataset that has since been reused by the team for multiple downstream modeling and testing efforts.

- Extended the **deviated-well FEM sucker rod pump model** by supporting the incorporation of viscoelastic material behaviour, improving fidelity of pump card prediction under realistic downhole conditions.
- Benchmarked a **hybrid physics-informed machine learning model** against an **XGBoost baseline** for CO_2-based corrosion prediction in oil & gas assets.

Research Analyst, Intern, *ChampionX, an SLB company* Nov 2024 – Apr 2025
Chennai, India

- Contributed a **FEM-based sucker rod pump model for deviated wells** to the team's ongoing pump modelling effort, a novel extension over standard vertical-well models, to predict pump cards and support downhole diagnostics.
- Built a **machine learning model to predict broken shafts** from sensor data, supporting predictive maintenance and reducing unplanned equipment failures.

Doctoral Researcher, *IIT Madras (Mechanical Engineering)* 2019 – 2025

- Built **multiphysics phase field models** (chemical diffusion + stress + electrochemistry) for Li-ion battery anodes using C++/deal.II with PETSc parallelization (~60% speed-up).
- Developed a **data-driven Gaussian Process Regression model** mapping battery voltammogram features to microstructure grain size for electrode design optimization.
- Published 3 peer-reviewed journal articles and 1 conference proceeding; contributed a standalone solver to the **deal.II code gallery**.

EDUCATION

M.S. + Ph.D., Indian Institute of Technology Madras 2019 – 2025
Mechanical Engineering

B.Tech, Jamia Millia Islamia 2015 – 2019
Mechanical Engineering

SELECTED PUBLICATIONS

Hussain, U., Phanikumar, G., & Swaminathan, N. (2023). Mapping of multiphase field model parameters to physical factors in order to simulate desired phase transformations. *Computational Materials Science, 226, 112227. https://doi.org/10.1016/j.commatsci.2023.112227*

Hussain, U., Swaminathan, N., & Phanikumar, G. (2024). Numerical Voltammetry of Phase Separating Materials Using Phase Field Modeling. *Journal of The Electrochemical Society, 171(7), 070502. https://doi.org/10.1149/1945-7111/ad59cc*

Agrawal, A. K., Swaminathan, N., & Hussain, U. (2025). Probabilistic Modelling of the Nonlinear Mapping between Voltammograms and the Grain Size of the Electrode Material in Li-Ion Batteries Using Optimally Tuned Gaussian Process Regression Models. *Journal of The Electrochemical Society, 172(1), 013501. https://doi.org/10.1149/1945-7111/ada0b6*

Hussain, U., Swaminathan, N., & Phanikumar, G. (2024). A Multi-phase Field Framework Application to the Study of the Peritectic Reaction for an Arbitrary Material System. In *Recent Advances in Mechanics of Functional Materials and Structures (pp. 231–240). Springer Nature Singapore. https://doi.org/10.1007/978-981-99-5919-8_20*

ACHIEVEMENTS & LEADERSHIP

- **Prime Minister Research Fellowship (PMRF)**, awarded 2020; supported doctoral research from 2020 to 2024.
- Contributed a standalone solver to the **deal.II code gallery** (open-source C++ FEM library).
- Vice President Education, **ChampionX Chennai Toastmasters Club** (Toastmasters International). Coordinated club programming and speech scheduling as part of the executive committee.
- Mentored ChampionX interns on their technical projects, providing regular guidance and feedback on their work.