# Statement of Purpose

*"We can only see a short distance ahead, but we can see plenty there that needs to be done." — Alan Turing*
This quote resonates with the curiosity that has fueled my journey from mastering the fundamentals of power systems to integrating Artificial Intelligence for smarter energy solutions. As an Electrical Engineer with a strong foundation in instrumentation and power optimization, I have gradually transitioned into an AI-powered research path focused on intelligent grid systems and automation. Through research projects, teaching at Stanford's Code in Place, and industry work as an RPA Engineer, I have come to view each algorithm as a step toward building sustainable and data-driven infrastructure. I now seek to pursue a graduate degree where I can contribute to real-world solutions in smart energy systems, combining optimization, machine learning, and automation.

My academic foundation was built at the Pakistan Institute of Engineering and Applied Sciences (PIEAS), where I pursued a Bachelor of Engineering in Electrical Power Engineering, Ranked among Pakistan's top engineering institutions (**QS Ranking 390**), PIEAS offered me a rigorous curriculum that sharpened both my analytical and hands-on engineering skills. Courses like Power Generation, Power System Analysis, Linear Control Systems, High Voltage Engineering, and Power System Protection grounded me in the mechanics of modern power systems. Meanwhile, electives in Linear Control System, and microcontroller interfacing deepened my interest in automation. This blend of control theory, signal processing, and instrumentation laid the groundwork for my transition into AI-driven solutions for power systems.

My final-year project optimizing a 177-bus grid with Genetic Algorithms proved optimization potential to cut line losses by 12%, cementing my focus on intelligent power systems, aiming to minimize line losses and improve the system's economic dispatch. To achieve this, I implemented Genetic Algorithms and later explored Particle Swarm Optimization to further enhance efficiency, especially with the inclusion of renewable energy sources like solar and wind. This project was my first real exposure to optimization in large-scale systems and showed me how data-driven techniques can directly contribute to energy sustainability. Presenting our findings at an international conference further deepened my motivation to pursue research that blends computational intelligence with practical energy solutions.

While working on power transmission, I found myself increasingly drawn to instrumentation and automation especially within smart grid systems. In my final year, I co-led a project to monitor grid performance using sensors, microcontrollers, and simulation tools to reduce line losses and improve reliability. An elective in robotics deepened my interest, introducing me to control systems, actuators, and feedback loops. Later, during a workshop at GEPCO, I saw firsthand how SCADA systems manage real-time grid operations. That experience showed me how critical intelligent, automated control is for modern power infrastructure and pushed me further toward combining AI with energy systems.

As I explored power systems more deeply, I realized how AI could revolutionize reliability and predictive maintenance. This led me to build a Python-based fault detection system using machine learning models like SVM, Random Forest, and Logistic Regression to spot anomalies in grid behavior. This automation of fault classification demonstrated the tangible value of AI in minimizing downtime and enabling predictive diagnostics. In another project, I conducted a comparative analysis of ML models including XG-Boost and Decision Trees—to predict smart grid stability under fluctuating load and renewable conditions. These hands-on experiences not only improved my skills in data handling and model evaluation but also sparked a lasting interest in using AI for smarter, more resilient power systems.

To push my skills beyond the classroom, I joined national and international hackathons, placing 3rd in the Un-hallucinate Challenge for building a hallucination-resistant chatbot using Mistral-7B and Vectara, and leading deployment in the Reasoning with o1 Hackathon using OpenAI's o1-preview model. I also ranked among the top 10 nationally in Meta Hacker Cup 2024. Alongside this, I've stayed committed to social impact volunteering as a backend developer for *Muaawin-e-llm*, an education platform for underserved children, and mentoring students in

programming competitions. These experiences taught me the value of using technology not just for innovation, but for inclusion and meaningful change.

Teaching has been one of the most fulfilling parts of my journey. I was selected as a mentor for Stanford's Code in Place program from over 30,000 applicants, where I taught Python, led interactive coding sessions, and helped students overcome conceptual challenges through one-on-one guidance. Earlier, I worked as a Teaching Assistant at PIEAS for the Power Transmission, Distribution & Utilization course, supporting students in understanding both theoretical concepts and practical design. These experiences not only refined my technical communication but also strengthened my passion for mentoring, something I see as essential to being both a good researcher and a responsible engineer.

At CureMD, I worked as a Robotic Process Engineer, identifying technical bottlenecks and building automation bots using UiPath and Automation Anywhere to streamline healthcare workflows. I also explored AI-driven solutions for tasks like data validation and intelligent routing. Through backend testing with SQL and API automation, and collaboration on Angular, Django, and .NET Core systems, I gained a deeper understanding of integrating AI and automation into complex, real-world platforms.

My early industry experience gave me valuable insight into how power systems function in the real world. As a Graduate Trainee Engineer at Mashal Construction Company, I worked on motors, control circuits, and automation systems in asphalt mixing and batching plants developing key skills in PLCs and diagnostics. Earlier, during my internship at ROUSCH Power Plant, I observed large-scale power generation through gas and steam turbines and learned how plant efficiency and system protection are managed. These experiences grounded my understanding of energy infrastructure and sparked my interest in applying intelligent, data-driven solutions to modernize power systems.

My journey began as the son of a farmer in rural Pakistan, where limited resources and a lifelong stammer taught me to communicate through problem-solving. Despite these challenges, I earned admission to PIEAS - one of Pakistan's top engineering schools - through competitive scholarships, proving that perseverance could transform barriers into motivation for technical excellence. Earning a competitive scholarship at PIEAS not only lightened the financial burden but also reaffirmed my belief that perseverance can outshine any limitation.

I am particularly drawn to Dr. Igor Molybog's research on power system state estimation, which addresses the challenges of nonconvexity and bad data in real-world grid monitoring. His work on using linear basis representations and mutual incoherence metrics to improve estimation accuracy and robustness resonates with my own background in power system modeling, optimization, and AI. Having worked on smart grid monitoring, fault detection using machine learning, and optimization using Genetic Algorithms and PSO, I find strong synergy with the group's goal of developing data-driven, mathematically grounded decision-making tools for critical energy systems. The group's focus on bridging theoretical guarantees with practical performance is exactly the kind of environment I hope to contribute to and grow in—pushing the frontier of reliable, intelligent power system design.

Looking ahead, I am driven by a clear goal: to help shape the future of intelligent, sustainable energy systems. In the short term, I aim to sharpen my expertise in optimization, state estimation, and AI-integrated power system control through a rigorous MS program. Long term, I envision pursuing a PhD where I can lead high-impact research at the intersection of power systems and machine intelligence developing resilient, real-time solutions for grid automation, renewable integration, and predictive diagnostics. I aspire not only to innovate but to lead to mentor future engineers, collaborate across disciplines, and contribute to building the next generation of smart, data-driven infrastructure that our world urgently needs.