

Statement of Purpose

My decision to pursue doctoral studies in the Department of Chemical Engineering at the Massachusetts Institute of Technology (MIT) stems from my passion for gathering and sharing knowledge and my desire to make a significant contribution to the world of academia. My long-term career goal is to become a professor and engage in high quality research and thus, I sincerely believe that a PhD at MIT would lay a strong foundation towards building my career path. I am interested broadly in the areas of Process Control, Systems Engineering and Optimization. At MIT, my research interests are closely aligned with Dr. Paul Barton, Dr. Richard Braatz and Dr. George Stephanopoulos of the Process Systems Engineering Laboratory.

In my first summer, I tried to identify my research interests by venturing into the field of Molecular Dynamics and Polymer Science with Prof. Upendra Natarajan of the Polymer Sciences Group at the Indian Institute of Technology (IIT) Madras. Although I could grasp the texts and references in the area, I wasn't particularly excited by the field and decided to keep looking into other fields for inspiration. This decision has turned out to be a valuable one, as I've realized through my few research experiences that motivation and a liking for one's work are the important factors for success in research.

In my sophomore year at IIT Madras, I was exposed to the Mechanical Operations course, taught by an enthusiastic faculty member, Prof. Abhijit Deshpande. The course was conducted in a highly conceptual manner and I was exposed to a lot of intriguing questions from time to time, which increased my liking for the subject. In due course, I was entrusted with the task of choosing a topic for the course project and had to coordinate with a group of 4 other students. We decided to work on the cyclone separator and carried out Computational Fluid Dynamics (CFD) Simulations using the Reynolds Stress Method in FLUENT, a commercial CFD software, to determine the correlation between the efficiency of separation and particle size and verified our results using existing literature studies. This project taught me the need to understand the methodology which software employ and the importance of verifying simulation results, either with the literature or by performing experiments. Later that year, I was presented with the Professor M Ramanujam Memorial Award for the best student in the course.

In the summer of my sophomore year, I had the opportunity to explore research in the industry. I worked at the R & D Centre of Orchid Chemicals and Pharmaceuticals Ltd., Chennai, which is one of the top pharmaceutical companies in India. In this internship, I developed several theoretical scale up solutions (to be used on a daily basis) using first principles in heat transfer and reaction engineering and implemented them in MATLAB. I was also involved in the design and implementation of a novel method to increase the resultant particle size of an API during the process of antisolvent crystallization to reduce the drying and filtration time. The newly implemented method helped reduce the filtration time from 14 hours per batch to 11 hours, thereby increasing productivity. My work at the industry taught me the importance of doing work which can be applied in the real world and has enthused me to pursue doctoral studies in such areas.

In my junior year, I took courses on Applied Time Series Analysis and Process Control and took an immediate liking to the subjects due to their elegance, interdisciplinary application and mathematical rigor. Around this time, I was awarded a Fellowship to work with Prof. Vassily Hatzimanikatis, Head of the Laboratory of Computational Systems Biotechnology at the École Polytechnique Fédérale de Lausanne (EPFL), on regulatory architectures and dynamic characteristics of biochemical reaction networks. During my stay in Switzerland, I helped refine Prof. Hatzimanikatis's multiple steady state analysis in Escherichia Coli and extended his work to analyze the stability of steady states, computed using an efficient implementation of the C-GRASP metaheuristic in C++. Further, I also used pre-existing models of reversibility and regulation to analyze their effects on stability. My wonderful research experience at EPFL has further convinced me that I belong to the world of academia.

In my junior year, I also had the opportunity to take a graduate elective course titled Finite Element Methods in Engineering, offered by Prof. Tanmay Basak of the Department of Chemical Engineering at IIT Madras. I took a liking to the computational aspects of the course and started implementing the algorithms/techniques discussed in the course in FORTRAN, a programming language. I decided to undertake a course project and worked on the Solution of the Laplace Equation using two-dimensional Orthogonal Collocation Finite Element Method. I implemented the above method in FORTRAN and found that the results were in good agreement with the journal articles published by Prof. Basak for various practical boundary conditions. Later that year, I received the Institute Merit Award, given to the student with the best academic performance in Chemical Engineering, from the Department of Chemical Engineering, IIT Madras.

As a part of my undergraduate thesis, I am currently working with Prof. Arun Tangirala of the Department of Chemical Engineering at IIT Madras on the Topological Reconstruction of Networks from plant data using frequency domain measures of Granger Causality such as the Directed Transfer Function and Partial Directed Coherence. I am also looking at the estimation of directed energy transfer and through that, the strengths of connectivities between the various pairs of elements in a network, which has applications in fields like neurological and regulatory networks, multivariable controller design and interaction assessment.

Alongside the research projects and courses I have undertaken, I have also taken part in many co-curricular and extra-curricular activities. I have won prizes in several competitions such as Math Modelling, Puzzle Championship and Chemtrek in Shaastra, the annual technical symposium of IIT Madras. I have coordinated keynote events in Shaastra such as Online Math and Math Modelling and have likewise held positions of responsibility in the Quality Management System of Saarang, the annual cultural festival of IIT Madras, and the Chem Modelling organizer in Chemclave, the annual technical symposium of the Department of Chemical Engineering at IIT Madras. I have also had the privilege of volunteering for the National Service Scheme (NSS), in which I helped design and demonstrate science experiments to deprived school students as a part of the Science Activities team. I have always liked to share knowledge with my peers and juniors and had the pleasure of training a group of Class X students for the Mathematics Olympiad at the Science and Math Academy for Real Talents (SMART), Chennai for a period of three years. I was elated when one of my students was selected to attend the International Mathematics Olympiad Training Camp held in Mumbai. The activities I have pursued apart from my research indicate my ability to coordinate and communicate effectively and I believe that these qualities will help me in my academic career.

Thus, I feel that my consistently excellent academic performances and my zest for acquiring and propagating knowledge, as demonstrated by my experiences, make me a good candidate for a PhD at MIT. The years I have spent at IIT Madras have taught me the importance of studying at a top notch institute with a bright and competitive peer group and thus, I feel that joining a world-class research institute such as MIT would give me the right atmosphere for my graduate studies and hold me in good stead for my future in academia. I sincerely believe that my dedication, commitment and focused approach will help me shine in my area of graduate study and enable me to contribute something useful to the world of academia.

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