Shaunak Joshi

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Research Interests

Lithium-based batteries, Electrochemistry, Electrochemical energy storage, Physics-based battery modeling, Electric vehicles, Next generation batteries, Lithium-sulfur batteries

Education

Indian Institute of Technology, Bombay *Mumbai, India*
Dual Degree (B.Tech + M.Tech) in Energy Science and Engineering *2017 - 2022*

GPA: 8.67/10
Master's Thesis: Mathematical modeling and simulation of lithium-sulfur batteries

Scholastic Achievements

- Awarded **Institute Academic Prize** (**41** out of **900** students) for exemplary academic performance in academic year 2020-21
- Department Rank **5** in a batch of **30** students; Secured **9+** SPI (semester performance index) in previous **3** semesters *Present*
- Presented in **AMIIUAC conference** surveying the state-of-the-art developments in energy systems of humanoid robots *2020*
- Secured **99.40** & **99.81** percentile amongst 1.2 million participants in **JEE Mains** & **JEE Advanced** respectively *2017*
- Secured a state rank of **60** out of **400,000** candidates in **MHT-CET** (Maharashtra - Common Entrance Test) *2017*

Research Experience

Mathematical modeling and simulation of lithium-sulfur batteries | **Master's Thesis** *IIT Bombay*
Prof. Venkatasailanathan Ramadesigan, Energy Science & Engineering Department *Spring 2020 - Present*

- Simulated an equivalent 0-Dimensional Li-S battery model using **PyBaMM** package in **Python**
- Verified the consistency of results from Python by simulating the same 0-Dimensional Li-S battery model in **MATLAB**
- Graphically demonstrated the **effects of precipitation and dissolution** on the voltage discharge and charge curves respectively
- Currently working on developing **1-Dimensional** and improving **tanks-in-series** models by including shuttling phenomenon

Control of multi-modular nuclear power plants | **Research Internship** *University of Illinois Urbana-Champaign*
Prof. Rizwan Uddin, Nuclear, Plasma & Radiological Engineering *Summer 2020*

- Proposed an **original** mathematical idea to evaluate correction factors enhancing header steam pressure decoupling
- Incorporated **disturbance estimation** via transfer function in order to estimate values of valve opening compensators
- Using **MATLAB Simulink**, analyzed the control system model of small modular reactors at the common steam header
- Conducted an in-depth literature review on control of small modular reactors and their involved nuclear physics

An overview of energy systems in humanoid robots | **Research Internship** *Defence R&D Organization (DRDO), India*
Dr. Sanjay Talole, R&DE (DRDO), Dighi, Pune *Summer 2019*

- **Published** an extensive academic review paper in a national University Grants Commission (UGC) approved journal as **1st author**
- Analyzed modern technologies like **nuclear batteries**, piezoelectricity to **increase endurance** of humanoid energy systems
- Designed thorough selection methodology built on power, energy, weight, price, maintenance and safety of energy systems
- Performed an extensive literature review on energy systems in humanoid robots, with focus on **ASIMO** and **HUBO** humanoids

Flow optimization in vanadium redox flow batteries (VRFB) | **Supervised Learning Project** *IIT Bombay*
Prof. Dayadeep Monder, Energy Science & Engineering Department *Autumn 2019*

- Modified existing **1D VRFB model** validating effects of key parameters like flow rate & SoC on vanadium concentration profiles
- Produced characteristic IV curve and concentration profiles of vanadium ions in VRFBs on **COMSOL** using the 1D model
- Studied in-depth chemistry & mechanisms of redox flow batteries along with existing models of VRFBs in a semester long project

Recycling and repurposing of end-of-life electric vehicle batteries | **Energy Design Project** *IIT Bombay*
Prof. Venkatasailanathan Ramadesigan, Energy Science & Engineering Department *Spring 2021*

- Maximized financial and environmental benefits via recycling and repurposing applications of end-of-life EV batteries
- Achieved **12% cost recovery** on purchase price of lithium ion batteries for EVs through a complete techno-economic analysis
- Demonstrated benefits of repurposing on financial and environmental fronts incorporating a B2U model and designing BMS
- Optimal process included **pyrometallurgical** recycling after repurposing EV battery for **peak-shaving** stationary applications

Major Projects

Modeling and simulation of lithium-sulfur batteries | **Bachelor's Seminar** *IIT Bombay*
Prof. Venkatasailanathan Ramadesigan, Energy Science & Engineering Department *Autumn 2020*

- Enhanced understanding of working and unique features like **precipitation of polysulfides** and **shuttling phenomenon**
- Explored specific challenges in lithium anode, sulfur cathode and organic electrolyte with respect to modeling Li-S batteries
- Identified the research direction for Master's thesis via an extensive literature survey on existing models of Li-S batteries

Optimal sizing of rooftop solar PV battery energy storage system (BESS) | **Course Project** *IIT Bombay*
Prof. Venkatasailanathan Ramadesigan, Energy Science & Engineering Department *Autumn 2020*

- Deduced requirement of atleast **90%** subsidy for BESS financial feasibility using **nonlinear exhaustive search optimization**
- Developed a model of **BESS** for sizing domestic rooftop solar PVs of an average Indian household in a team of 4 on **MATLAB**
- Obtained real time weather data to identify design parameters and optimize energy and power requirement of BESS

Forecasting of wind power | **Course Project** *IIT Bombay*
Prof. Zakir Hussain Rather, Energy Science & Engineering Department *Autumn 2020*

- Built a statistical wind forecasting model on **MATLAB** using Adaptive Network-based Fuzzy Interference system **(ANFIS)**
- Validated results obtained from short-term forecast model for four cities in Malaysia with RMS error of approximately **4%**
- Analyzed merits of **physical** and **statistical** approaches in forecasting wind power from Indian and international perspective

Net zero energy CSMT (Mumbai) railway station | **Term Paper** *IIT Bombay*
Prof. Satish Vitta, Metallurgical Engineering and Materials Science Department *Autumn 2020*

- Analyzed feasibility by following systematic **5-step approach** considering real time data and effects on **3P's** of sustainability
- Achieved **94%** energy consumption coverage from rooftop solar PVs utilizing CSMT administrative buildings and platforms
- Explored alternative energy sources including **piezoelectric platform**, floating solar panels and biomass-based generation

Technical Skills

Programming	C++, Python, PyBaMM, NumPy, Pandas, MySQL
Software	COMSOL Multiphysics, MATLAB, AutoCAD, SolidWorks, Design Builder, LaTeX

Mentorship & Leadership Experience

Head | **Department Academic Mentor Program, Department of Energy Science and Engineering** *Summer 2020 - Summer 2021*
*Head of the **14** member mentorship team responsible for mentoring **40+** sophomore and academically challenged students*

- Completed crucial **academic reforms** including refining electives, establishing interdisciplinary master's and exit-degree policies
- Achieved a **220%** Y-o-Y growth in engagement on student blog enhancing students' **academic** and **co-curricular** experience
- **Three-time mentor**, mentoring **4** sophomores and **5** academically severely affected juniors as well as **seniors** *2019-Present*

Institute Student Mentor | **Student Mentorship Program** *Summer 2021 - Present*
*One out of selected 133 out of 300 applicants based on interview, peer reviews and substantial **overall performance***

- Guiding **12** undergraduate freshmen in their smooth personal, academic and co-curricular transition to college life
- Helping economically weaker students in **procuring scholarships** for tuition and associated resources for online learning

Teaching Assistant | **Department of Energy Science and Engineering** *Autumn 2021*
Prof. Venkatasailanathan Ramadesigan, Energy Science & Engineering Department

- Serving as **Teaching Assistant** for **33** students in Energy Systems Modeling and Analysis course
- Responsible for grading assignments, along with solving technical and academic queries for the students of the course

Manager, Energy Club | **Institute Technical Council** *Summer 2019 - Summer 2020*
*Head of a two-tier team of 3 conveners and 2 volunteers, representing **200+** clean-tech enthusiasts*

- Achieved **70%** Y-o-Y growth in participation and outreach by **promoting technical discussions** on energy-related topics
- **Spread energy awareness** in campus through lectures, discussions, quizzes, industrial visits and hands-on-workshops
- Conducted **14** events, utilizing a budget of over **USD 1400** to maximize **student involvement in energy** and connected topics

Secretary, Energy Students' Association | **DESE Department Council** *Summer 2018 - Summer 2019*
*Part of **7** membered council responsible for functioning of DESE, IIT Bombay affecting **400+** students*

- Took up responsibility to organize informal department-level activities, enhancing **junior-senior** and **student-faculty interaction**
- Organized events like outdoor trip and cultural day to **break the ice** between department students **from all programs** and faculty

Key Courses Undertaken

Electrochemistry	Electrochemistry, Electrochemical Energy Storage, Electrochemical Materials Science, Thin Film Technology, Electrochemical and Materials Perspective in Energy Storage
Energy	Transport Phenomena, Power Electronics, Control & Instrumentation, Electrical Energy Systems, Thermodynamics, Nuclear Reactor Theory, Materials for Sustainable Development, Energy Policy Analysis, Renewable Energy Integration
Math & Programming	Linear Algebra, Differential Equations, Data Analysis, Numerical Analysis, Energy Systems Modelling and Analysis, Probability & Random Processes, Computer Programming and Utilization, System Modelling and Simulation, Introduction to Machine Learning

Extracurriculars

Social engagement

- Volunteered in SoULS to teach 2000 students with **limited electricity access** to build solar lamps
- Documented lives of **students with disabilities** to spread awareness and **raise funding** in team of 14

Technical

- Constructed an antenna capable of importing **weather signals** from NASA weather satellite NOAA18
- Mentor to **3** students in summer science projects on technical aspects of **lithium-based batteries**
- Stood **2nd out of 12** teams in **Shell** Sustainable Business inter-college competition in team of 4

Miscellaneous

- Actively involved in **badminton, soccer** and **hockey**, winning multiple championships at IIT Bombay
- Attended industrial visits to Tarapur Atomic Power Station, Reliance Metro, IIT Bombay biogas plant
- **On-field work experience** as an operations intern at a cookie-producing startup, Open Secret

References

Prof. Venkatasailanathan Ramadesigan
Associate Professor
Energy Science and Engineering
IIT Bombay
Webpage ◇ Email

Dr. Sanjay Talole
Senior Scientist
R&DE (DRDO) Dighi, Pune
Defence R&D Organization
Google Scholar ◇ Email

Prof. Zakir Hussain Rather
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