Soham Phanse

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Research Interests

System Dynamics Modelling of Socio-Economic Systems, Public Policy Design and Analysis, Space Technology, Systems Engineering and Project Management

Education

B.Tech (Honors) in Aerospace Engineering — Indian Institute of Technology Bombay — GPA: 8.99/10 Mumbai, India

Coursework: Structures, Propulsion, Aerodynamics, Control Systems and Optimization, Systems Design and Engineeering

Minor: Artifical Intelligence and Data Science

Academic Achievements

- Offered **MITACS Globalink Graduate Fellowship** of $15,000 for graduate studies in Canada *('21)*
- Awarded **MITACS Globalink Research Internship Award** of $8,900 for a Summer Research Internship in Canada *('21)*
- Selected among the **Top 23** finalists for the prestigious **Honda Y-E-S Award** from **345** applicants from **6 IITs** *('21)*
- Awarded **Undergraduate Research Award** for developing a System Dynamics framework to model India's energy use *('21)*
- Awarded a **Conference Student Award** of $2000 by SmallSat 2022, Utah State University, Logan, U.S
- Secured a merit-based **Branch Change** to Department of **Aerospace Engineering**, IIT Bombay *('20)*
- Ranked 85^{th} in **MHT-CET** (Engineering Entrance test of Maharashtra State) 2018 among 1,30,000+ candidates *('18)*

Publications and Conferences

- ___, **Phanse S.** et al, "AstrIS: An Astronomical Image Simulation framework for Star Tracker verification" abstract accepted in **SmallSat 2022**, Logan, Utah, United States *('22)*
- Presented 'Star Tracker Design for Nano-Satellite Applications (Poster and Project Competition)' and was awarded **third prize** at the **International Conference on Small Satellites** (Jalandhar, India), Apr 28-30, 2022 *('22)*
- **Soham Phanse** (2021), "BIG Data Analysis of NASA's 5 Millennium Solar Eclipse Database (v1.0)" Zenodo. https://doi.org/10.5281/zenodo.5809996 *('21)*
- Katla V., **Phanse S.** et al, "An Approach to Star Tracker Design for Nano-Satellite Applications" (extended abstract) presented in **National Conference on Small Satellite Technology & Applications**, India, 2020 *('20)*

Research Internship

Visiting Research Scholar — University of Toronto Toronto, Ontario, Canada

Prof. Hugh Liu, Institute of Aerospace Studies, University of Toronto *(May'22 - Present)*

- Design, development and flight testing of a novel water sampling assembly by an Octarotor Tarot 15

Research Projects

System Dynamics Modelling Framework for Industrial Energy Use | *Report* *(Jun '20 - Jul '21)*

Guide: Prof. Rangan Banerjee, Department of Energy Science and Engineering

- Constructed a **systems theory-based framework** to analyze static and dynamic energy usage
- Implemented **Interface Control Document**-based structures, **Process Flow Diagrams** and **Stock** and **Flow** diagrams to depict energy balance of steel, aluminium and paper industries with **Sankey** diagrams
- Formulated discrete-time governing equations and created **Causal Loop Diagrams** for dynamic modelling of energy usage with a case of **Population Dynamics** and energy usage of IITB campus

Design Optimization with FEniCS *(Oct '20 - Jun '21)*

Guide: Prof. Amuthan Ramabathiran, Department of Aerospace Engineering

- Implemented numerical techniques like **Finite Difference Method**, **Backward and Forward Euler Methods** in Python, and **Finite Element Method** (Galerkin Approximation) for ODE in **Python**
- Implemented numerical solutions of PDEs governing deflection of membrane with point load, 2D linear elastic analysis of a cantilever beam, time-dependent heat equations with the **Finite Element Method** in **FEniCS**
- Explored **Calculus of Variations**, **Functional Optimization** with Euler-Lagrange equations and applied it to **Shape** and **Topology** Optimisation problems like compliance minimisation of a cantilever beam

Teamwork Experience

IIT Bombay Student Satellite Program *(Mar '20 - Present)*

A 70-member student team dedicated to the vision of making IITB a center of excellence in space technology

PSLV-Stage 4 Orbital Platform Mission

Design and Development of a **Star Tracker based Attitude Determination System for Nano-Satellites**

Team Leader & Systems Engineer *(Dec '21 - Present)*

- Leading an interdisciplinary 3-tier team of 60+ members across 5 subsystems to build Cubesat and allied subsystems
- Pitched and got approval for a funding of $15k for CubeSat development from LnT Infotech
- ICSS 2022
- Led a **3 step** recruitment process to select **students** for the team out of _+ **applicants**

Subsystem Head *(Aug '21 - Present)*

- Leading an interdisciplinary team of 6 members for CubeSat structural and thermal design
- Compiled rigorous **Quality Assurance and Version Control** practices for SolidWorks and ANSYS
- Refined existing practices to ensure reliability and reproducibility in simulation results

Mechanical Engineer *(Jan '20 - Present)*

- Ideated the configuration layout and design for the star tracker Module on SolidWorks.
- Performed structural simulations on ANSYS for ensuring launch load compatibility
- Integrated the module and made Interface Control Documents
- Prototyped the module for analysing manufacturing defects through 3D printing.
- Designed and performed verification tests for the hardware and software setup

Select Course Projects

Systems Engineering Analysis of Autonomous Surveillance System | *Report* *(Jan '21 - May'21)*

Guide: Prof. Hemendra Arya - AE759 Systems Engineering Principles

- Conceptualised multiple configurations for the system and finalised one by comparing parameters like surveillance unit topology, vehicle parameters, communication protocols with help of **Decision Matrices**
- Decomposed the system to obtain clear **System Hierarchy**, and conceptualised the **System Architecture**
- Formulated exhaustive **functional**, **performance**, **transition**, **support** and **disposal** requirements and an exhaustive **testing plan** for verification and validation testing while ensuring **bi-directional traceability**
- Implemented Operational Capabilities, System Architecture and Operational Scenario Diagrams in **Capella**

Portfolio Optimization for Efficient Investment | *Report* *(Jan '22 - Apr '22)*

Guide: Prof. Abhijit Gogulapati - AE755 Optimization for Engineering Design

- Implemented **Markowitz's Critical Line Algorithm** to find the efficient investment frontier for minimum risk
- Benchmarked the results with the algorithms from the **PyPortfolioOpt** library

Flight Dynamics Analysis of Naviator | *Report* *(Jan '22 - Apr '22)*

Guide: Prof. Shashi Ranjan Kumar - AE305 Flight Dynamics

Control System Design | *Repository* *(Jul '21 - Nov '21)*

Guide: Prof. Arnab Maity - AE308 Control Theory

- Designed multiple **Lead Compensators** to satisfy the system specifications like **overshoot** and **settling time**
- Designed and implemented a **PI** controller to produce a system output with **zero steady state error** for various inputs

PSLV Rocket Engine Analysis | *Report* *(Aug '21 - Nov '21)*

Guide: Prof. Hrishikesh Gadgil - AE330 Aerospace Propulsion

- Analysed the stage configuration of the **PSLV** and calculated mass ratios for each of the 4 stages
- Studied the Burn Profile, Propellent Grain Configuration of the motor and nozzle geometry of all stages
- Calculated performance parameters for Solid and Liquid Rocket Engine Thrust chambers & Feed systems

Spacecraft Trajectory Planning and Analysis | *Report* *(Jan '21 - Apr '21)*

Guide: Prof. Ashok Joshi - AE240 Spaceflight Mechanics

- Analyzed specifications of **Space Shuttle** Mission STS-51G and orbital parameters of payload **ArabSat-1B**
- Designed a burn profile and trajectory with constraints of mass, velocity, acceleration, altitude and range with **Constant Pitch Rate Gravity turn** trajectories for the launch vehicle

- Simulated Orbital Maneuvers for the shuttle and **Hoffman Transfers** from Low Earth Orbit to the Geostationary Orbit, and **Plane Change** maneuvers for ArabSat-1B in Python

Scramjet Engine Analysis | *Report* *(Jul '20 - Nov '20)*

Guide: Prof. Krishnendu Sinha - AE223 Thermodynamics and Propulsion

- Studied about compressible fluids, total enthalpy, normal and oblique shocks, **ram effect**, choked flows etc.
- Analyzed intake, combustor, and nozzle of a **Scramjet** Engine in the hypersonic flow regime
- Studied effect of nozzle geometry on thrust and **Single Ramp Expansion Nozzle** with different values of the **Base Expansion factor** to calculate maximum value of thrust

Big Data Analysis of NASA's 5 Millennium Solar Eclipse Database | *Repository* *(Mar '21 - Nov '21)*

Guides: Profs. Amuthan R., Prabhu R., Amit S., Sunita S., Manjesh H., Sudarshan S. - DS203 Data Analysis

- Visualized data effectively, computed **sampling distributions**, **confidence intervals** & performed **Hypothesis testing**
- Performed **Regression** on various parameters and implemented **K-means clustering** to analyse the data

Positions of Leadership

Department Academic Mentor *(Jul '21 - Present)*

- Selected into a **team of 23 mentors** based on extensive **peer reviews and interviews**
- Entrusted with the responsibility to monitor the academic performance of **6 second-year** undergraduate students and provide academic guidance and counsel and help improve academic performance
- Involved in bridging the student-faculty gap, thereby enhancing the students' academic experience by **curating reading material** and detailed solutions for improvement in conceptual understanding of students

Manager, Controls and Dynamical Systems Student Community *(Jul '21 - Present)*

- Arranged multiple talks, workshops by emminent speakers based on Control Theory, Optimization, Dynamical Systems by senior students, alumni and professors for knowledge sharing and fostering interest within the student community
- Created a new website for documenting past events and and building an online presence for interested students
- Collaborating with Aeromodelling Club to arrange mentors for launching projects like designing ornithopter, autonomous drones and thrust vectoring rocket

Technical Skills

Programming	Python (scipy, matplotlib, seaborn, pandas, sklearn, pytorch, FEniCS, control, pyPortfolioOpt), C++
Softwares	MATLAB, GitHub, Capella, LaTeX, Google-Office
Design & Simulation	SolidWorks, ANSYS Workbench and AutoCAD
Equipment	3D printing

Extra Curricular Activities

Public Speaking

- Delivered a talk to 80+ students on '**Systems Engineering and Project Management**' and applications *('22)*
- Interviewed by the Editorial Team of Magazine '**Shaastra'** - the annual technical magazine of **IIT Madras** on **Emerging Space Technologies** and role of Student Satellite Teams in the current space scenario *('22)*
- Presented the annual report of Student Satellite Program to Faculty Committee for budget approval of $20k *('22)*
- Guided _+ of freshman year undergraduates for counseling and guiding them to select the engineering major *('21)*
- Organised a day-long workshop and delivered a talk on '**Structural Design of Ground Station**' for equipping **150 participants** from **40+ universities** to set up a ground station *('21)*

Miscellaneous

- Developing and maintaining a **blog on System Dynamics** to share experience and knowledge with the community
- Learned playing acoustic **Guitar** in a 3-year long course and **Harmonium** via self study
- Devoted **80** hrs of service towards **environment** and **sustainability** under **National Service Scheme**, IITB *('19 - '20)*

Mentoring and Guidance

- Volunteered as a mentor for **Student Solar Workshop - 2019**, a program to train students to assemble solar study lamp and resulted in a **Guinness World Record** for lighting 6800+ solar lamps simultaneously *('19)*
- Participated as a mentor for Glider-Making workshop of Aeromodelling Club of IITB for freshmen *('20)*

Recommenders

- Prof. Rangan Banerjee, Director, IIT Delhi
- Prof. Varun Bhalerao, Professor, Department of Physics, IIT Bombay
- Prof. Hemendra Arya, Professor, Department of Aerospace Engineering, IIT Bombay
- Prof. Hugh Liu, Professor, Institute of Aerospace Studies, University of Toronto