NAKUL RANDAD

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Education

Examination	University	Institute	Year	CPI/%
Graduation	IIT Bombay	IIT Bombay	2022	9.29/10
Intermediate/+2	Maharashtra HSC	Dawale Jr. Science College, Akola	2018	93.85 %
Matriculation	Maharashtra SSC	Mount Carmel High School, Akola	2016	97.20 %

Major Degree: B.Tech. with Honors in Aerospace Engineering, IIT Bombay *(currently pursuing)*
Additional Degree: Minor in Systems and Control Engineering, IIT Bombay *(currently pursuing)*

Scholastic Achievements

- **Ranked 2^{nd}** amongst 59 students in the Department of Aerospace Engineering
- Awarded **Institute Academic Prize (1^{st})** - IIT Bombay for the academic year 2019-20 and 2020-21
- Recipient of the **Institute Technical Special Mention** for exemplary technical contributions in the institute *[2020]*
- Selected to participate in **DST-INSPIRE Internship Camp** held at IISER, Pune *[2016]*

Professional & Industrial Experience

Quantitative Summer Analyst | Goldman Sachs, Bengaluru *[Jun 2021 - Jul 2021]*
Multi-Asset Solutions, Asset Management Division

- Analysed **corporate bonds relative to equity** for varying valuations, macro-economic conditions and tenors
- Identified high-momentum/mean-reverting assets across classes by **Variance-Ratio test** to exploit using options

Underwater Remotely Operated Vehicle (ROV) *[Jan 2020 - Present]*
A joint effort by IIT Bombay (PI: Prof. L. Vachhani) and Larsen & Toubro Ltd. under IMPRINT IIC scheme

- Spearheading the team developing **Class-1 ROV** to be deployed in sea-waters for scanning and ship maintenance
- Performed **hydrodynamic analysis**(CFD) & incorporated drag in controller to reduce **stabilization time** by **40%**

Key Projects

Trajectory Optimization of Reusable Launch Vehicle | Bachelor's Thesis *[May 2021 - Present]*
Guide: Prof. D. Chatterjee and Prof. R. Banavar, Systems & Control Eng., IIT Bombay

- Modelled the system as a **high-dimensional optimization** problem with complex path and landing constraints
- Solved constrained optimal control problem by parameterizing states and controls by **quasi-interpolation** scheme

Autonomous Underwater Vehicle (AUV-IITB) | Website *[Oct 2018 - Present]*
An all-student team working on development of underwater robots that navigate & perform realistic tasks
Accolades: ***Young Researcher Prize****, IEEE OES 2021, Japan |* ***Winner****, NIOT-SAVe 2019, Chennai*

Mechanical Designer | AUV-IITB *[Oct 2019 - Present]*

- Implemented **topology optimization** methods on exoskeleton of the vehicle, reducing weight by **25%**
- Fabricated an **underwater robotic gripper arm** (weight capacity **:** 1.5kg) by genetic algo. with two DoFs
- Formulated an **algorithm** to ensure **optimal positioning of thrusters** on a body to ensure 6 Degrees of Freedom

Fabrication Engineer | AUV-IITB *[Oct 2018 - Sep 2019]*

- Devised an **in-air waterproofing feedback mechanism**, capable of increasing depth rating of hulls by **50%**
- Designed a **multi-seal underwater connector** which has current rating upto **80 A** and a depth rating of **10 m**
- Performed **static structural** analysis(FEM) of **hyperelastic materials**(O-Rings) to estimate optimal sealing force

Path Optimization for Combinatorial Problems | Source & Documentation *[Jan 2021 - Apr 2021]*
Development of multiple optimization tools to solve the travelling-salesman problem

- Devised heuristic & exact algorithms for combinatorial optimization of **mixed-integer programming** problem
- Performed comparative analysis of **Genetic, Ant Colony, Simulated Annealing** and **Branch** & **Bound** methods

Direct Methods for Optimal Control | Source & Documentation *[Jan 2021 - Apr 2021]*

- Implemented direct collocation and pseudospectral methods for **constrained nonlinear** optimization problems
- Achieved over $18\times$ **time efficiency** over shooting methods with NLP solver (Ipopt) by faster convergence rates

Flow Analysis of Rotary Machines *(Mar 2021 - May 2021)*

- Modelled trailing vorticity by **Free-Wake Theory** as a series of vortex filaments by **predictor-corrector** method
- Incorporated **ground-effects** on the rotor efficiency | Developed a visualization tool for the magnitude of effect

Time Optimal River Crossing Problem | Source & Demo *[Aug 2020 - Dec 2020]*

- Devised the **navigation strategy** for a high dimensional boat problem using **Pontryagin's maximum principle**
- Utilized shooting methods to numerically solve the boundary value problem achieving $< 0.01\%$ **L2-loss**

Solar Radiation Prediction | Source *[Feb 2020 - Apr 2020]*

Implemented a machine learning model which predicts Solar Radiation for varying time-horizons

- Achieved **20**% **MAPE** using **support vector machine** and compared it with custom **neural network model**
- Constructed **3 layer MLP** architecture in NN with ReLU activation and SVM classification using **RBF kernel**

Topological Data Analysis *[Jun 2020 - Jul 2020]*

- Analyzed biological and ecological systems using **group theory** and **simplicial complexes** (topological)
- Worked on novel topological methods for data-driven estimation and analysis using **GUDHI package**

Controller Design and Analysis *[Aug 2020 - Dec 2020]*

Classical Control Theory | *Guide: Prof. Arnab Maity, Aerospace Eng. Dept., IIT Bombay*

- Designed a **lead-lag compensator** based controller for a system using bode plots and root locus
- Analysed unit step response & achieved **steady-state error** of $<$ **5%** and **phase margin** of around **45**$^\circ$

State Space Methods | *Guide: Prof. Ashok Joshi, Aerospace Eng. Dept., IIT Bombay*

- Developed a **full-state feedback** controller for a system | Reduced observer dynamics settle time by **60%**

Modelling of Biological System *[Oct 2020 - Dec 2020]*

A multi-DoF engineering approximation of Humming Bird using rigid and flexible links, springs and dampers

- Estimated **energy cost per cycle** of flying and hovering ($<$ **15%** error) | Developed visualization tool for motion

Big Data Analytics *[Mar 2019 - Apr 2019]*

- Inspected data using **statistical tools** on most popular movies (from IMDb) to predict movie ratings **a-priori**
- Developed a **linear regression** model on the refined data-set to find causation and predictions of the variables

Technical Skills

Programming & **Scripting**	Python | C++ | MATLAB | SQL | HTML + CSS
Softwares	IPOPT | SolidWorks | ANSYS (Mechanical, Fluent) | Simulink | AutoCAD
Frameworks	Git | ROS | TensorFlow | OpenCV | CasADi

Positions of Responsibility

Team Leader | AUV-IITB, IIT Bombay *(Jun 2021 - Present)*

Accolades: ***Ranked 2nd*** *in Tech. Demonstration &* ***4th*** *in Technical Design Report, RoboSub 2021, San Diago*

- Managing **operations, logistics and knowledge transfer** in a **4-tier** multi-disciplinary student team
- Setting vision and strategy for a **40+ membered team** | Planning for cognate risks and contingencies
- Represented the team in **R&D Technical Exposition**, IIT Bombay with a **400+ total audience**

Institute Student Mentor | Student Mentorship Program (SMP), IIT Bombay *(Jun 2021 - Present)*

- Part of a team, selected based on extensive interview and peer reviews, that mentors freshmen students
- Responsible for mentoring a group of incoming students to provide necessary support, academic and otherwise

Team Leader | AgroBot Design Innovation Challenge | Source *(Mar 2021 - Apr 2021)*

Contingent representing IIT Bombay for AgroBot Challenge at 9th Inter IIT Tech Meet

- Led the **team of 6** students to design an agricultural robot capable of mechanized farming in hilly terrain
- Presented the product concept, innovative features and market impact | **Ranked 3rd** across India

Department Academic Mentor | Aerospace Eng. Dept., IIT Bombay *(Jul 2020 - Jun 2021)*

- Part of a **19** member team, selected based on extensive interview and peer reviews, which mentors **70+ students**
- Responsible for monitoring the performance of **5 second-year** students providing academic guidance and counsel

Convener | Tinkerers' Laboratory, IIT Bombay *(2019 - 2020)*

*A 24*7 'Makerspace' for innovators; open to all the students to promote hands on learning experience*

- Launched monthly **Do-It-Yourself (DIY) projects** and brainstormed with the participants to develop prototypes
- Managed inventory worth $\sim$ **6M INR** | Orchestrated **TL Talks**, a lecture series by prominent industrialists

Extra Curricular Activities

Presentations	• Presented poster at **1st National Tech. Symposium**, IIT Madras | Received special mention
Social	• Increased awareness of marine issues at **4th World Congress on Disaster Management**
Sports	• Completed Prarambh Swimming Camp and a year-long guitar course by IITB Sports
Lingual	• Pursued **German Communication Course** by International Relations Office, IIT Bombay
Miscellaneous	• Industrial visit to **Hindustan Aeronautics Ltd.** - (Nasik) assembly line and manufacturing unit • Involved in open-source game development (Source) | Interested in music (Guitar and Ukulele)