

Amal S Sebastian

Curriculum Vitaé

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Education

2017–2022 **Master of Technology and Bachelor of Technology**
Indian Institute of Technology Bombay, Aerospace Engineering, GPA – 9.25/10.
Pursuing Minor in Computer Science and Engineering

Research Interests

Computational Fluid Dynamics, Meshfree methods, Data driven CFD modelling, Multiphase flows, Biological Flows, Turbulence, Uncertainty Quantification, Optimization

Publications

Published Prabhu Ramachandran, Aditya Bhosale, Kunal Puri, Pawan Negi, Abhinav Muta, A. Dinesh, Dileep Menon, Rahul Govind, Suraj Sanka, **Amal S. Sebastian**, Ananyo Sen, Rohan Kaushik, Anshuman Kumar, Vikas Kurapati, Mrinalgouda Patil, Deep Tavker, Pankaj Pandey, Chandrashekhkar Kaushik, Arkopal Dutt, and Arpit Agarwal. 2021. PySPH: A Python-based Framework for Smoothed Particle Hydrodynamics. *ACM Transactions on Mathematical Software*. DOI : <https://doi.org/10.1145/3460773>

Research Projects

- 2021 - **Surface Tension Modelling in Smoothed Particle Hydrodynamics**
Present *Guide: Prof. Prabhu Ramachandran, Dept. of Aerospace Engineering, IIT Bombay.*
- Worked on implementing and reproducing results of six **standard surface tension** models in Smoothed Particle Hydrodynamics for an open-source SPH framework, **PySPH**.
 - Tested the implemented models against a variety of **benchmark tests** to assess how they capture interfacial oscillations, their performance in high density ratio and high viscosity ratio simulations as well as their ability to capture complex interfacial dynamics for problems like Kelvin-Helmholtz instability.
 - Based on the conclusions drawn from the benchmark tests, currently working on using the appropriate models to problems with **real world applications** like an air bubble rising in water, droplet collision, breakup of a jet.
- 2020 **Simulation of vortex rings, sloshing tanks, dam break using SPH**
Guide: Prof. Prabhu Ramachandran, Dept. of Aerospace Engineering, IIT Bombay.
- Implemented a Gaussian vortex ring simulation using PySPH. Currently working on simulating collision of vortex rings and verifying accuracy of simulations done so far.
 - Carried out simulations of rectangular sloshing tanks under **horizontal and rotational excitations**. Compared computed results with experimental data from literature and close agreement between the two was obtained.
 - Simulated multiple dam break problems in 2D and 3D space with **various types of obstacles**. Computed results showed good agreement with experimental results.
- 2019 **PySPH and Mayavi**
Guide: Prof. Prabhu Ramachandran, Dept. of Aerospace Engineering, IIT Bombay.
Worked on improving functionality and adding features to PySPH and Mayavi which are open source Python projects
- Developed code to generate **uniform** particle distribution and surface **particle distribution** of an object from its **mesh**, this is used for SPH simulations in PySPH.
 - Developed code to **visualize STL objects** along with their normals and allow for inversion of the normals using mouse interaction. This was done for Mayavi a 3D scientific data visualization toolkit.
 - Modified the Picker structure to display coordinate and data information on the scene using VTK's Text widget.
- 2020 **Computer Graphics Schemes and Multiphase Flows in Smoothed Particle Hydrodynamics**
Guide: Prof. Prabhu Ramachandran, Dept. of Aerospace Engineering, IIT Bombay.
- Studied various schemes like IISPH, DFSPH, PCISPH which are used in computer graphics simulations.
 - Carried out a **performance study** of these schemes for a large scale simulation, for multiple timesteps.
 - Implemented the Cohesive Pressure model to simulate multiphase flows in SPH. Successfully simulated an **air bubble rising in water** using this model.

Awards, Scholarships and Achievements

- 2021 Currently **ranked 2nd** in the Aerospace Engineering Dual Degree program.
- 2019 Inducted as a student member of the **Indian National Academy of Engineering**.
- 2019 Received AP grade for **exceptional performance** in Vibrations and Structural Dynamics course. (Given to 1 student out of 90)
- 2017 Secured All India Rank 1572 (**99.214 percentile**) in JEE Advanced 2017 among 200,000 students.
- 2017 All India Rank 834 (**99.93 percentile**) in the JEE Mains 2017 taken by over 1.2 million students.
- 2015 Recipient of the **prestigious** National Talent Search Examination (NTSE) **scholarship** given by NCERT.

Technical Projects

2020-2021 Intercity Electric VTOL Aircraft Design

NACDeC IV, Aeronautical Society of India, Guide: Prof. Dhwanil Shukla.

- o Led a team of five students in an 8 month long aircraft design competition and secured **2nd position** among 26 teams from all over the nation.
- o Conceptually designed an electric VTOL aircraft for intercity transport of both passenger and cargo, giving special attention to **wing, rotor and fuselage** design and ensuring that the RFP requirements are met.
- o Developed a Python toolkit for **VTOL sizing** and **rotor design** using ideas found in literature and the blade element momentum theory.

2018-2020 Senior Design Engineer

RAKSHAK, IIT Bombay.

RAKSHAK is a student tech team which designs and builds autonomous UAVs for search and rescue missions

- o Part of the **aerodynamics** subsystem which mainly deals with the design and manufacturing of the UAV.
- o Primarily involved in the structural and aerodynamic design of the wing, estimation of **performance characteristics** of the UAV using **computational and experimental** techniques.
- o Represented RAKSHAK at the Indian National Academy of Engineering's Youth Conclave under the Lab to Market category and secured **first place** among 30+ other teams from across the nation.

Key Course Projects

2021 Wind Farm Design Optimization

Guide: Prof. Abhijit Gogulapati, Dept. of Aerospace Engineering, IIT Bombay.

- o Carried out a **wind rose based optimization** problem for placing wind turbines on a given area of land in order to **maximize the profit** generated. Results obtained were consistent with standard benchmarks in literature.
- o Implemented Genetic, Simulated Annealing and Pattern Search algorithms from scratch to achieve results.

2021 Ray Tracing in Parallel

Guide: Prof. Shivasubramanian Gopalakrishnan, Dept. of Mechanical Engineering, IIT Bombay.

- o Achieved **250x speedup** compared to a serial ray tracer using parallel programming with **CUDA and MPI**.
- o Implemented **anti-aliasing**, finite light source and reflection properties to generate realistic looking images.

2020 Vortex Methods

Guide: Prof. Prabhu Ramachandran, Dept. of Aerospace Engineering, IIT Bombay.

- o Wrote generalized code for 2D vortex methods and simulated flow over a cylinder to obtain the **Karman Vortex Street** using **panel methods**.

2019 Trajectory Modelling of Long March 3B/Bediou 3M-15

Guide: Prof. Ashok Joshi, Dept. of Aerospace Engineering, IIT Bombay.

- o Designed the complete ascent mission trajectory of the four stages of Long March 3B, by finding the **optimal burn profile** and the gravity turn at each stage.
- o Found out the **optimal orbital manoeuvres** taken by Bediou 3M-15 to reach final orbit from point of release in actual mission time.

2018 Data Analysis

Guide: Prof. Prabhu Ramachandran, Dept. of Aerospace Engineering, IIT Bombay.

- o Analyzed how **education** affects various parameters of society on the basis of the 2001 districtwise **Indian Census** report using pandas library.
- o Correlated the data of literacy rate to various parameters such as sex ratio, number of educational institutions, graduates, workers.

Standardized Test Scores

GRE Quant - 170/170, Verbal - 158/170, AWA - 4.5/6.0
TOEFL Reading - 30/30, Writing - 28/30, Speaking - 25/30, Listening - 28/30

Technical skills

Languages C, C++, Python, Cython
Tools OpenMP, MPI, CUDA, XFLR5, Ansys Fluent, SOLIDWORKS, AutoCAD, Git

Relevant Coursework

Fluid Mechanics Particle Methods for Fluid Flow Simulation, Computational Fluid Dynamics, Numerical Methods for Conservation Laws, Hypersonic Flow Theory, Aeroacoustics, Rotary Wing Aerodynamics, Aerodynamics, Incompressible Fluid Mechanics, Compressible Fluid Mechanics
Computer Science High Performance Scientific Computing, Intro. to Machine Learning, Data Structures and Algorithms, Design and Analysis of Algorithms, Logic for Computer Science, Data Analysis and Interpretation, Computer Programming and Utilization

Teaching Experience

2021 **Teaching Assistant, State Space Methods for Flight Vehicles**

Dept. of Aerospace Engineering.

- Responsible for guiding 30+ **graduate and undergraduate** students, solving their doubts and boosting the performance of weak students.
- **Conducted tutorials** which included concept revision and problem solving, created the assignments and graded course evaluations.

2020-2021 **Teaching Assistant, Introduction to Launch Vehicle Analysis and Design**

NPTEL, Prof Ashok Joshi, Dept. of Aerospace Engineering, IIT Bombay.

NPTEL is a MOOC platform, offering a multitude of courses in various engineering disciplines

- Guided **2100+ students**, clarified their doubts daily and gave weekly feedback on their assignments.
- Responsible for creation of weekly assignments and their solutions, solutions for the final exam and ensuring accuracy of the content in the video lectures.

Positions of Responsibility

2020-2021 **Head, Department Academic Mentorship Program .**

Department Academic Mentorship Program(DAMP) provides necessary help and guidance to all sophomores and under performing upperclassmen

- Responsible for mentoring of **82** sophomores and representative of **250 students** in Dept. Undergraduate Council.
- Hand-picked a team of 18 mentors from 40 applicants via 3 week long interview and peer review process.
- Coordinated with faculty to monitor and counsel 11 students under the **Academic Rehabilitation Program**.
- Created a **new website** for the DAMP Blog, which houses various information ranging from course reviews to project reviews, to assist students in the department.

2020-2021 **Mentor, Department Academic Mentorship Program .**

- Responsible for looking after the **academic and non-academic welfare** of five second year students.
- Given the duty of looking after the academic well being of a student who was academically under performing.

Extracurriculars

2017-2018 Selected for one year training in **Table Tennis** under National Sports Organisation.

2018 Represented hostel in the **Table Tennis General Championship**, also secured second position in the intra hostel table tennis tournament.

2015 One among 100 students selected by **NCERT** to participate in the **National Youth Festival** conducted at NCERT, New Delhi on the basis of a creative writing competition as part of the Adolescent Education Program.