Anay Mohan Shembekar

Profile

Engineer-builder who goes deep and handles breadth, and enjoys **end-to-end ownership of a product**. Started in hardware: owned the **electric powertrain** of IIT Madras's SpaceX Hyperloop pod, then **stepped up to lead its entire 40+ engineer team**; the pod finished **8th of 1,600+ teams**. The PhD at IISc added **depth in simulation and experiments**, along with **teamwork and international collaboration**: silicon wafer testing at IEMN, France, finished in four months against a six-month plan. Brings a **finance lens from J.P. Morgan's quantitative research** and plans **people, money, compute and time** on every project: sets clear goals, breaks them into achievable targets with fair timelines, and delivers. Uses AI tools to move faster, checking every output against **domain expertise**, whether physics or finance. Looking to **own technology problems end to end** and help build products in India that compete in, and export to, world markets.

Education

Indian Institute of Science (IISc), Bangalore 2021–present
PhD, Aerospace Engineering (Prime Minister's Research Fellow); thesis submission expected Q2 2027; CGPA: 9.5/10

Indian Institute of Technology Madras 2015–2020
B.Tech, Mechanical Engineering + M.Tech, Robotics (Dual Degree); CGPA: 9.31/10; ranked 6th of 160+; 10/10 GPA in final semester

Engineering & Research Experience

Hyperloop Pod: EV Powertrain Design and Engineering Leadership Oct 2017 – Mar 2019
Engineering Team Lead (Mar–Jul 2018) · Propulsion Team Lead (Oct 2017 – Mar 2019) · Avishkar Hyperloop, IIT Madras

- **Stepped up to lead the entire engineering team (40+ engineers, 8 subsystems) for five months (Mar–Jul 2018) while the founders raised capital:** ran recruitment, set subsystem timelines toward the final design review, cut pod cost by about 10% through a component review, and pitched to alumni for funding.
- **Owned the powertrain end to end against a fixed propulsion budget:** selected motor, inverter and cells (EMRAX 268 PMSM, Bamocar D3, a **740 V 20s2p Li-Po pack** for 300 A continuous), worked directly with vendors including Siemens, and **designed the transmission in-house from first principles** instead of buying a costlier vendor unit.
- **Redesigned twice as constraints changed:** when the motor vendor pulled out, a combined gear and timing-belt transmission kept every existing interface; when the speed target rose to 630 km/h, dropped the transmission for a lighter **direct-drive BLDC** system, reaching the final **0.3 g** design point.
- **Design in Fusion 360, analysis in Ansys:** chose a keyed coupling (SF 3) over a bolted one (SF 1.1) despite higher manufacturing cost; sized bearings for 3.4 kN; analysed PU tread failure modes (delamination, flat-spotting, wear per ASTM G65).
- **Thermal and reliability:** simulated motor and ESC temperatures in vacuum (no convection) against magnet demagnetisation and controller limits; worked out fault-tolerant limp-home kinematics for motor failures to size the auxiliary battery.
- **Designed the motor–ESC dynamometer test bed** for torque–speed, K_t and efficiency characterisation, including power conversion and fuse protection, and ran initial validation tests.
- Team was the **only Asian finalist (top 21 of 1,600+ teams) and finished 8th** at the SpaceX Hyperloop Pod Competition 2019.

Silicon Wafer Defect Detection: Simulation, Experiments and Root-Cause Analysis Mar–Jul 2026
Research internship, IEMN Laboratory, UPHF, Valenciennes, France

- **Built an end-to-end defect-detection workflow for silicon wafers:** 3D transient **Elmer FEM** models (Gmsh meshes), **laser Doppler vibrometry** experiments up to 4 MHz across **72 measurement points**, **passive ambient-noise NDT** using cross-correlation methods adapted from **seismology**, and **Python** pipelines for beamforming and defect localisation; used Claude Code to write scripts and checked each stage independently.
- **Found the root cause of a model–measurement mismatch:** simulations began from a 500 μm thickness we had been given; a parametric sensitivity study showed thickness was the dominant input, and fitting to the measurements alone corrected it to about **390 μm (3% above the 380 μm spec)**, later supported by an independent gauge reading.
- **Prototyped the test hardware:** designed and **resin-3D-printed a wafer fixture** for repeatable mounting; wrote Python motion control for the scanning stage.
- **Turned raw signals into decision metrics:** designed six indicators (arrival-time shift, energy ratio, waveform correlation and others) for a **200 nm gold patch**; the patched wafer's signals **separated from the healthy baseline**, though the shifts could not yet be traced to its location; documented these limits for follow-on work.
- **Completed experimental design and all defect-free and defective wafer experiments in four months against a six-month plan**, despite losing a month to travel disruption.

Multiscale Computational Framework for Elastic Wave Propagation 2021–present
PhD thesis research, Aerospace Engineering, IISc

- Coupled the atomistic **Quasicontinuum** model with the **Spectral Finite Element Method**: **50x speedup** over full Quasicontinuum at up to 2% displacement error, with up to 99.6% signal-energy transfer across the interface; now applying the framework to **metal (gold) deposits on silicon wafers**.
- **Calibrated Eringen's nonlocal length scale against Quasicontinuum** for aluminium nanostructures in extension, bending and bulk waves, validating the methodology against **published experimental data** over several iterations before producing final results (first-author paper under review, *Int. J. Engineering Science*).
- Built a Deep Material Network **from scratch in NumPy** on Abaqus RVE data for particle composites; about **3x faster** training than the published implementation using Numba JIT and a shared-memory redesign.

Multi-Medium Air–Water Robot: Concept to Detailed Design 2019–2020
M.Tech thesis, IIT Madras (Guide: Prof. T. Asokan)

- Generated six concepts for a robot that flies and swims, and selected one with a **weighted decision matrix**.
- Ran **Ansys Fluent** drag simulations on **six hull variants** in both air and water; added water-flow channels that cut the water drag coefficient by **about 10%** (0.93 to 0.83). Designed airfoil-based control planes and a rudder, and balanced weight against buoyancy.
- Designed the central electronics hub, waterproofing and **control logic** for switching between air and water modes, and modelled both regimes in **Simulink**. Design and simulation only; the build was cancelled due to COVID-19.

Professional Experience

Quantitative Analyst Jul 2020 – Feb 2021
Quantitative Research, J.P. Morgan Services India, Mumbai

- **Modelled and valued rate–rate and rate–spread instruments**, combining pricing theory with **calibration to market data** so traders had accurate models for real-time decisions; the models supported desks in the **UK, Germany and the US**.
- **Implemented a correlation-based adaptation to the pricing model that went into production use:** pulled correlation data through the C++ libraries, modified the model equation and implemented it in Python, working from requirements set by the desk head.
- **Went from user to builder of the firm's pricing code:** started in Python on top of the existing C++ libraries, then worked inside the C++ libraries themselves, in a shared Git codebase with code review.

Simulation and Test Data Automation Nov 2017 – Jan 2018; May – Jul 2018
Winter and Summer Intern, ITDD, Caterpillar India

- Built **Python tools with a GUI** to post-process Abaqus thermomechanical simulations of engine valves and modal analyses of engine blocks, cutting post-processing from **about a week to under 8 hours**.
- Automated analysis of **vibration-test data** and simulation reports, and deployed it as a post-processing toolset of **20+ Python, Visual Basic and batch scripts** used by the team.

Thermal Management Systems in Aircraft May – Jul 2019
Undergraduate Research Intern (PURE Scholar), Purdue University, USA (Guide: Prof. Neera Jain)

- Reviewed 30+ papers and a thesis on aircraft thermal management, proposed new architectures, and tested them by modifying the lab's heat exchanger models (Switched Moving Boundary formulation) in **MATLAB**/**Simulink**.

Selected Projects

Automated Manufacturing Plant: Simulation and Costing Mar – May 2018
Course project, IIT Madras

- Planned and simulated material flow through a plant in **Siemens Tecnomatix**, computed process times with CAM, RobotStudio and Jack, and produced a **cost analysis** covering materials, capital investment and labour.

India's Crude Oil Dependence and Ethanol Blending Mar – May 2019
Case study, IIT Madras

- Analysed trends in India's crude oil and natural gas use, production and imports, and **forecast consumption and domestic production over the next decade** to assess ethanol blending as a way to cut import dependence.

Leadership

- **Team Lead, Smart India Hackathon 2025** (IISc-nominated): led the team to the in-person pre-final round in Delhi with a **retrofit smart cane** for visually impaired users (ESP32, IMU, ultrasonic and ToF sensing, low-power sleep logic, Android app) at a prototype BoM of about **Rs. 3,100**.
- **Organising Team Lead, IISc Aerospace Department Sports Fest** (2026): led a 20-person team, largely through delegation, to deliver the first five-day, six-sport event with nearly 150 participants.
- **Manager, Editorial and Research Team, E-Cell IIT Madras** (2017): wrote articles on technology and business for E-Cell's site and magazine *Entrepreneurship Insider* (the Hyperloop concept; the rise and fall of Nokia and Yahoo) and interviewed senior

students and visiting dignitaries.

Teaching

- **Course Instructor, PMRF Teaching Programme:** Finite Element Modelling with FEniCS (2025; 8 lectures on wave propagation, heat transfer and impact) and Introduction to Numerical Methods (2022; designed and taught the course).
- **NPTEL Teaching Assistant** for four courses (2022–2024): Solid Mechanics, Engineering Mathematics, Dynamic Behaviour of Materials, and Computational Mathematics with SageMath; ran weekly tutorials.

Technical Skills

- **EV & hardware:** motor, inverter and battery pack selection and sizing; motor/controller thermal design; dynamometer test-bed design; laser Doppler vibrometry; sensor integration (IMU, ultrasonic, ToF); ESP32, Arduino, PID control; resin 3D printing.
- **Simulation & analysis:** Ansys (structural, modal, thermal), Abaqus, COMSOL, Elmer FEM, FEniCS; CFD in Ansys Fluent; parametric sensitivity studies, mesh-convergence and analytical cross-checks; root-cause analysis.
- **Programming & data:** Python (NumPy, Numba, TensorFlow), C++, C, Fortran, MATLAB/Simulink; signal processing and beamforming; Git with code review; AI-assisted development (Claude Code).
- **CAD & manufacturing:** Fusion 360, SolidWorks, Creo, FreeCAD, Gmsh; Siemens Tecnomatix.
- **Languages:** English, Hindi, Marathi, German (basic).

Relevant Coursework

IIT Madras: Energy Conversion Systems, Introduction to Semiconductor Devices, Solar Cell Device Physics, Renewable Energy Technology, Product Reliability, Principles of Product Design, Manufacturing Processes, Automation in Manufacturing, Process Simulation, Heat Transfer, Design of Machine Elements, Measurements, Instrumentation and Control.
IISc: Finite Element Method, Non-Destructive Testing and Evaluation, Fracture Mechanics.

Selected Publications (Google Scholar)

- A.M. Shembekar, S. Gopalakrishnan. Calibrating Eringen's nonlocal length with the Quasicontinuum method: what it measures in extension, bending and bulk waves. *International Journal of Engineering Science* (under review, submitted Nov 2026).
- A.M. Shembekar, S. Gopalakrishnan. Concurrent Multiscale Framework for Wave Propagation in Crystalline Material Nanostructures. ASME SSDM (2025).
- B. Pramay, A.M. Shembekar, S. Gopalakrishnan. Early-loading tangent modulus maps for dense spherical DEM assemblies across contact laws and particle-modulus regimes. *Particuology* (2026, in press).

Awards

- **Prime Minister's Research Fellowship (PMRF)**, IISc (2022); **PURE Scholarship**, Purdue (2019); **Finalist, Bajaj Auto MACH Challenge** (2020).
- **Ram Shriram Scholarship** (2017) and **Merit-cum-Means Scholarship** (2015), IIT Madras.
- **JEE Advanced AIR 1332** (top 0.1% of about 1.4 million) and **JEE Main AIR 415** (2015); **KVPY Fellowship** (2014); **NTSE Scholarship** (2011).