KRTIN KALA

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EDUCATION

Georgia Institute of Technology — Atlanta, GA
Masters in Science (MS) in Aerospace Engineering — *Aug 2024 – Present*

Birla Institute of Technology and Science (BITS), Pilani — Pilani, India
Bachelor of Engineering (BE) in Mechanical Engineering — *Aug 2019 – May 2023*

SKILLS

CAD & Drawings: SolidWorks, CATIA V5, Fusion 360, AutoCAD, ANSYS DesignModeler; GD&T, tolerance analysis, drawing reviews
Programming & Automation: Python, C/C++, MATLAB; scripting for post-processing, batch runs, data collation; Linux/CLI
Simulation & Tools: ANSYS Fluent, ANSYS CFX, OpenFOAM, Simulink, NPSS, ParaView; mesh preparation, solver setup, post-processing
Modeling Methods: RANS, LES, reacting flows (FGM/flamelet workflows), conjugate heat transfer, FSI; thermal stratification/ventilation; rarefied gas flow
Systems & Decision Methods: SysML / MBSE, requirements-driven trade studies, QFD, TOPSIS; multi-fidelity workflows (OpenMDAO, FLOPS/NPSS integration where applicable)
Data/ML (applied): feature engineering, clustering/regression/classification workflows; physics-informed modeling exposure; model evaluation and validation
Certifications: MATLAB (MathWorks): Nonlinear Equations, Machine Learning, ODEs; Deep Learning: deeplearning.ai

EXPERIENCE

Graduate Student Researcher — Atlanta, GA
Ben T. Zinn Combustion Laboratory | Georgia Tech — *Jun 2025 – Present*

- Developing an entropy-generation analysis framework for turbulent diffusion flames using the canonical Sandia-D flame as the baseline, with the goal of quantifying thermodynamic irreversibilities from resolved temperature and species fields
- Building and validating an ANSYS-based reacting-flow CFD model against the Sandia-D experimental dataset, achieving agreement within three significant digits at multiple axial and radial measurement locations
- Implemented the Bilger mixture fraction formulation and an automated post-processing workflow to extract planar ASCII fields from ANSYS, non-dimensionalize coordinates (x/D, r/D), and collate variables for direct, point-by-point comparison to Sandia-D laser-diagnostic measurements
- Establishing prerequisites for local entropy generation rate evaluation (field consistency checks, sampling strategy, and benchmark comparisons) to enable a complete entropy-budget analysis for turbulent combustion systems

Graduate Teaching Assistant (GTA) — Atlanta, GA
AE 3330: Introduction to Aerospace Vehicle Performance | Georgia Tech — *Aug 2025 – Dec 2025*

- Mentored undergraduate students in core aerospace performance topics, including aircraft propulsion, thrust and power analysis, and range/endurance calculations
- Held review sessions to provide one-on-one guidance on complex concepts in fixed-wing, rotorcraft, and spacecraft performance
- Assisted in evaluating student assignments and exams on topics ranging from aerodynamics and propulsion to orbital mechanics, ensuring a thorough understanding of fundamental principles
- Developed supplementary learning materials, including detailed problem walkthroughs and concept summaries, to enhance student comprehension of challenging topics and improve exam preparation
- Served as a liaison between students and the course instructor, communicating common areas of difficulty to help refine lecture focus and teaching strategies in real time

Research Project Assistant — Eindhoven, Netherlands
Baker Hughes & Eindhoven University of Technology (TU/e) — *Aug 2023 – Aug 2024*

- Evaluated the computational performance of Flamelet Generated Manifold (FGM) methodology in ANSYS for turbulent Ammonia-Hydrogen combustion compared to conventional LES methods
- Achieved an 86.7% reduction in simulation runtime through effective use of the FGM model significantly enhancing the efficiency of combustion design simulations and enabling quicker design iterations
- Calibrated the FGM model by correlating simulated flame front progression with experimental data from Baker Hughes achieving a 92.66% F1 score in model validation
- Projected ML-integration to accelerate Look-Up Table (LUT) generation with 99.55% predictive accuracy enabling data-driven combustion modeling approach

Research Project Assistant — Mumbai, India
Indian Institute of Technology (IIT), Bombay — *Jul 2023 – Jan 2024*

- Conducted detailed CFD simulations to analyze airflow patterns and thermal stratification in fully occupied classroom environments to determine critical stagnation zones where virulent airborne particles could accumulate and increase disease transmission risks
- Parameterized geometric and environmental variables across multiple classroom layouts to systematically evaluate and identify optimal, sustainable ventilation configurations that minimized pathogen spread potential
- Proposed and validated an innovative HVAC system redesign that relocated identified stagnation zones closer to the ceiling significantly reducing occupants' exposure to airborne contaminants associated with COVID-19 and other airborne diseases
- Collaborated closely with teams developing IoT-based sensor integration and algorithmic air-quality management, aligning CFD results with practical sensor-driven ventilation strategies to achieve a projected 23.7% increase in Air Changes per Hour (ACH)

Training Intern Bengaluru, India
Aircraft Research and Design Centre (ARDC), HAL *Aug 2022 – Aug 2022*

- Analyzed subsystem integration strategies across propulsion, structural, thermal, and avionics domains, assessing compatibility and performance trade-offs to enhance overall aircraft system efficiency
- Evaluated sustainable aircraft design methodologies used at HAL, documenting best practices in subsystem integration and design optimization for future aircraft development cycles
- Studied and documented various computational design tools and workflows utilized at HAL, providing insights into early-stage design decision-making processes critical for efficient system development

Project Intern Bengaluru, India
Centre for Airborne Systems (CABS), DRDO *Jun 2022 – Jul 2022*

- Investigated the mathematical foundations of non-linear dynamical systems relevant to airborne surveillance platforms, focusing on their behavior, stability, and transformation into analyzable linear equivalents
- Modeled the Lotka-Volterra predator-prey system as a case study for understanding phase portraits, equilibrium points and bifurcations, enabling intuition around feedback-driven control system behavior
- Conducted extensive numerical simulations in MATLAB to explore the transient and steady-state dynamics of such systems, generating visualizations that guided qualitative system insights
- Applied linearization techniques and Jacobian stability analysis to extract interpretable approximations of non-linear responses, offering a framework for reduced-order modeling in future aircraft systems

Research Project Assistant Ewing, NJ
The College of New Jersey *Jun 2022 – Oct 2022*

- Investigated incipient cavitation in a centrifugal pump to identify vibration signatures associated with its onset
- Modeled vapor bubble formation and collapse using the Zwart-Gerber-Belamri cavitation model within the Volume of Fluid (VOF) framework in ANSYS Fluent
- Predicted acoustic emissions from cavitation events using the Ffowcs Williams-Hawkings (FW-H) acoustic analogy
- Performed Fast Fourier Transform (FFT) analysis on vibration and acoustic pressure data to extract frequency bands characteristic of cavitation onset
- Projected a methodology for early detection of cavitation through vibration spectrum analysis enabling predictive maintenance and operational safety improvements

Design Engineer Pilani, India
Hyperloop India *Jul 2021 – Jun 2022*

- Contributed to the conceptual design and mechanical integration of a new Hyperloop pod, with a focus on propulsion system architecture and subsystem compatibility across aerostructure, drivetrain, and braking interfaces
- Led multiple CAD redesigns of propulsion components to resolve interface conflicts and improve manufacturability; collaborated with the fabrication team to ensure alignment between design intent and production capability
- Accelerated Learning by 22% through iterative refinement of design tolerances, implementing DFM principles, and optimizing part geometries for additive and subtractive manufacturing processes
- Performed detailed GD&T analysis on over 50 high-load, safety-critical components to ensure assembly precision under high-speed operating conditions
- Participated in cross-subsystem reviews to evaluate structural response, thermal buildup, and mounting configurations, contributing to a more robust and integrated pod layout

Project Intern New Delhi, India
CCS Strategy Solutions *May 2021 – Aug 2021*

- Conducted end-to-end analysis of a client's supply chain to identify inefficiencies in resource allocation, process sequencing, and inventory movement, with a goal to enhance throughput and reduce lead times
- Led a 4-member team in mapping operational workflows and uncovering critical bottlenecks through value stream analysis
- Simulated current and proposed workflow models in FlexSim to evaluate improvements in resource utilization, order fulfillment rates, and cycle times
- Implemented Lean principles and restructured workforce allocation across key stages of the supply chain, resulting in a 40% increase in overall process efficiency and a measurable reduction in operational costs

PROJECTS

Hybridized XV-15 | *Vertical Flight Society (VFS) Design Competition* Aug 2025 – Present

- Developed a MATLAB-based mission and battery sizing tool for the XV-15 tiltrotor, coupling momentum-theory hover, fixed-wing drag polar, and ISA atmosphere models to compute segment-wise shaft power, energy use, and weight histories for the given mission
- Engineered a constraint-driven weight convergence algorithm that iteratively adjusted battery and fuel masses to satisfy the rigid MTOW and rotor disc-loading limit, demonstrating via PL-DL convergence traces that the final design point was both structurally and energetically constrained
- Developed a pack-level battery sizing framework that bound both energy and peak-power requirements (Wh/kg, thermal-management, and structural penalties) into pack mass (including structural and TMS penalties) validated against the NASA X-57 reference pack (55.3 kWh, 370.86 kg), achieving a prediction error of +0.41%
- Quantified the required hybridization ratio, yielding a mandatory fuel mass to compensate for the electrically supplied energy deficit, which was limited to 6% of the total mission energy

Gas Turbine Cycle Design and Design-Point Selection | *Course Project* Aug 2025 – Dec 2025

- Built a 1D, steady-flow, station-based turbojet/turbofan cycle model (normalized core flow) to compute total/static properties across diffuser, fan, compressor, combustor, turbines, mixer, and nozzle blocks
- Coded full thermodynamic component relations for work and pressure balance, including turbine–compressor power matching, bleed handling, and nozzle expansion, enabling consistent calculation of specific thrust and TSFC
- Executed a structured design-space sweep ($\pi_c \in [8, 40], \pi_f \in [1.0, 2.5], \beta \in [0, 12]$) at cruise to identify feasible solutions and efficiency frontiers while enforcing temperature, pressure-ratio, and operational constraints
- Extended the model from constant γ to variable $\gamma(T), c_p(T)$ using NASA polynomial fits, and quantified the resulting degradation in predicted performance (higher TSFC, lower specific thrust) relative to constant-property assumptions
- Selected a final cycle based on the physically realistic variable-$\gamma(T)$ optimum ($\beta \approx 2, \pi_c \approx 34, \pi_f \approx 2.5$), then determined maximum thrust within a fixed architecture by ramping fuel schedule to the Tt4 = 1500 K hot-section limit and tracking the movement along the ST–TSFC trade curve

Formula 1 AI PitWall | **Project Website** May 2025 – Aug 2025

- Developed an interactive Formula 1 strategy dashboard integrating five machine learning models to perform driver performance profiling, tyre choice optimization, qualifying pace prediction, track DNA clustering, and pit-stop strategy forecasting to deliver data-driven insights for real-time race strategy
- Led the "Track DNA Analysis" module, engineering feature extraction pipelines from multi-season track geometry and curvature data, and applying unsupervised learning (DBSCAN & Gaussian Mixture Models) to classify circuits into distinct archetypes that informed race strategy models
- Conducted "Driver Analysis" by mining telemetry data to identify unique braking signatures, cornering patterns, and performance archetypes across multiple tracks, producing actionable profiles for competitive benchmarking
- Designed and deployed the project's multi-page website using HTML, CSS, and JavaScript, embedding interactive visualizations to translate complex analytics into an accessible format for both technical and non-technical audiences
- Collaborated within a five-person team to integrate the diverse ML models into a cohesive project narrative and a unified web presentation

Option Pricing using DL | *Project* May 2025 – Aug 2025

- Designed and implemented a hybrid surrogate pricing engine for European options under the Heston stochastic volatility model by integrating a physics-informed Reduced-Order Model (ROM) with a neural operator residual learner
- Applied the Lift & Learn framework to construct an arbitrage-free ROM capable of generating price surfaces in approximately 0.3 ms while retaining 99.9% of the variance from the full-order PDE model
- Generated a synthetic training set of 240 high-fidelity price surfaces via Latin Hypercube sampling over realistic Heston parameters
- Integrated real historical ORCL option chain data from 2019 to 2025 for market calibration and validation of the hybrid model
- Enhanced baseline ROM predictions using a Fourier Neural Operator (FNO) trained on residuals between ROM outputs and market prices
- Achieved a 77% overall error reduction in relative L2 error and Mean Max Pointwise Error on unseen market data capturing market-specific volatility smiles and skews
- Preserved financial consistency by enforcing no-arbitrage constraints in the ROM stage
- Embedded soft PDE penalty terms during fine-tuning to ensure solution stability and interpretability in production use

Minimum-Time Climb Trajectory Optimization | *Course Project* Jan 2025 – May 2025

- Formulated and solved a minimum-time climb trajectory optimization problem using both reduced-space and full-space nonlinear programming approaches to meet terminal altitude, speed, and flight-path constraints
- Developed six high-fidelity surrogate models for $C_{L\alpha}$, C_{D0}, η, thrust (M, h), density $\rho(h)$, and speed of sound $a(h)$ with $R^2 > 0.99$ including neural networks and spline interpolations
- Implemented a reduced-space approach by optimizing the angle-of-attack history and integrating the state dynamics with the trapezoidal rule
- Computed an adjoint-based gradient evaluation for terminal constraints and verified gradients against complex-step derivatives with relative error on the order of 10^{-8}
- Constructed a full-space optimization using trapezoidal collocation, optimizing states and controls simultaneously
- Validated full-space constraint Jacobians against complex-step derivatives, achieving agreement within 2×10^{-6}
- Introduced solver-level enhancements zero-Hessian enforcement, surrogate clamping, and trust-region tuning-to ensure robust convergence

Strategic Decision Making through Data Analytics | *Harvard Business Publishing (HBSP) Design Project* Jan 2025 – May 2025

- Led a 4-year brand turnaround using data-driven decisions to increase market share from 11.0% to 27.5%
- Generated $302M in cumulative profit through adaptive pricing strategies based on competitive benchmarking and demand forecasts
- Reduced inventory mismatch by over 30% through iterative production calibration and cost-benefit tradeoffs
- Outperformed competitors and ranked as the most profitable brand through strategic pricing, positioning, and promotions

Global Supply Chain Management | *Harvard Business Publishing (HBSP) Design Project* Jan 2025 – May 2025

- Simulated 4-year supply chain outcomes for two mobile phone models achieving a 27.65% gross profit margin ($176M)
- Leveraged consensus forecasting to evaluate feature upgrades, optimize product enhancements and reduce demand variability
- Balanced ordering costs and inventory holding costs ensuring optimal order quantities while mitigating forecast error impacts
- Executed offshoring versus local production trade study optimizing shipping cost and lead time to minimize inventory cost
- Presented strategic decisions to secure the board of stakeholders' confidence by explaining all trade-offs securing Tier 1 votes

Tactical Mobility Transport Aircraft | *AFRL Sponsored Design Project* Aug 2024 – May 2025

- Designed a hybrid-electric propulsion architecture for a tactical mobility transport aircraft, integrating NPSS and FLOPS within an OpenMDAO multi-fidelity optimization framework
- Conducted systems engineering trade studies balancing operational speed, fuel efficiency, payload capacity, STOL performance and mission range
- Identified hybrid-electric configurations that met AFRL tactical mobility requirements while staying within structural and thermal limits
- Established requirement flowdown and verification logic to keep the configuration within performance envelopes
- Built a structured Design of Experiments (DoE) in JMP (screening + response-surface) to explore the design space and quantify sensitivities/interactions
- Developed component-level models (motors, generators, energy storage) and mission energy management strategies; evaluated energy flow, thermal loads, and sizing impacts under operational loads with OpenMDAO drivers
- Achieved a 15.7% range increase, 6.67% reduction in takeoff distance, and 2.78% payload gain versus the baseline C-130J via optimized hybrid power split and mission-specific energy management
- Implemented modular subsystem interfaces to enable drop-in upgrades (future batteries/fuel cells), reducing projected integration and test effort
- Validated results against baseline models and confirmed alignment with theoretical predictions

Strategic Materials Scarcity for Aerospace | *Boeing Supported Study Project* Aug 2024 – May 2025

- Led the vulnerability assessment of the Ti-6Al-4V titanium alloy supply chain used extensively in Boeing 777 components, focusing on disruption risks from geopolitical, regulatory, and market concentration factors
- Mapped the multi-tier supply chain from raw mineral extraction through processing, component assembly, and subsystem integration using public domain data
- Built a dynamic discrete-event simulation (DES) model to evaluate disruption propagation times across tiers and quantify the impact on final aircraft production
- Applied graph-theory-based network modeling to identify single-point failures, high-risk supplier clusters, and critical inter-material dependencies with aluminum and vanadium chains
- Integrated Herfindahl-Hirschman Index (HHI) metrics to measure geographic concentration risk and assess the resilience of supplier networks
- Designed scenario analyses incorporating events such as counterfeit material detection, trade tariffs, and geopolitical conflicts to stress-test supply chain performance
- Evaluated mitigation strategies including supply diversification, redundancy through foreign facility establishment, and pan-government cooperation for critical alloy access
- Delivered a repeatable decision-making methodology within the SOVERN tool, enabling stakeholders to identify vulnerabilities, simulate disruption scenarios, and compare mitigation alternatives

Next Generation Transport Aircraft Design | *Study Project led by NASA* Aug 2024 – Dec 2024

- Led the conceptual design of a hydrogen-powered Blended Wing Body (BWB) transport aircraft aimed at reduction in fuel burn and emissions while maintaining compatibility with existing airport infrastructure
- Built an MBSE architecture with SysML with requirements decomposition, parametric modeling, and subsystem allocation to ensure traceability from stakeholder needs to design verification
- Created and analyzed a morphological matrix of 30+ design variables covering fuel type, propulsion architecture, structural material, wing geometry, and fuselage configuration
- Conducted trade studies using QFD to translate customer needs into measurable engineering characteristics and applied TOPSIS to rank design alternatives
- Selected the final configuration based on TOPSIS rankings and performance trade-offs, achieving a projected 20% reduction in CO_2 emissions compared to current-generation aircraft
- Optimized the chosen concept to deliver a 10% increase in fuel efficiency and a 15% increase in operational range while retaining compatibility with existing airport infrastructure
- Assessed structural risks unique to the BWB layout, such as pressurization-induced buckling, and proposed mitigation strategies including tessellated stiffener grids and multi-bubble pressure cabins

Analysis of Flow Past Drone's Blade | *Undergraduate Thesis (BITS Pilani)* Aug 2022 – May 2023

- Designed and executed an experimental-computational study to compare downwash flow characteristics of two-blade and three-blade fixed-pitch drone rotors
- Built a low-cost experimental rig from scratch using a Raspberry Pi controlled variable RPM motor and vane-type anemometer to measure downwash flow at different RPMs
- Simulated flow over the drone blades using RANS k-ω SST turbulence model in OpenFOAM validating computational results with experimental measurements
- Achieved a 51.7% improvement in upthrust for the 3-blade rotor compared to the 2-blade rotor, demonstrating its enhanced aerodynamic performance in generating lift
- Demonstrated that the 3-blade rotor produced a more consistent flow with less variation in velocity, transferable to high-performance aerodynamic applications

3D Fluid-Structure Interaction of elastic wave propagation in a pipe | *Course Project* Aug 2022 – Dec 2022

- Simulated coupled fluid-solid dynamics to investigate pressure wave propagation in an elastic water-filled pipe using OpenFOAM for fluid flow and CalculiX for structural deformation linked via preCICE adapter
- Implemented a serial implicit multi-coupling scheme and pimpleDyMFoam solver to capture transient oscillations, generating pressure, velocity, and displacement profiles along the pipe
- Analyzed damping effects and pressure loss due to fluid-wall shear interactions demonstrating a 38% reduction in flow pressure under dynamic loading
- Verified numerical contours against accepted solid mechanics theory, identifying high displacement at the inlet tip due to compounded shear and pressure effects

Inlet Nozzles of Scramjets | *Course Project* Aug 2021 – Dec 2021

- Conducted a CFD-based validation of inlet flow characteristics for 3-ramp and 4-ramp external compression scramjet inlet configurations
- Simulated inlet performance at Mach 5 and Mach 8 to evaluate shock-on-lip behavior and compression efficiency under hypersonic flow conditions
- Modeled oblique to replicate flow compression patterns and surface pressure distribution for both inlet designs

Vertical Axis Wind Turbine | *Academic Project* Jul 2021 – Jun 2022

- Investigated the self-starting capability of Savonius-type vertical axis wind turbines to improve low-wind-speed operational reliability
- Conducted parametric CFD analysis to study the impact of blade count, helical twist and overlap ratio on initial torque generation
- Analyzed flow attachment and separation characteristics, including the influence of the Coandă effect, to identify aerodynamic features enhancing startup performance
- Achieved a 72% improvement in power output and a significant increase in starting torque through optimized multi-blade helical configurations

Achievements

Patent: Compound Vision using drones for search and rescue missions (Grant Pending, 2023)
Presentation: Optimization of Simulation of Turbulent Flows through ML (EAISI, TU/e, 2024)
Poster: CFD Studies of Ammonia/Hydrogen Flames in Gas Turbines (COMBURA, TU/e, 2023)

Leadership and Outreach

Bhumi, India: Organized a fundraiser and raised over INR 17,000 in scholarships to promote STEM access for under-served communities (2021)
Blind People's Association: Designed and delivered interactive learning modules on math and spatial reasoning for visually impaired youth (2019)

Test Scores

GRE: 332 [8 Nov 2023] (Quant - 170, Verbal - 162, AWA - 4.0)
TOEFL: 112 [19 Nov 2022] (Reading: 29, Listening: 30, Speaking: 25, Writing: 28)