

## Curriculum Vitae

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### Education

**University of Minnesota, Twin Cities, USA****2022-present***Doctor of Philosophy, Mechanical Engineering | [CRFEL](#) | Advisor: [Prof. Suo Yang](#)**GPA: 3.88/4.00***National Institute of Technology(NIT), Tiruchirappalli, India****2018 -2022***Bachelor of Technology(Hons.), Mechanical Engineering | Dept. Rank:1/124 | Inst. Rank 2**CGPA: 9.89/10*

### Academic Awards and Scholarships

- University of Minnesota Mechanical Engineering Department Fellowship, 2022
- Secured second highest CGPA across the entire Institute's graduating batch of 2022 (9.88/10)
- Mechanical Engineering Department Gold Medallist, NIT Trichy, 2022
- RECAL Best Outgoing Student in Mechanical Engineering Award, NIT Trichy, 2022
- Indian Academy of Sciences Summer Research Fellowship Programme (IAS-SRFP), 2021
- Accepted to the University of Heidelberg School on Hardware-Aware Scientific Computing, 2021
- Spark IIT Roorkee Summer Research Fellowship, 2020
- S.J.Chainulu Medal of Excellence -highest CGPA in the first year of college (9.92/10.0), 2020
- Institute Day Prize Winner for highest CGPA in Mechanical Engineering (9.94/10.0), 2021
- O.P.Jindal Engineering and Management Scholarship, 4 times Nominee

### Publications

**Peer-Reviewed Journal Articles**

2. **Ramachandran, S.**, Srinivasan, N., Taneja, T.S., Zhang, H. and Yang, S., 2023. Numerical study of turbulent non-premixed cool flames at high and supercritical pressures: Real gas effects and dual peak structure. *Combustion and Flame*, **249**, p.112626.
1. **Ramachandran, S.**, Srinivasan, N., Wang, Z., and Arsam, B., Yang, S., 2023. A Numerical Investigation of Deflagration Propagation and Transition to Detonation in a Microchannel with Detailed Chemistry: Effects of Thermal Boundary Conditions and Vitiation. (*submitted to the Special Edition of Physics of Fluids on Hydrogen Flames and Detonation Physics*)

**Refereed Conference Proceedings and Presentations**

6. **Suryanarayan, R.**, Srinivasan, N., Zou, S. and Yang, S., 2023. Spectral Analysis of Unstable Detonation. *In AIAA SCITECH 2023 Forum* (p. 0349).
5. **Suryanarayan, R.**, Srinivasan, N., Zou, S. and Yang, S., 2022. Spectral Characterization of Overdriven Irregular Detonations. *Bulletin of the American Physical Society*.
4. **Ramachandran, S.**, Srinivasan, N., Wang,Z, and Arsam, B., Yang,S, 2023. A Numerical Investigation of the Deflagration to Detonation Transition (DDT) in Microchannels: Effects of Vitiation and Wall Boundary Conditions. *13th US National Combustion Meeting*
3. **Ramachandran, S.**, Srinivasan, N., Zou, S. and Yang, S., 2023. Spectral Characterization of Overdriven Irregular Detonations. *13th US National Combustion Meeting*
2. **Ramachandran, S.**, Srinivasan, N., Zhang, H., Taneja, T. and Yang, S., 2023. Numerical Simulations of turbulent non-premixed cool flames at supercritical/high pressures: dual peak structure, pressure scaling and real-gas effects. *13th US National Combustion Meeting*
1. Srinivasan, N., **Suryanarayan, R.**, Zhang, H., Taneja, T. and Yang, S., 2022. Numerical Simulations of turbulent non-premixed cool flames at supercritical/high pressures: dual peak structure, pressure scaling and real-gas effects. *Bulletin of the American Physical Society*.

## Community Memberships and Services

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### Memberships

2. Student Member, American Institute of Aeronautics and Astronautics (AIAA)
1. Member, Combustion Institute

### Community Service

3. Session Chair, Spray Combustion I, AIAA SciTech, 2023
2. Session Chair, Energetic Materials I, AIAA SciTech, 2023
1. Session Chair, Detonations III, 13th US National Combustion Meeting, 2023

## Research Interests and Technical Proficiency

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### Research Interests

Turbulent Combustion, Deflagration to Detonation Transition (DDT), Irregular Detonations, Supercritical Fluids and Combustion, Manifold Based Modelling, Machine Learning for Reacting Flow, Computational Fluid Dynamics, High-Performance Computing, Data Science

### Combustion Software

AMReX-Combustion PeleC, PeleLM, PeleAnalysis, Cantera, Shock Detonation Toolbox, ChemKin-Pro, Arrhenius.jl

### Programming Languages

C++, C, Python, Julia, MATLAB, Shell Scripting, Git, MPI, OpenMP, Fortran, L<sup>A</sup>T<sub>E</sub>X

### Other Simulation Software

ANSYS (Fluent, Explicit Dynamics, Structural, CFX, SpaceClaim), Paraview, VisIt, yt, SolidWorks (Certified Solid Works Associate), XFLR5, OpenFOAM

### Graduate Courses

Molecular Gas Dynamics, Computational Fluid Dynamics, Fluids I, Introduction to Combustion (Ongoing), Model Reduction and Approximation of Dynamical Systems (Ongoing)

## Professional Experience

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### University of Minnesota, Twin Cities

**Aug 2022 – Present**

*Graduate Research Assistant* | Guide: [Prof.Suo Yang](#)

*Minneapolis, USA*

- Worked on 3 major research projects (see projects section for more information) involving detonations, DDT, and supercritical turbulent combustion. Published a paper in *Combustion and Flame*.
- Spearheaded the collaborative effort of the lab with ExxonMobil Research and Engineering(EMRE). Communicated results of research in bi-weekly meetings with EMRE
- Generated preliminary results and assisted in writing grant proposals to the AFOSR, ARO, and NSF
- Gave talks and presentations at two international conferences.

### Indian Institute of Science, Bangalore

**Oct 2020 – Oct 2021**

*Research Intern* | Guide: [Prof.Konduri Aditya](#)

*Bangalore, India*

- Worked flame stabilization in supersonic combustors and low-Mach number porous media combustion
- Spearheaded the use of [AMReX-Combustion Pele](#) suite in the FLAME lab for Exascale DNS computations
- Also demonstrated the use of *PeleLM* leading to a grant from *Royal Dutch Shell*

### Indian Institute of Space Science & Technology

**Apr 2020 – Oct 2020**

*Research Intern* | Guide: [Prof.Satheesh.K](#)

*Kerala, India*

- Developed 0-D and 1-D solvers for high-temperature reacting gas-dynamics of air dissociation [[EoS](#)][[CHEMOC](#)]
- Validated the solver with NASA CEA obtaining a 98% match
- Developed a framework called CHEMOC to design a de-Laval nozzle for non-equilibrium chemically-reacting flow
- Used Method of Characteristics for solving hyperbolic partial differential equations of supersonic reacting flow

### ExxonMobil Upstream Research and Development

**May 2021 – July 2021**

*Summer Research Intern* | Guide: [Dr.Kaustubh Kulkarni](#)

*Bangalore, India*

- Investigated large datasets on well performance for assets in Cold Lake, Canada and Bakken, Denmark
- Performed Root-Cause Failure (RCFA) and Statistical Analyses to arrive at decisions on novel pump coatings

## Relevant Projects

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- DNS of Flame Acceleration and DDT in Adiabatic and Isothermal Microchannels** **Sept 2022-Feb 2023**
- Performed DNS of pure and vitiated  $H_2$  and  $CH_4$  flame acceleration in microchannels with PeleC
  - Designed parametric studies to demonstrate that vitiation reduces flame speed and the flame acceleration rate
  - Identified the formation of “secondary” finger-like flame fronts in preheated isothermal walls due to auto-ignition
  - Conducted an extensive and systematic literature survey on isothermal wall DDT processes.
- Numerical Simulations of Supercritical Cool Flames** **Sept 2021-Sept 2022**
- Performed DNS using PeleC for a supercritical mixing layer configuration of DME and air at 150 atm with both ideal gas and SRK equation of states
  - Captured the formation of cool flames at supercritical pressures due to the two-stage ignition of DME
  - Studied the pressure as well as equation of state (real vs ideal) dependence on the thermophysical results.
  - Discovered a two-peak structure in mixture fraction space concluding it to be a result of multiple temperature dependent pathways (LTC, ITC, HTC) present for the complex fuel.
- Spectral Analysis of Unstable Detonations** **Sept 2022-Dec 2022**
- Performed highly-resolved simulations of an unstable detonation wave using PeleC
  - Developed fast Python codes to perform FFTs of non-periodic domains in large CFD datasets using a balanced signal-periodization procedure
  - Conducted *a-posteriori* spectral analyses of the simulation data to identify coherent structures in detonations
  - Obtained spectra of different quantities to investigate inter-spectral interactions between pressure and TKE
- DNS of Flame Stabilization in Scramjet Combustors** **Oct 2020-Jun 2021**
- Performed DNS using PeleC for the University of Michigan cavity-based scramjet combustor and the DLR strut-based cavity flame-holder
  - Used the Embedded Boundary cut-cell technique in PeleC to setup different geometries
  - Performed 2-D simulations using AMR for premixed flame stabilization for a vitiated fuel jet in both subsonic and supersonic crossflow for inlet Mach numbers ranging from 0.3-2 for the Michigan combustor
- High Temperature Reacting Gas Dynamics Solvers in Julia** [\[EoS\]](#) [\[CHEMOC\]](#) **Apr 2020-Jun 2020**
- Used the Julia Programming language to write fast Equation of State (EoS) solvers for high-temperature hypersonic dissociating air problems
  - Tested and benchmarked the EoS solvers with NASA CEA obtaining a 98-99% match
  - Solved three canonical test problems in *Vincenti and Kruger*, namely, the Normal Shock (Shock Tube), Prandtl-Meyer Expansion, the Rocket Nozzle using the solver and obtained a 98% match
  - Devised a method to couple Cantera with Julia using the PyCall package to enable non-equilibrium finite-rate chemistry for complicated mechanisms
  - Developed a solver to design the contour of a de-Laval nozzle using the Method of Characteristics taking into account effects of non-equilibrium finite-rate chemistry
- Development of an Incompressible Navier-Stokes Solver in MATLAB** [\[link\]](#) **Mar 2020-Apr 2020**
- Developed a 2-D unsteady incompressible Navier-Stokes solver in MATLAB using the Finite Volume Method (FVM) on a structured mesh
  - Implemented discretization on a staggered mesh for velocity and pressure
  - Used the Semi-Implicit Method for Pressure Linked Equation (SIMPLE) algorithm to couple momentum and continuity equations. Used a hybrid upwind and central-difference interpolation technique for fluxes.
  - Project is hosted on MATLAB Central File Exchange with over 1000+ downloads
  - Conducted benchmark studies using the Lid-Driven Cavity and vortex-shedding behind a square
- API documentation for Arrhenius.jl** [\[link\]](#) **Sept 2021-Oct 2021**
- Worked with Dr. Weiqi Ji, postdoctoral scholar at MIT-DENG Lab for developing API documentation for their new auto-differentiation based combustion solver, Arrhenius.jl
  - Wrote examples of usage of the solver for new users
- Heat-transfer characteristics in a porous fin** | *Course Project-CFD* | [\[link\]](#) **Apr 2021-May 2021**
- Numerically solved complicated differential equations governing heat-transfer in a porous fin using Finite Difference and Finite volume methods
  - Developed a MATLAB code and hosted its documentation using GitHub pages
  - Benchmarked numerical solutions using analytical results