MECHANICAL PROJECTS

SMART HOME SPICE BLEND MAKING DEVICE

<u>Mechanical:</u> Individual "spice dispenser" capable of dispensing powders with a range of sizes accurately. A system containing a solenoid and thrust bearing to actuate 12 different "spice dispensers".
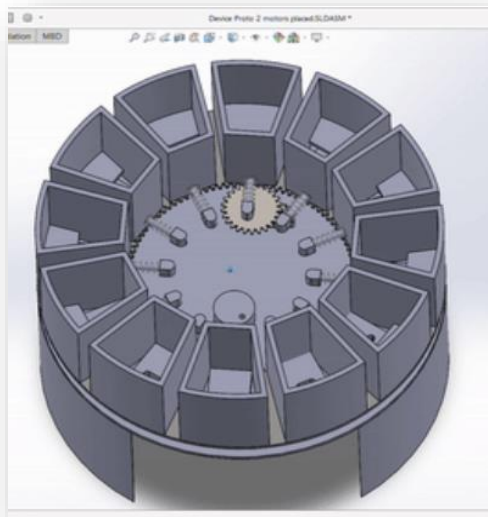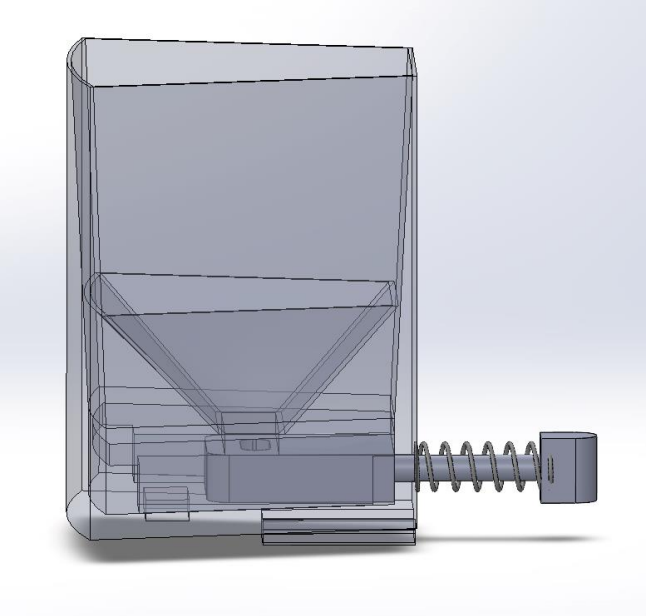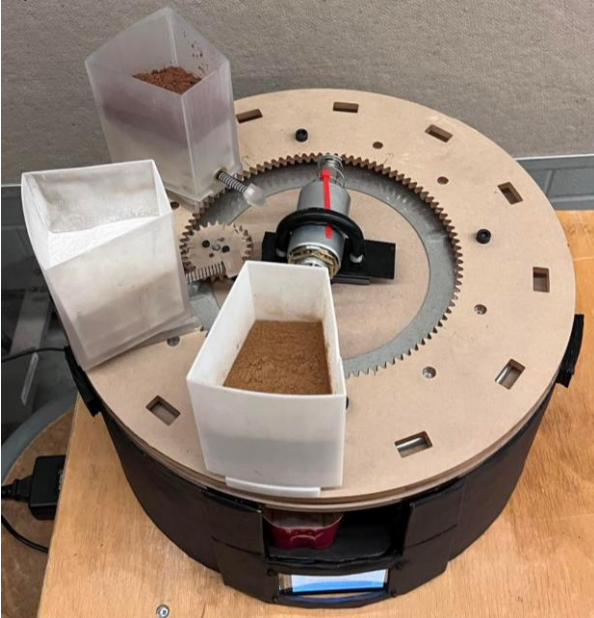
<u>Electrical:</u> Arduino connected to iPhone app via Bluetooth and a touch screen. Stepper motors and limit switch responsible for accurate rotation

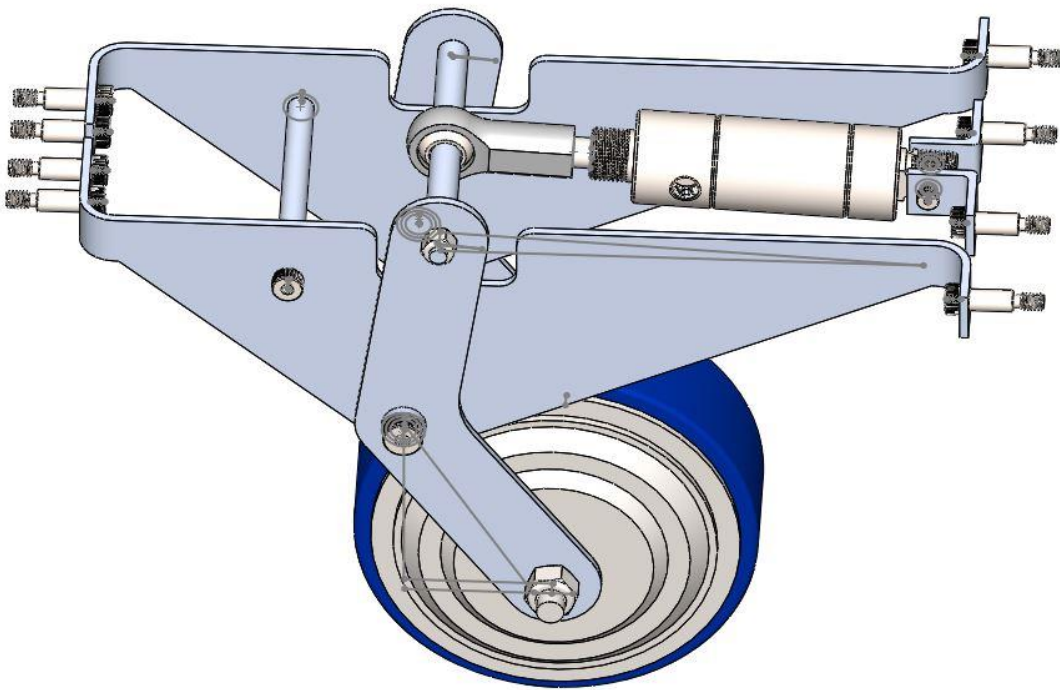Overall Device & Individual spice dispenser
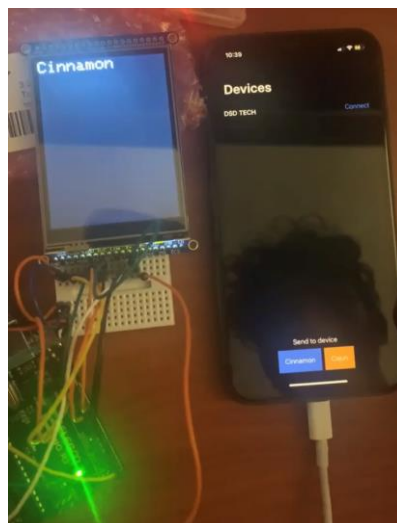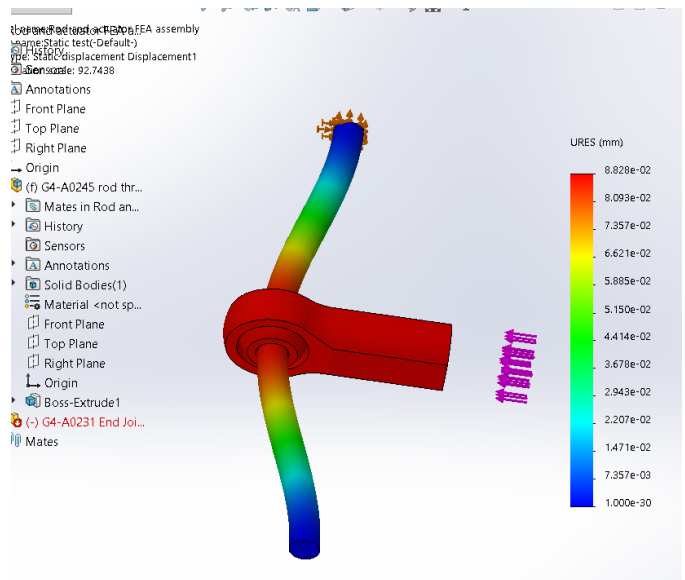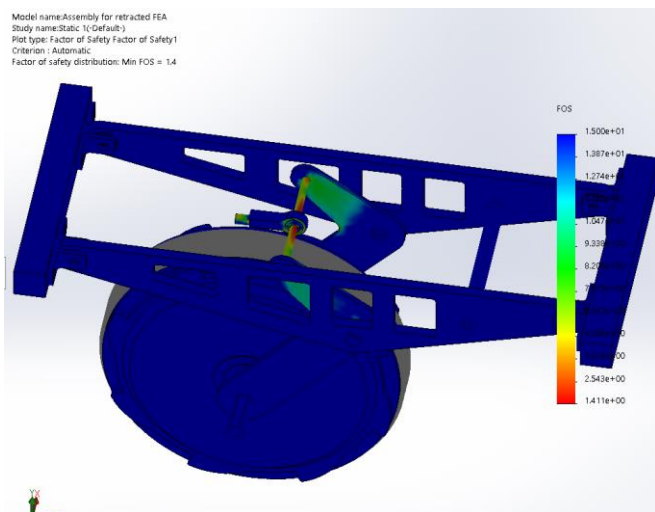

Screen to Phone Connection

RETRACTABLE ELECTRIC DRIVE SYSTEM

<u>Aim</u>: Design a robust retractable drive system for the hyperloop team
Uses a Bafang hub motor actuated by a pneumatic actuator through a pivoting arm. Inspired by glider landing system design

SolidWorks Design

Model name:Assembly for retracted FEA
Study name:Static 1(-Default-)
Plot type: Factor of Safety Factor of Safety1
Criterion : Automatic
Factor of safety distribution: Min FOS = 1.4

FOS
1.500e+01
1.387e+01
1.274e+
1.047
9.338
8.2
2.543e+00
1.411e+00

the retracted FEA assembly
name:Static test(-Default-)
ype: Static displacement Displacement1
ion scale: 92.7438
Annotations
Front Plane
Top Plane
Right Plane
Origin
(f) G4-A0245 rod thr...
Mates in Rod an...
History
Sensors
Annotations
Solid Bodies(1)
Material <not sp...
Front Plane
Top Plane
Right Plane
Origin
Boss-Extrude1
(-) G4-A0231 End Joi...
Mates

URES (mm)
8.828e-02
8.093e-02
7.357e-02
6.621e-02
5.885e-02
5.150e-02
4.414e-02
3.678e-02
2.943e-02
2.207e-02
1.471e-02
7.357e-03
1.000e-30
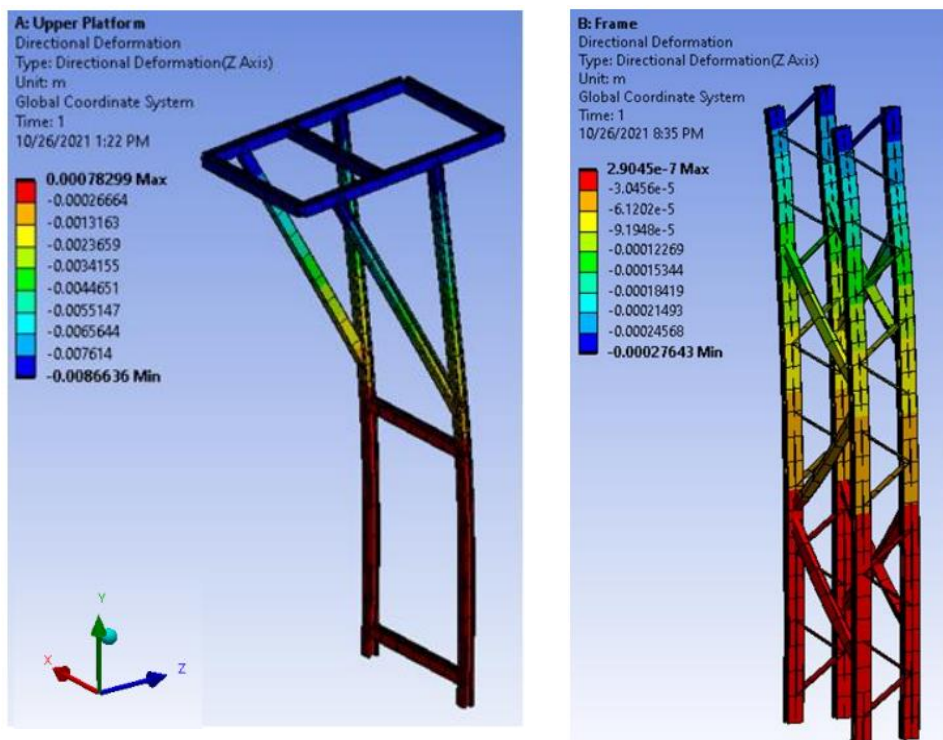
FEA Simulations

SLIDING SUPPORT STRUCTURE

<u>Aim</u>: Design and build a Unistrut structure capable of precisely moving a large stinger into a liquid helium tank
Uses a winch and pulley system with rails to lift and lower structure

SolidWorks Design

FEA Simulation

AUTONOMOUS ROBOTIC ARM PROJECT

<u>Aim</u>: Make the simplest/cheapest autonomous robotic arm using rapid prototyping techniques.

Uses an Arduino and two ultrasonic sensors to detect the height of boxes. Controlled by 4 high torque servo motors
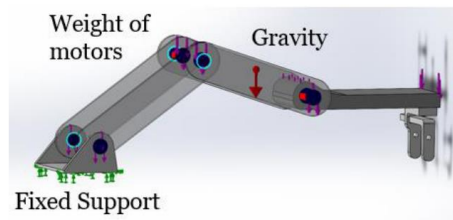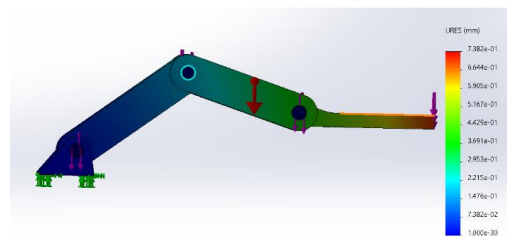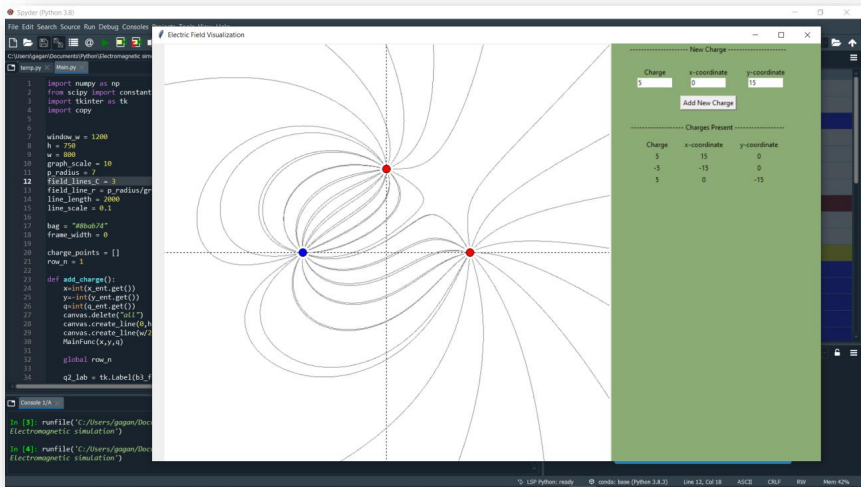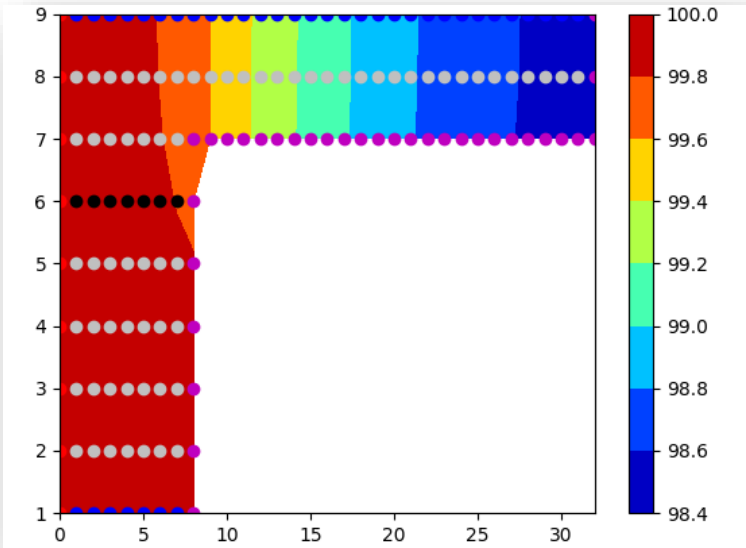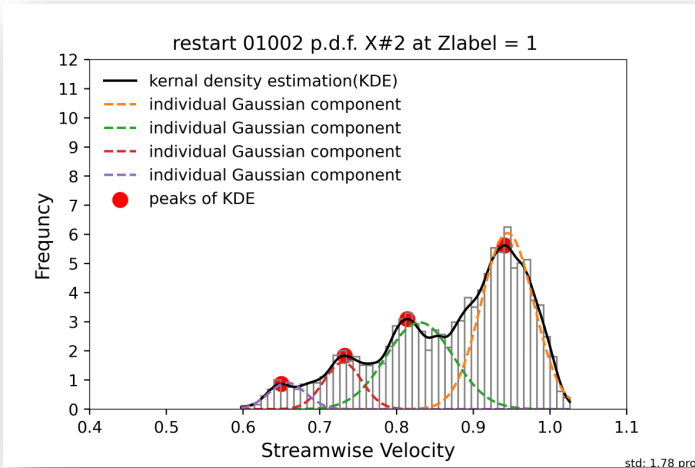

SolidWorks Design and FEA Simulation

First Design Prototype

SOFTWARE PROJECTS

DATA-DRIVEN FLUID TURBULENCE RESEARCH

Uses the Gaussian Mixture Method ML model to deconstruct the fluid velocity distribution into separate "uniform momentum zones".
Statistics and visualizations were then obtained for the research paper
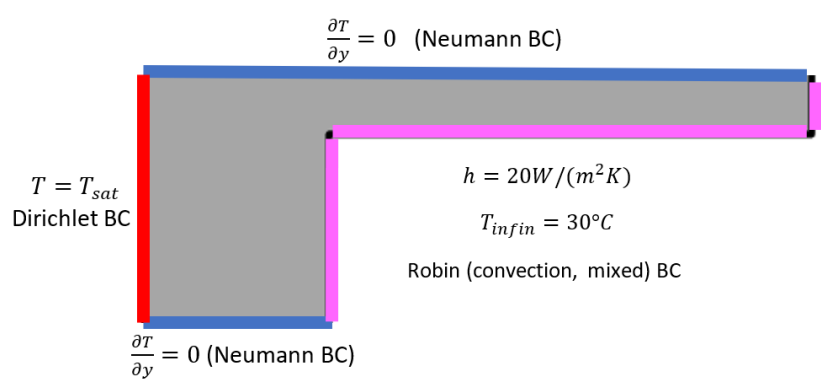Supervisor: Prof. Jean-Pierre Hickey
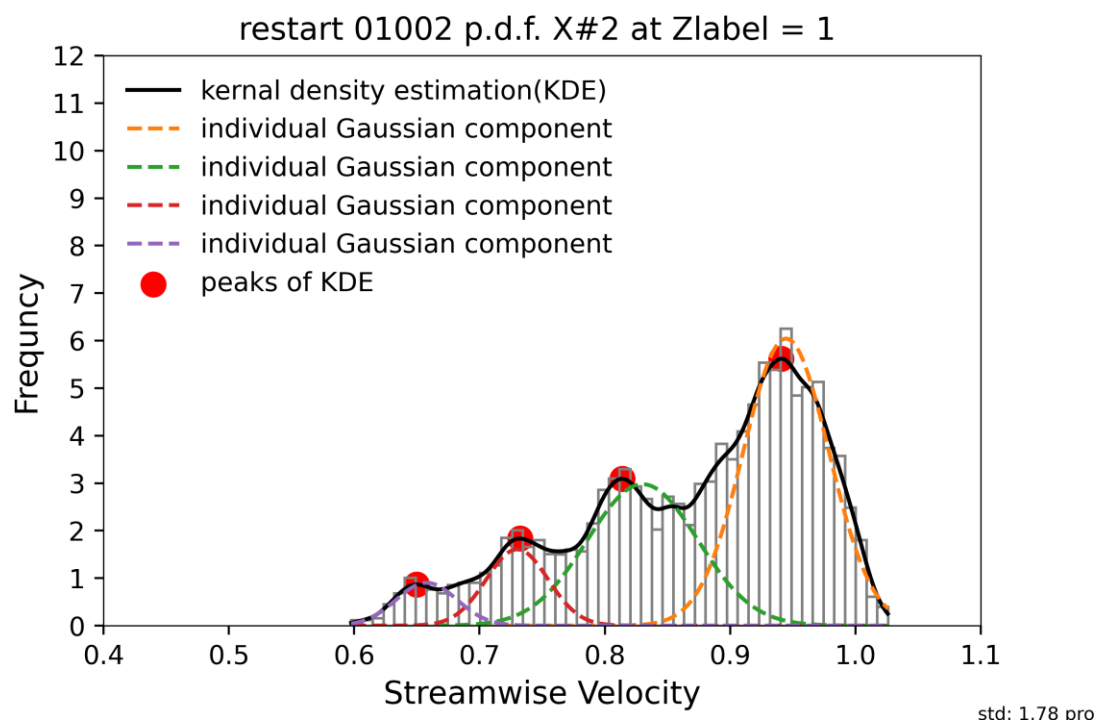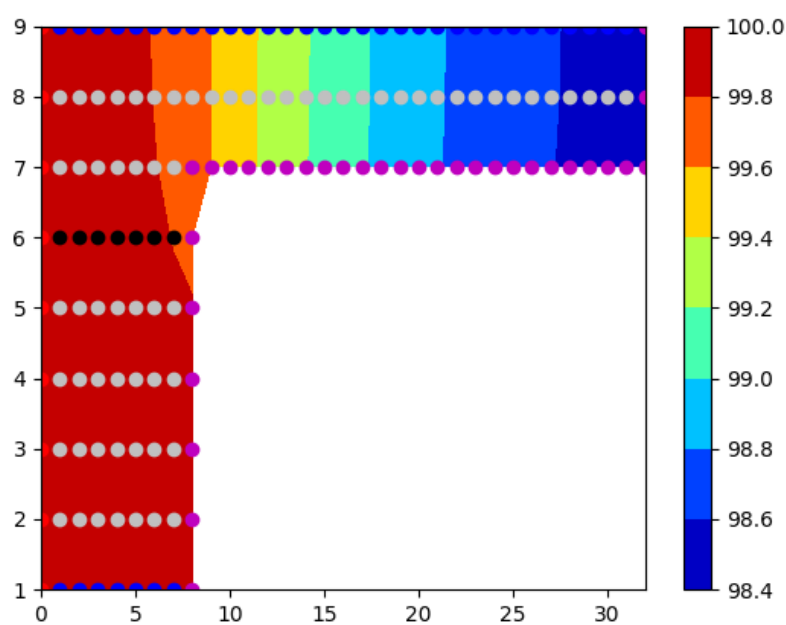

The gaussian components obtained from the algorithm
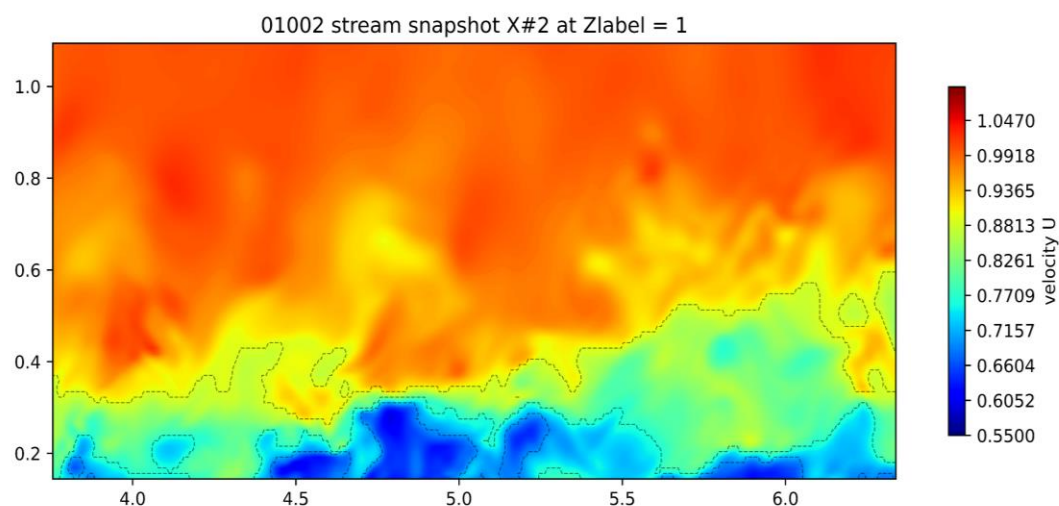
Boundary Layer Simulation Snapshot

HEAT CONDUCTION FEA CODE

The temperature profile and total heat transfer from a fin was calculated using custom finite element code from scratch using python. The solution was validated using the analytic approach

$$\frac{\partial T}{\partial y} = 0 \quad \text{(Neumann BC)}$$

$T = T_{sat}$
Dirichlet BC

$h = 20 W/(m^2 K)$

$T_{infin} = 30°C$

Robin (convection, mixed) BC

$$\frac{\partial T}{\partial y} = 0 \text{ (Neumann BC)}$$

Computational geometry and boundary conditions

Final contour plot with node locations

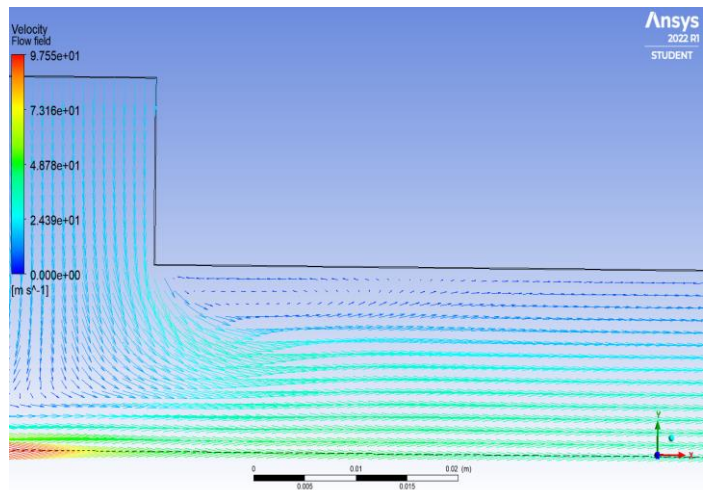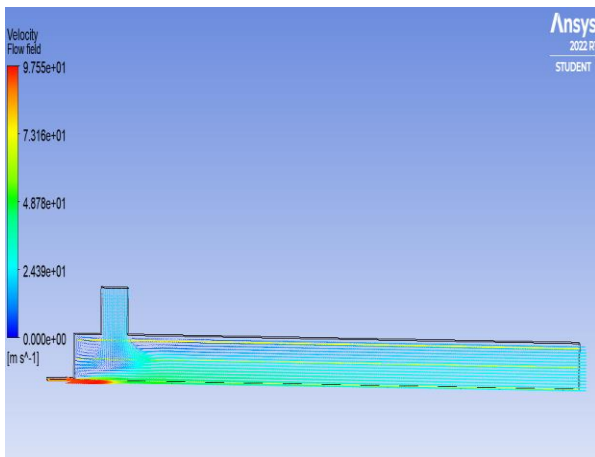T corner

Celcius

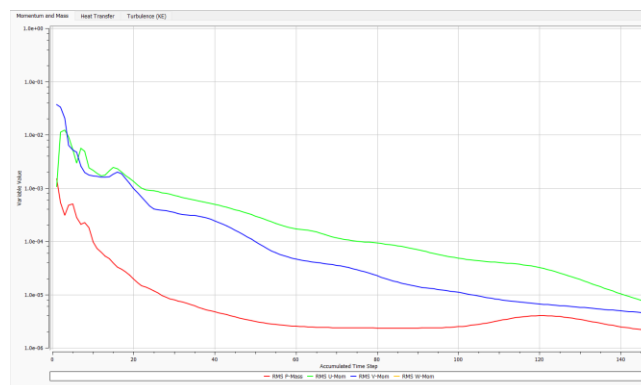No. of Iterations
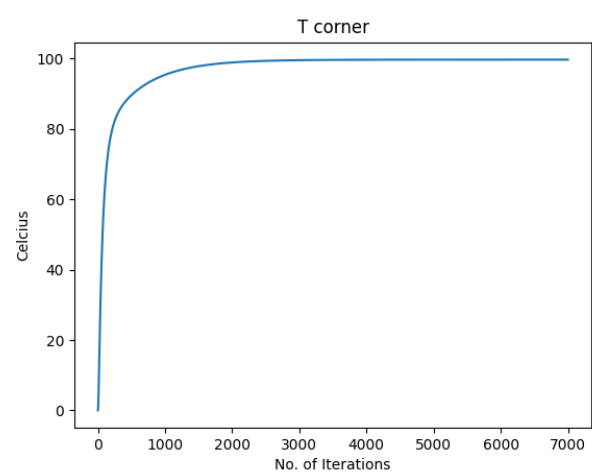
Convergence achieved

CFD OF A MIXING CHAMBER

The effectiveness of mixing of fuel and air in a combustor was simulated using ANSYS CFX. The k-ε model was used as the turbulence model and temperature was used as an indicator.
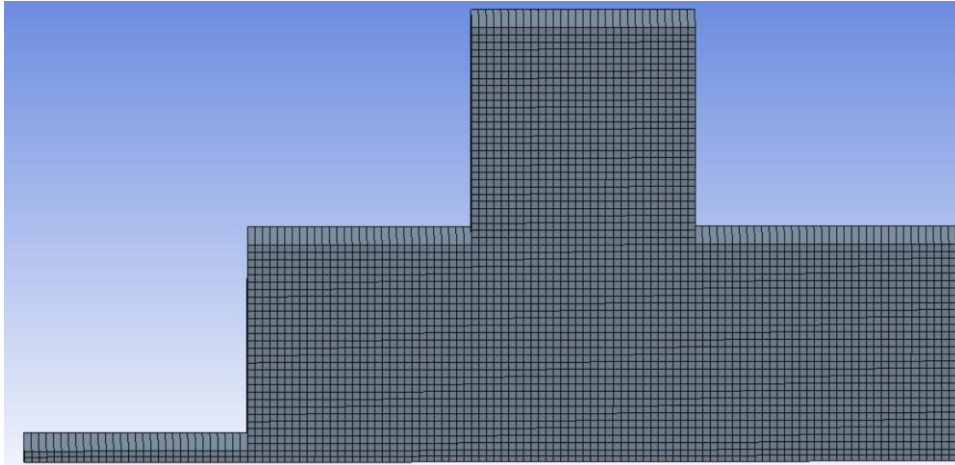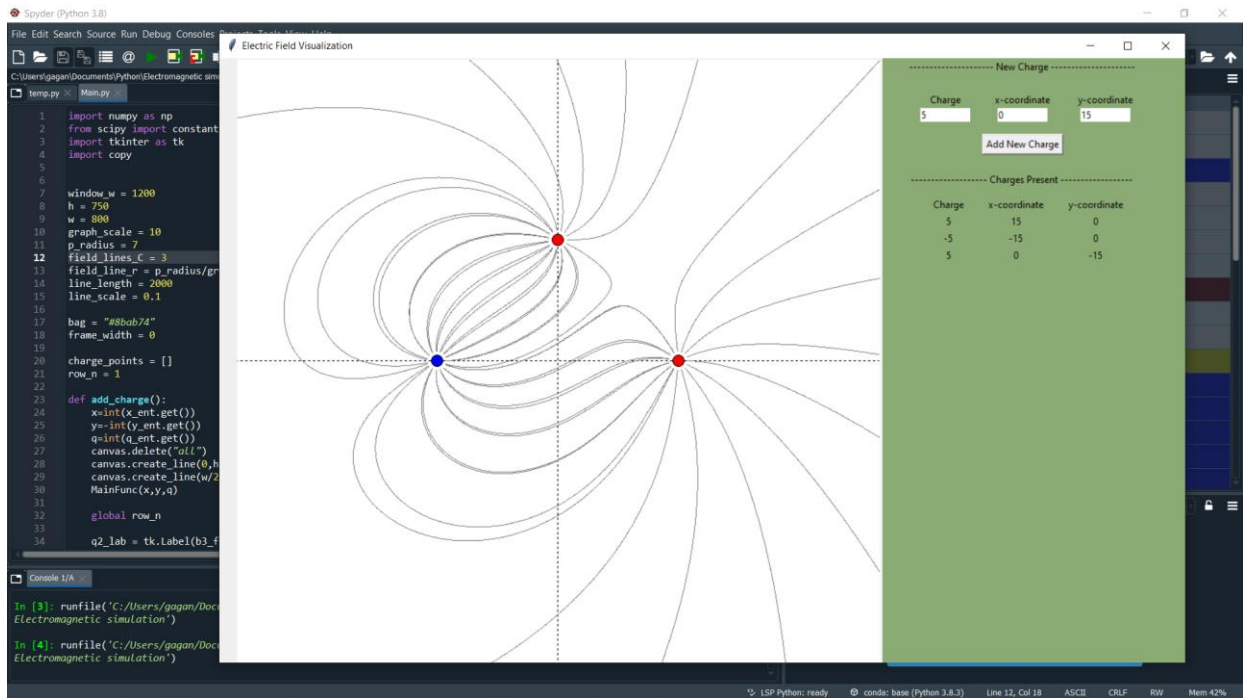

Zoomed in view of mesh

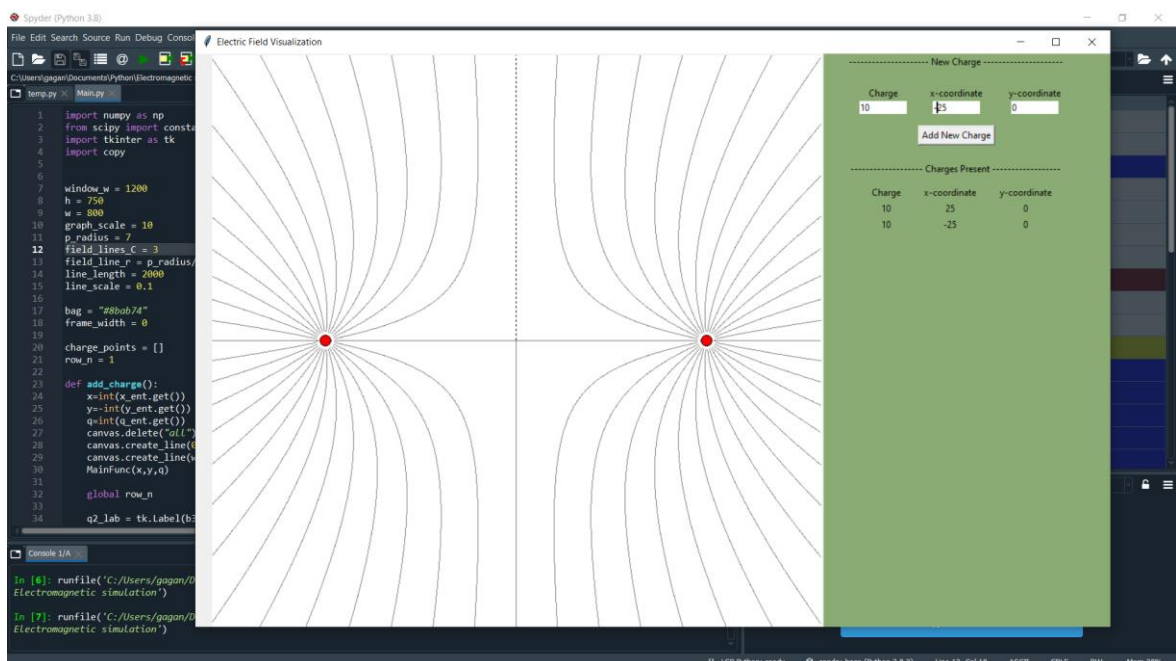Velocity Field & zoomed in view of a separation bubble

Residuals (convergence achieved)

ELECTRIC FIELD LINES SIMULATION PROJECT

Uses the Tkinter library and object oriented programming principles to allow the user to specify location and magnitude of point charges and generates the corresponding electric field lines.

Two positively charged and one negatively charged point charges

Two positively charged point charges