# Heat Transfer Report after Eval_1

Determination of fin - shape with highest efficiency

# TABLE OF CONTENTS

# 01

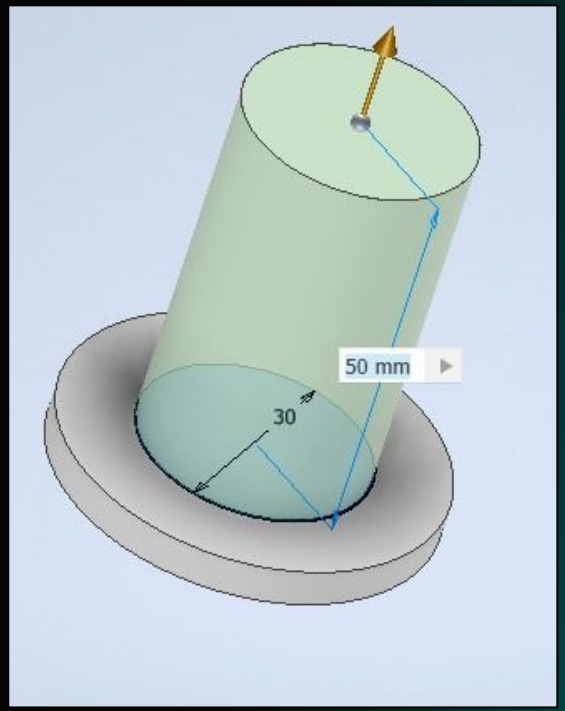
# About the project

# About the project

The objective of our project is to determine the optimal shape of fins that would yield the highest efficiency in heat transfer. We aim to analyze temperature profiles and identify the most efficient shape among three variations: cylindrical pin fin, tapered profile pin fin, and concave parabolic pin fin, Variable area straight fin. The aim of this project is to find a balance between convection heat transfer coefficient and surface area, considering the practical constraints associated with fluid motion and the potential drawbacks of excessive fin density.

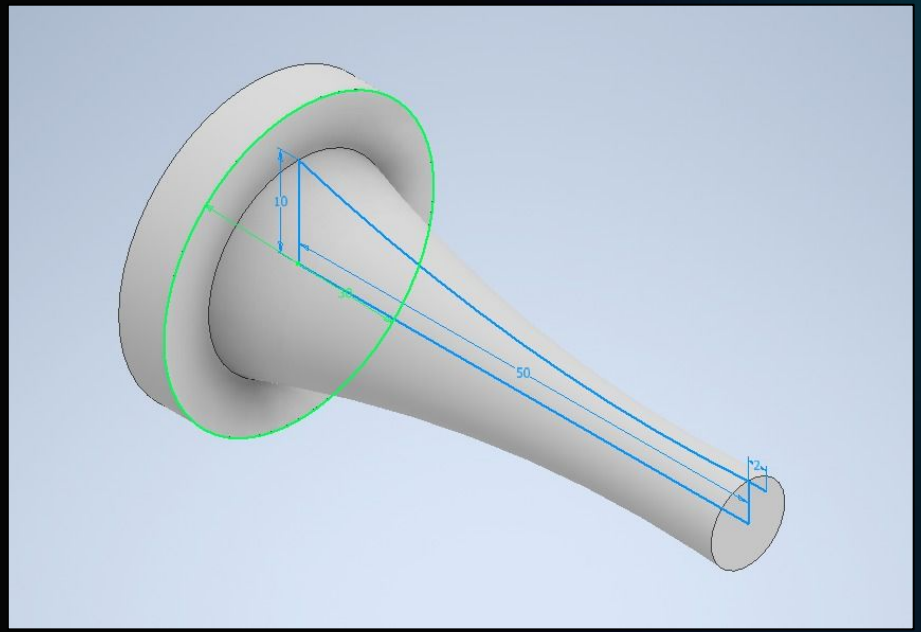
# CAD Models

02

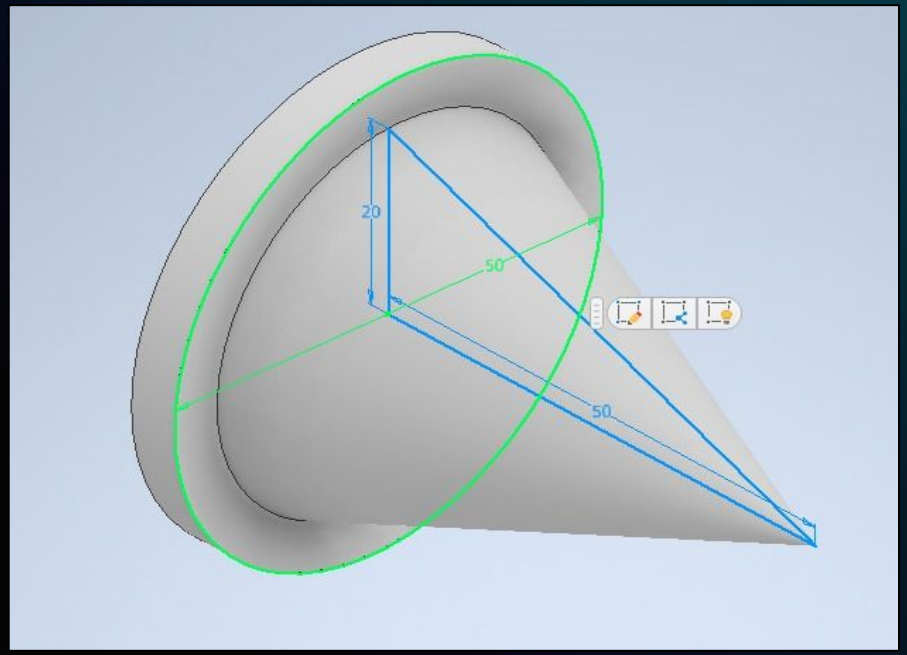



# CYLINDRICAL FIN

# CONCAVE FIN



# CONICAL FIN



# Types of fins

03

# TYPES OF FINS

Material used for the fin: Aluminium

- Cylindrical Fin
- Concave Pin Fin
- Conical Pin Fin

# 04

# Initial Setup

# INITIAL SETUP

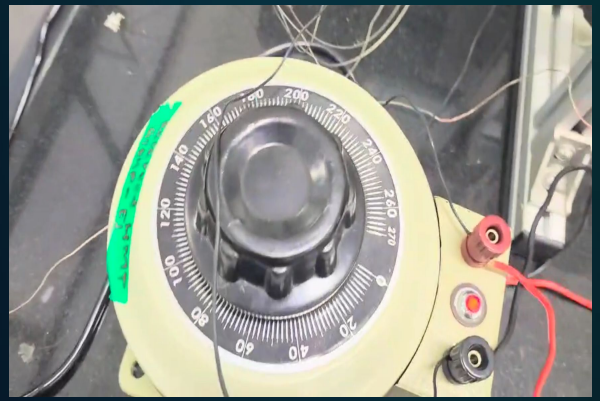
For Detailed Explanation about the setup scan this :

https://drive.google.com/file/d/1ZPNPWyrJ22aRag_fqXbGgNzLX2Acu_Mq/view?usp=drivesdk

# EQUIPMENTS OF EXPERIMENTAL SETUP

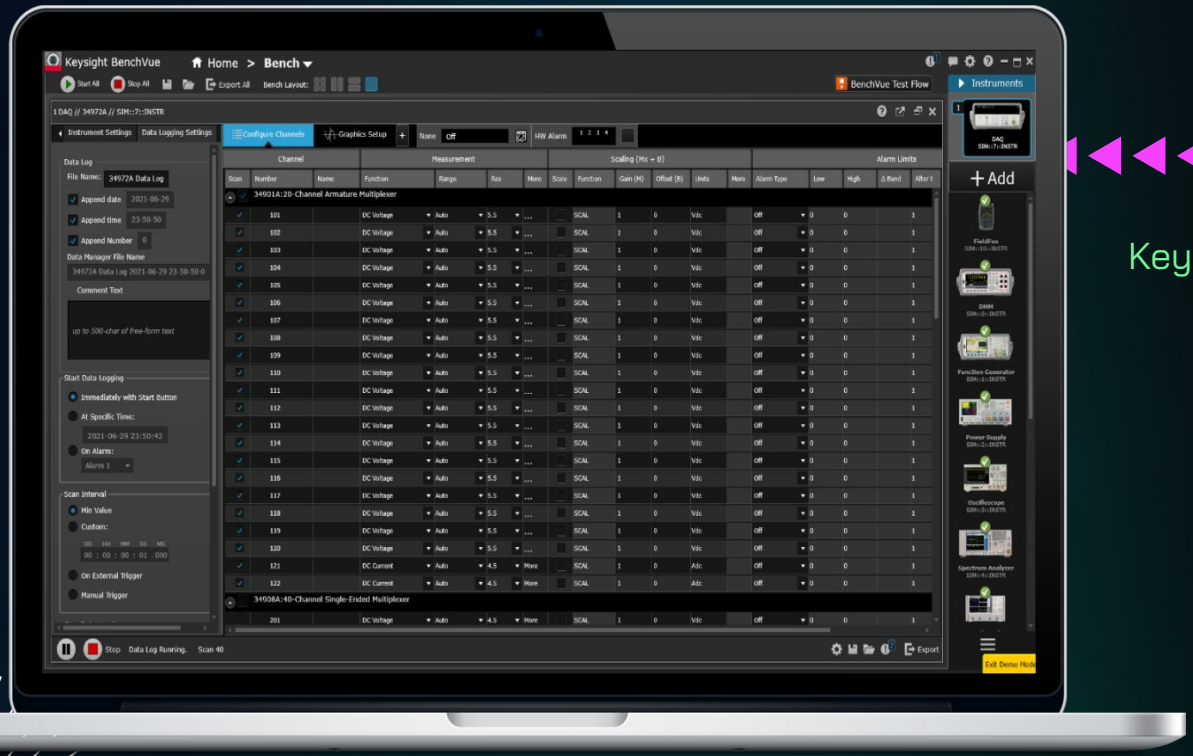
## Electric Heater

## Voltage Controller



## Data Acquisition System

# Software Used: Keysight-BenchVue



# Process calculations and equations

05

# Process Explanation

We place the object with its extruded surface on the heater. We have made the base of the object with 30mm diameter so that it could fit properly on the heater.We then use the polyimide tape to stick the K type thermocouple on the tip or the starting part of the fin. Then, we set the voltage to 80V and fix the duration of 20 minutes. In the BenchVue Keysight software, we have the 3 second time interval of temperature recording and recorded 400 scans of each fin. We have also recorded the temperature of the heater at 3 points at distance of 0.5mm each.

We will be plotting the graph of each fin with all the four temperatures i.e. the surface temperature and the heater temperatures. Then, we will be doing a comparative analysis of all the graphs to see the maximum temperature loss from the surface.

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# Equations

On evaluation we get the temperature profile equation for:

- **Infinitely Long Fin**

$$\frac{T(x) - T_\infty}{T_b - T_\infty} = e^{-ax} = e^{-x\sqrt{hp/kA_c}}$$

- **Adiabatic Tip**

$$\frac{T(x) - T_\infty}{T_b - T_\infty} = \frac{\cosh a(L - x)}{\cosh aL}$$

**Fin Effeciency**

$$\eta_{\text{fin}} = \frac{\dot{Q}_{\text{fin}}}{Q_{\text{fin, max}}} = \frac{\text{Actual heat transfer rate from the fin}}{\text{Ideal heat transfer rate from the fin if the entire fin were at base temperature}}$$

# 06

# Data Analysis

- Raw Data

| | | | | | | |
|---|---|---|---|---|---|---|
| Address | USB0::0x2A8D::0x8601::MY59005419::0::INSTR | | | | | |
| Model | DAQ973A | | | | | |
| Serial Number: | MY59005419 | | | | | |
| Firmware Versio | A.02.02-01.00-02.01-00.02-02.00-03-03 | | | | | |
| Start Time | 2024-03-21 17:4 | | | | | |
| Stop Time | 2024-03-21 18:0 | | | | | |
| Data Log Stopped | | | | | | |
| | | | | | | |
| Instrument Configuration | | | | | | |
| Modules | 4 | Slot 0 | SCD | Slot 1 | DAQM901A | Slot 4 |
| Total Channels | 5 | | | | | |
| | | | | | | |
| Channel Configuration | | | | | | |
| Channels | Name | Function | Range/Arg1 | Res/Arg2 | NPLC | Channel Delay (' |
| 101 | | Temp (Type K) | None | C | 1 | 0.0006 |
| 102 | | Temp (Type K) | None | C | 1 | 0.0006 |
| 103 | | Temp (Type K) | None | C | 1 | 0.0006 |
| 104 | | Temp (Type K) | None | C | 1 | 0.0006 |
| 105 | | Temp (Type K) | None | C | 1 | 0.0006 |

| Scan Sweep Tim | Scan Number | 101Time (Sec) | 101 (°C) | 102Time (Sec) | 102 (°C) | 103Time (Sec) | 103 (°C) | 104Time (Sec) | 104 (°C) | 105Time (Sec) | 105 (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2024-03-21 17:4 | 1 | 2024-03-21 17:4 | 31.4297315 | 2024-03-21 17:4 | 31.4337365 | 2024-03-21 17:4 | 31.4402183 | 2024-03-21 17:4 | 27.7819205 | 2024-03-21 17:4 | 36.5048152 |
| 2024-03-21 17:4 | 2 | 2024-03-21 17:4 | 31.4374626 | 2024-03-21 17:4 | 31.4412355 | 2024-03-21 17:4 | 31.4303429 | 2024-03-21 17:4 | 27.8720677 | 2024-03-21 17:4 | -14.1808515 |
| 2024-03-21 17:4 | 3 | 2024-03-21 17:4 | 31.4277856 | 2024-03-21 17:4 | 31.4368945 | 2024-03-21 17:4 | 31.4182776 | 2024-03-21 17:4 | 27.8320321 | 2024-03-21 17:4 | 9.82479036 |
| 2024-03-21 17:4 | 4 | 2024-03-21 17:4 | 31.4048545 | 2024-03-21 17:4 | 31.3990895 | 2024-03-21 17:4 | 31.419124 | 2024-03-21 17:4 | 27.9261955 | 2024-03-21 17:4 | 25.7202195 |
| 2024-03-21 17:4 | 5 | 2024-03-21 17:4 | 31.4034525 | 2024-03-21 17:4 | 31.4084252 | 2024-03-21 17:4 | 31.42742 | 2024-03-21 17:4 | 28.0331779 | 2024-03-21 17:4 | 41.1582572 |
| 2024-03-21 17:4 | 6 | 2024-03-21 17:4 | 31.4862703 | 2024-03-21 17:4 | 31.4969736 | 2024-03-21 17:4 | 31.5097408 | 2024-03-21 17:4 | 27.9871284 | 2024-03-21 17:4 | 19.6310181 |
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| 2024-03-21 17:4 | 17 | 2024-03-21 17:4 | 33.734551 | 2024-03-21 17:4 | 33.7192121 | 2024-03-21 17:4 | 33.7486336 | 2024-03-21 17:4 | 31.9443615 | 2024-03-21 17:4 | 39.0407825 |
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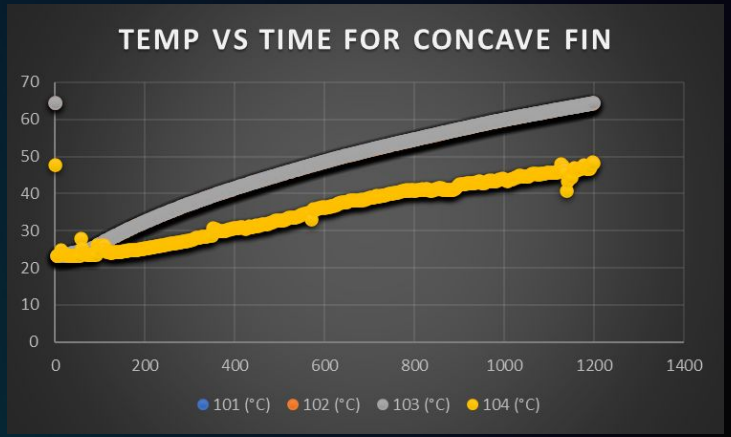
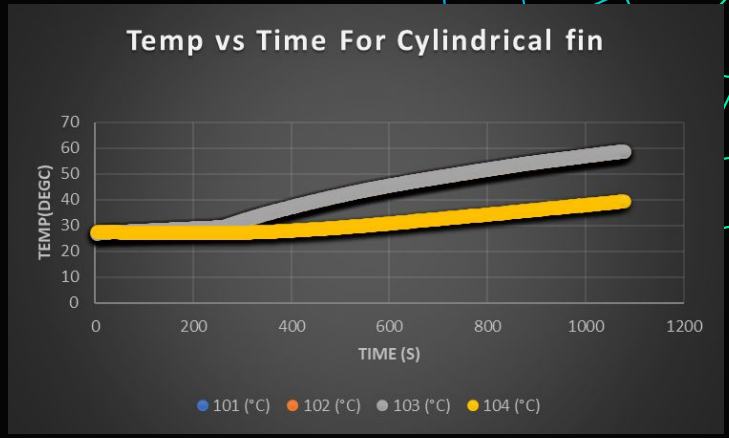
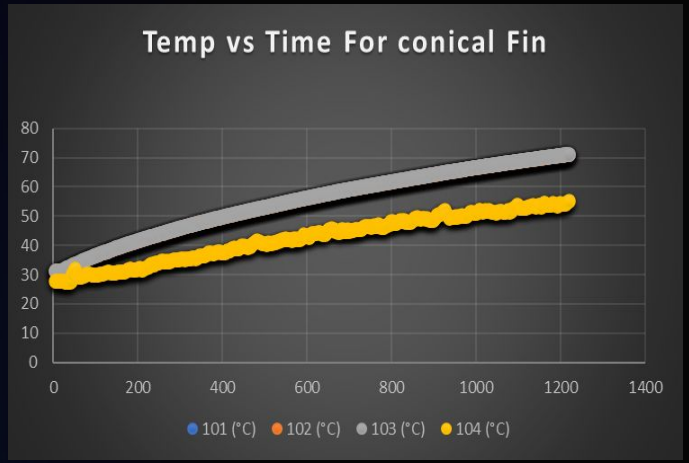
# TEMP VS TIME PLOTS FOR ALL FINS



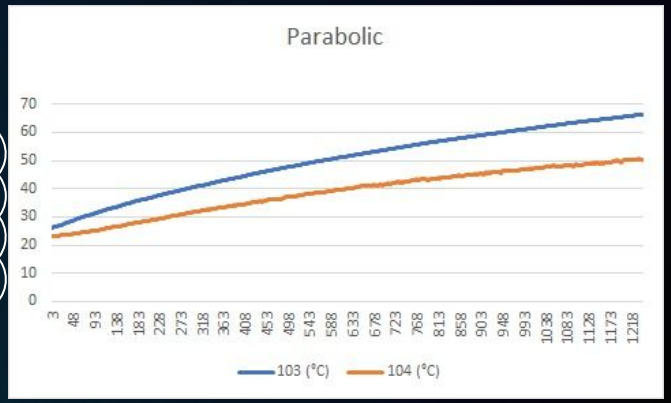



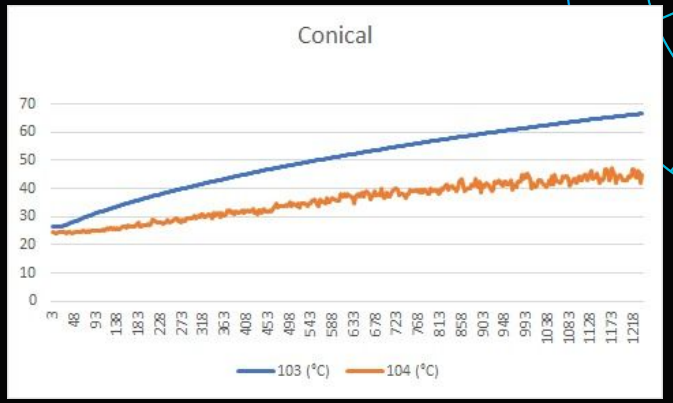
# Tasks completed After Eval - 2

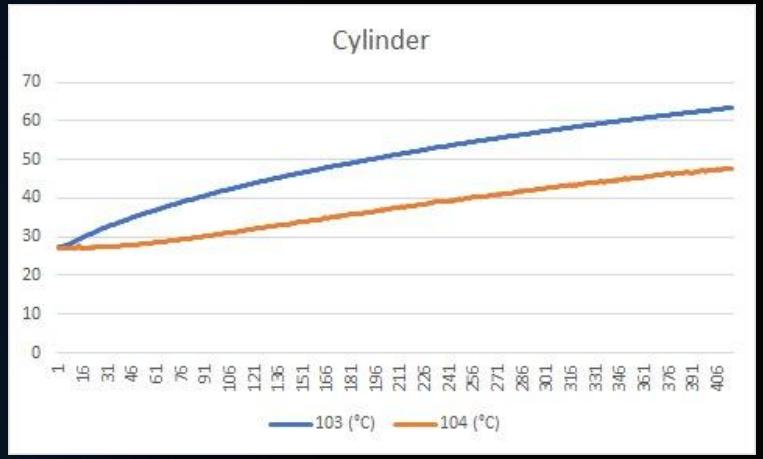
# Validation of data

07

# TEMP VS TIME PLOTS FOR ALL FINS (Done Again)



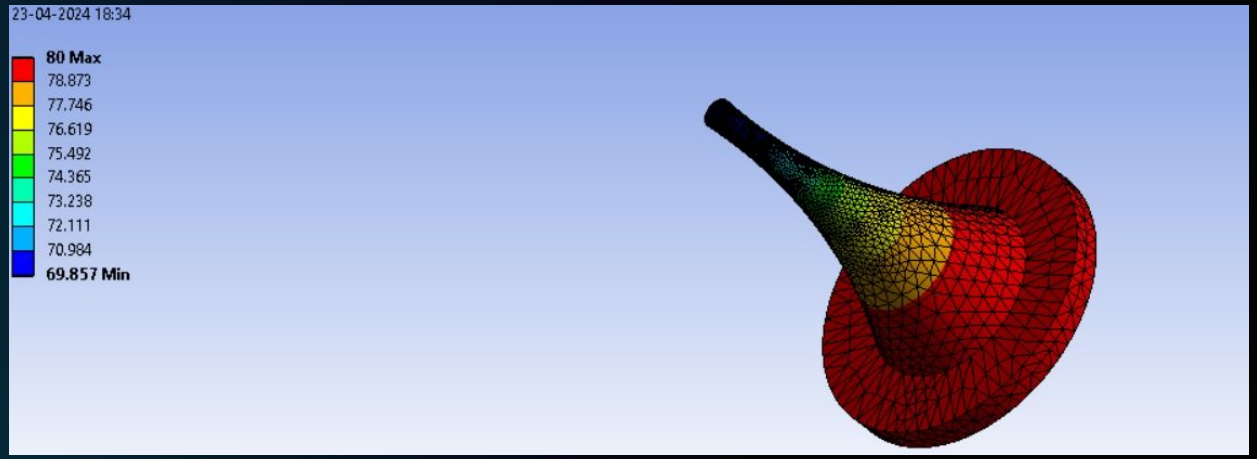



# 08

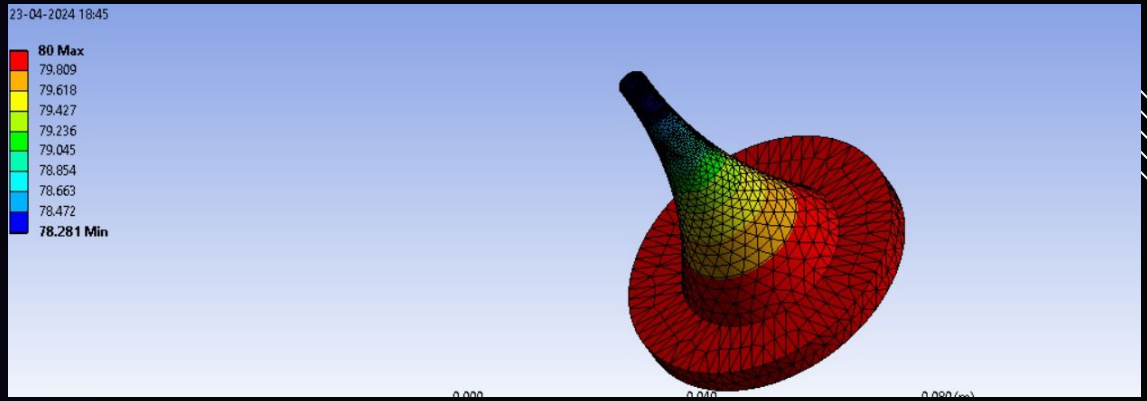
# Simulations

# Simulations: Concave fin

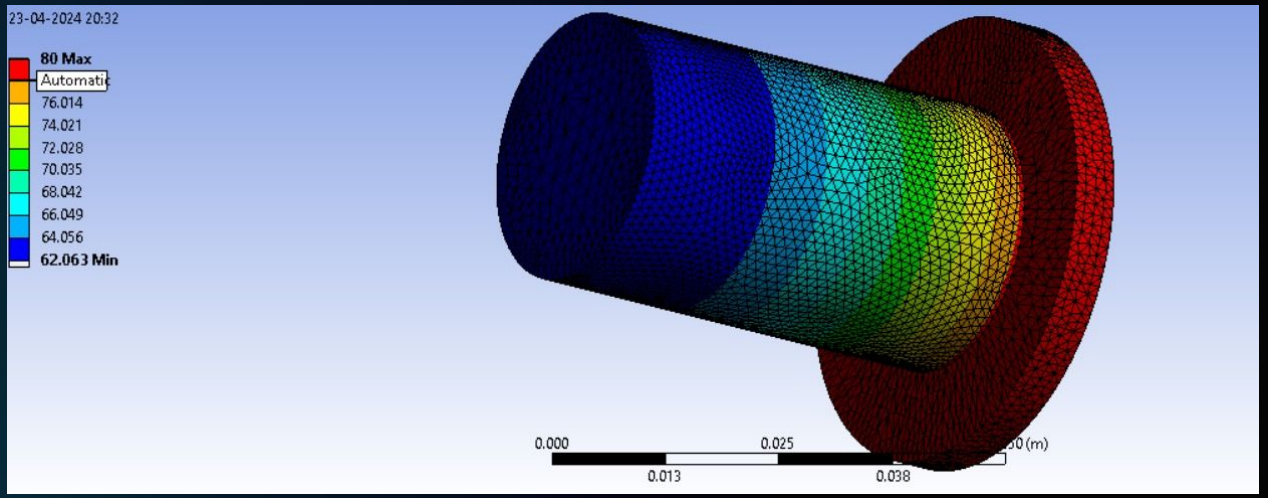



50 mm

40 mm

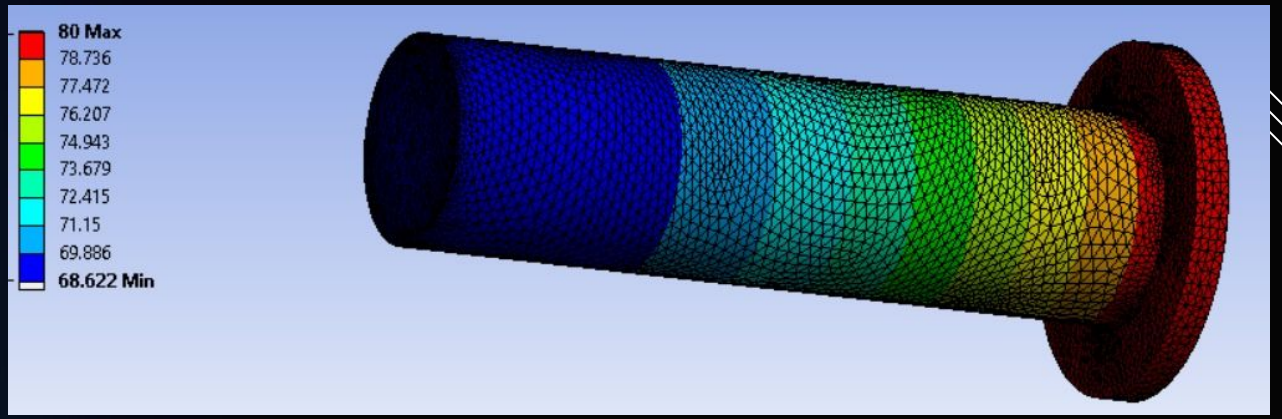


# Simulations: Cylindrical fin

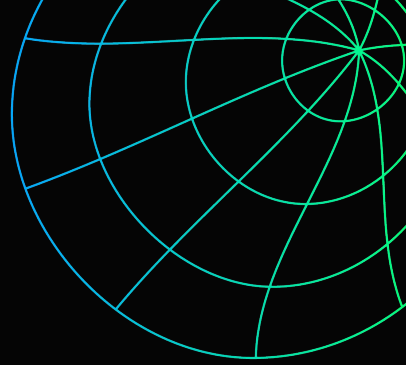



50 mm

60 mm



# Efficiency



**Real Experiments**

Concave fin :
With Length 50 mm : 70%

Cylindrical fin :
With Length 50 mm : 45%

Conical fin:
With Height 50 mm : 68.75%

**Ideal**

Concave fin:
With Length 50 mm : 82.5%
With Length 40 mm : 97%

Cylindrical fin :
With Length 50 mm : 69%
With Length 60 mm : 80.3%

Conical fin:
Could not do due to error

# Acknowledgements

We would like to thank Prof.Soumyadip Sett and Prof.Biswajit Saha for their guidance.We would like to thank the machine shop IITGN for their essential help. We would also like to thank the Teaching Assistants for their guidance and support.

# OUR TEAM


Atharva Bodhale
22110043

Shivrajsinh Bhosale
22110048

Purva Shah
22110207

Shrey Agarwal
22110244

Vedant Chichmalkar
22110282