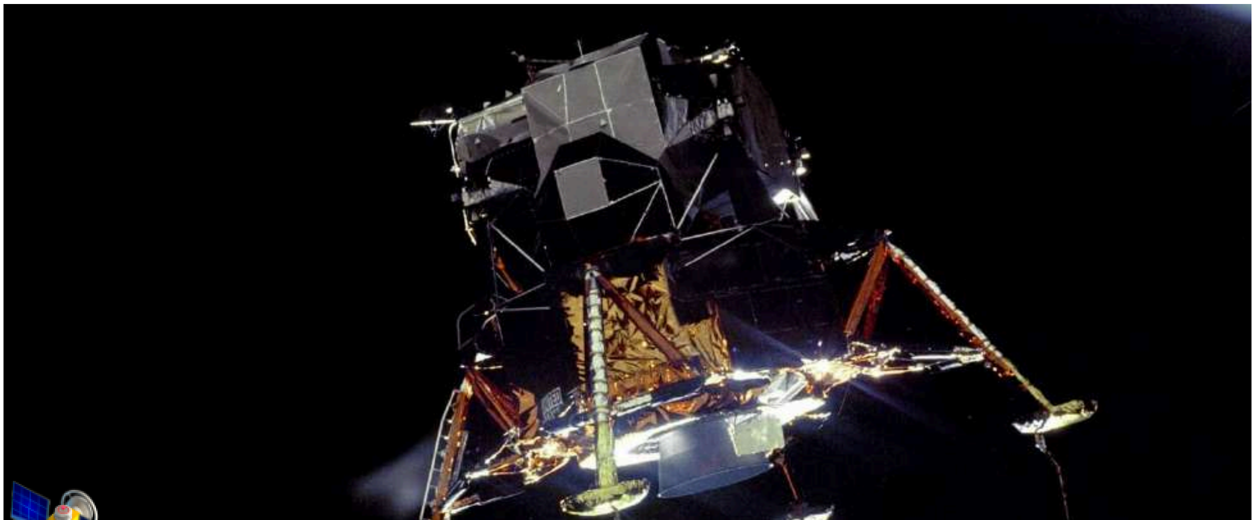


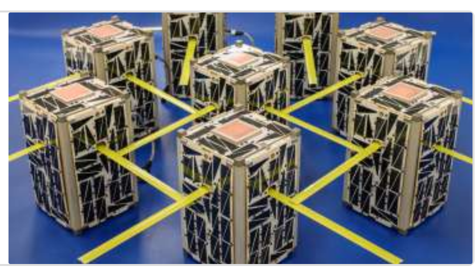
Cubesat casing project

- Project Goal: "To design and test a lightweight CubeSat casing that can protect payloads under launch conditions.”
- The primary objective of this project was to design and test a lightweight CubeSat casing capable of protecting payloads under launch and orbital conditions. The idea emerged after I attended a satellite engineering course conducted by Space Zone India.

Refrences :

What are SmallSats and CubeSats?

https://www.nasa.gov/what-are-smallsats-and-cubesats/



Project log :

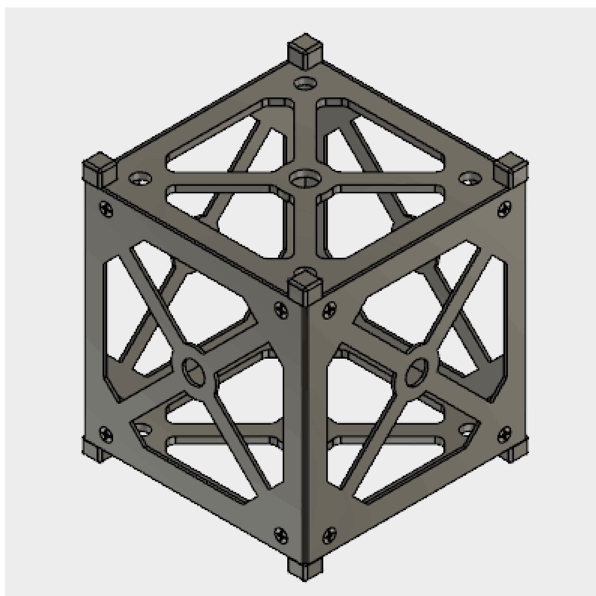
Pre design phase

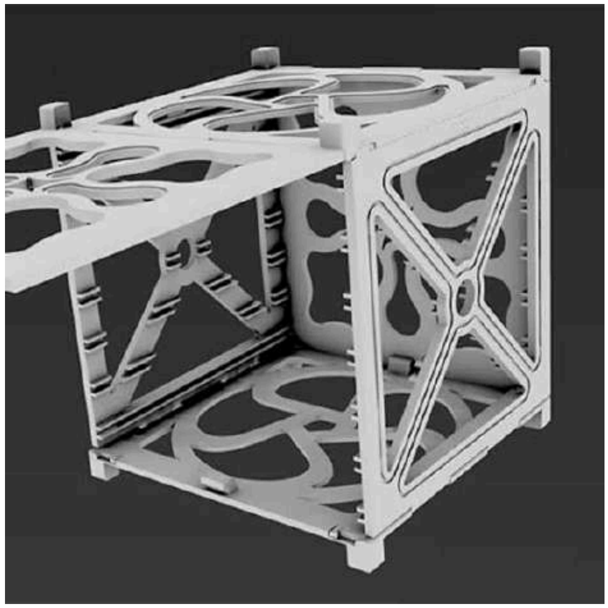
Week 1 :

- Learned the basics of Autodesk Fusion 360.
- Practiced basic sketching and explored available design tools.
- Initially tried modeling without tutorials, but found it challenging. Tutorials greatly improved my understanding and efficiency

Week 2 :

- Researched standard CubeSat dimensions and materials.
- Shortlisted materials : aluminium alloys and titanium .
- Decided on a hexagonal design for stability and structural integrity

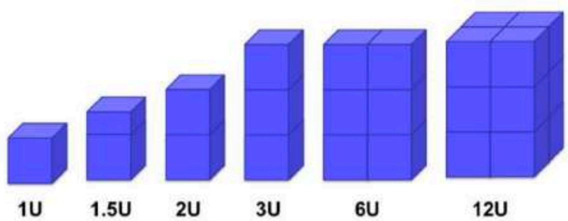




- Selected 0.5U CubeSat dimensions as an appropriate design scale

What are CubeSats?

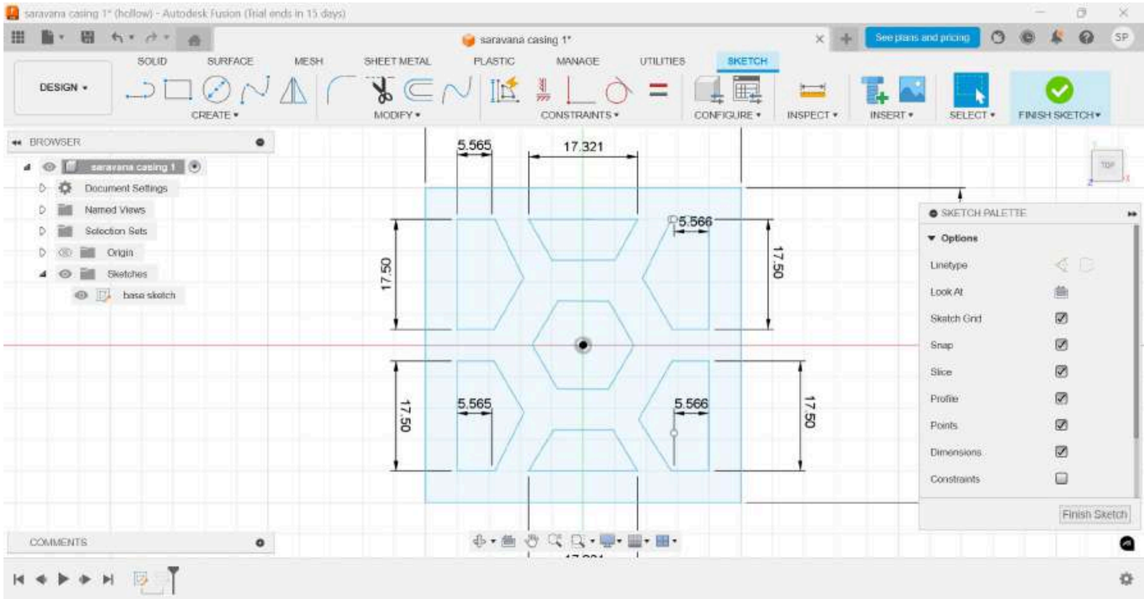
CubeSats are a class of nanosatellites that use a standard size and form factor. The standard CubeSat size uses a "one unit" or "1U" measuring 10x10x10 cms and is extendable to larger sizes; 1.5, 2, 3, 6, and even 12U. Originally developed in 1999 by California Polytechnic State University at San Luis Obispo (Cal Poly) and Stanford University to provide a platform for education and space exploration. The development of CubeSats has advanced into its own industry with government, industry and academia collaborating for ever increasing capabilities. CubeSats now provide a cost effective platform for science investigations, new technology demonstrations and advanced mission concepts using constellations, swarms disaggregated systems.

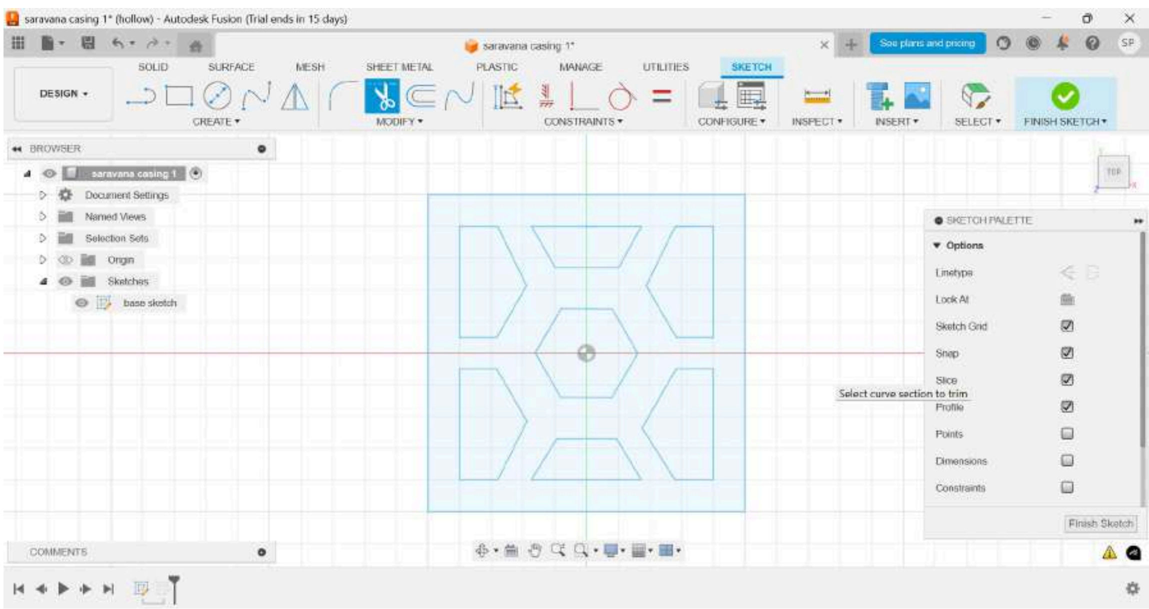


▼ Design phase

Week 3 :

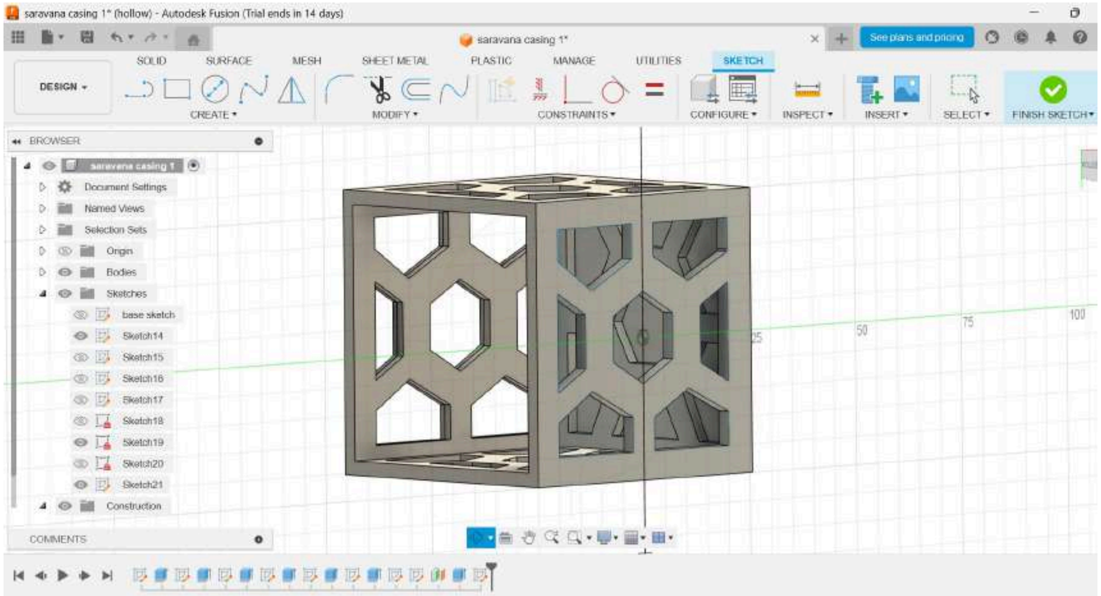
- Created initial 2D sketches with symmetrical hexagonal features.
- Overcame difficulties with symmetry by refining constraints and aligning sketches

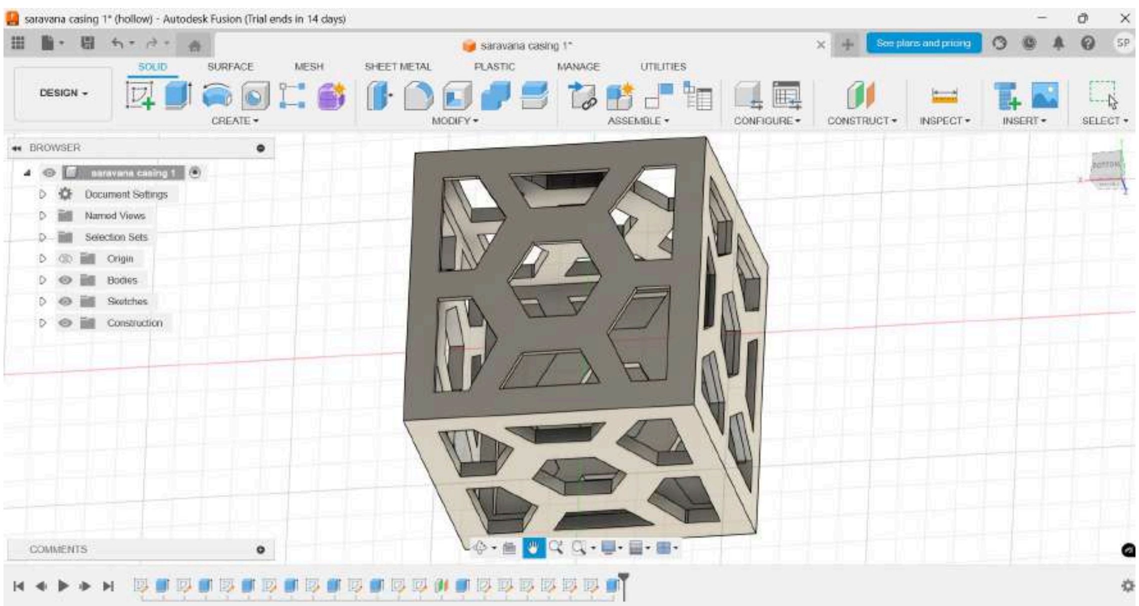




Week 4 :

- Extruded the sketches into a 3D model representing the CubeSat casing.
- Faced challenges in completing the bottom face of the design but resolved them through trial and error.


saravana casing 1* (hollow) - Autodesk Fusion (Trial ends in 14 days)
SOLID
SURFACE
MESH
SHEET METAL
PLASTIC
MANAGE
UTILITIES
SKETCH
DESIGN
CREATE
MODIFY
CONSTRAINTS
CONFIGURE
INSPECT
INSERT
SELECT
FINISH SKETCH
BROWSER
COMMENTS


saravana casing 1* (hollow) - Autodesk Fusion (Trial ends in 14 days)
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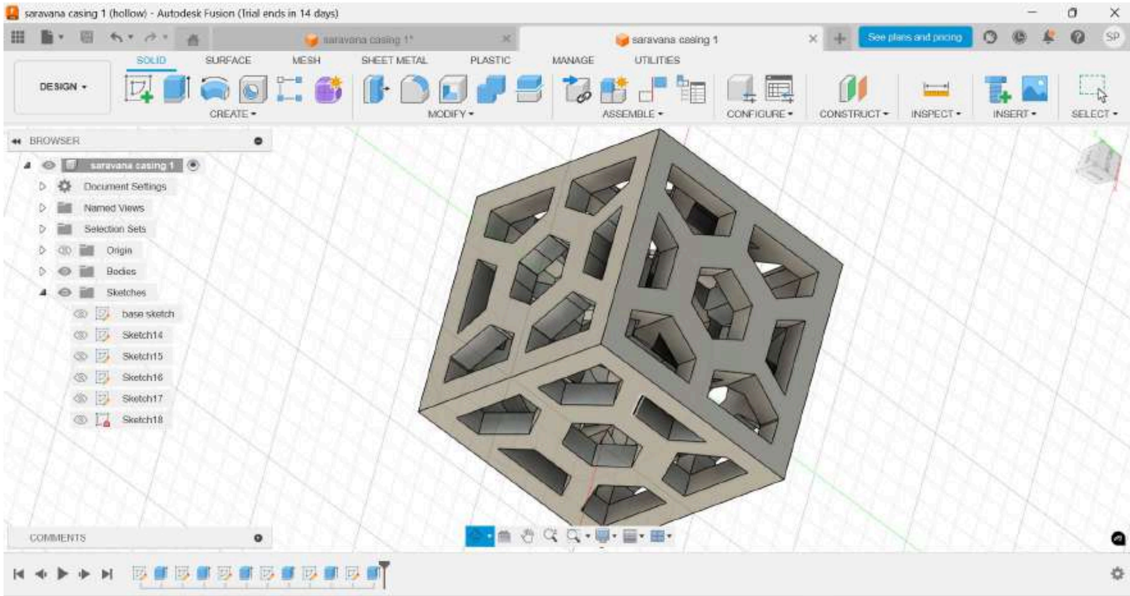


- Successfully developed a complete 3D model of the CubeSat casing.

▼ SIMULATION :

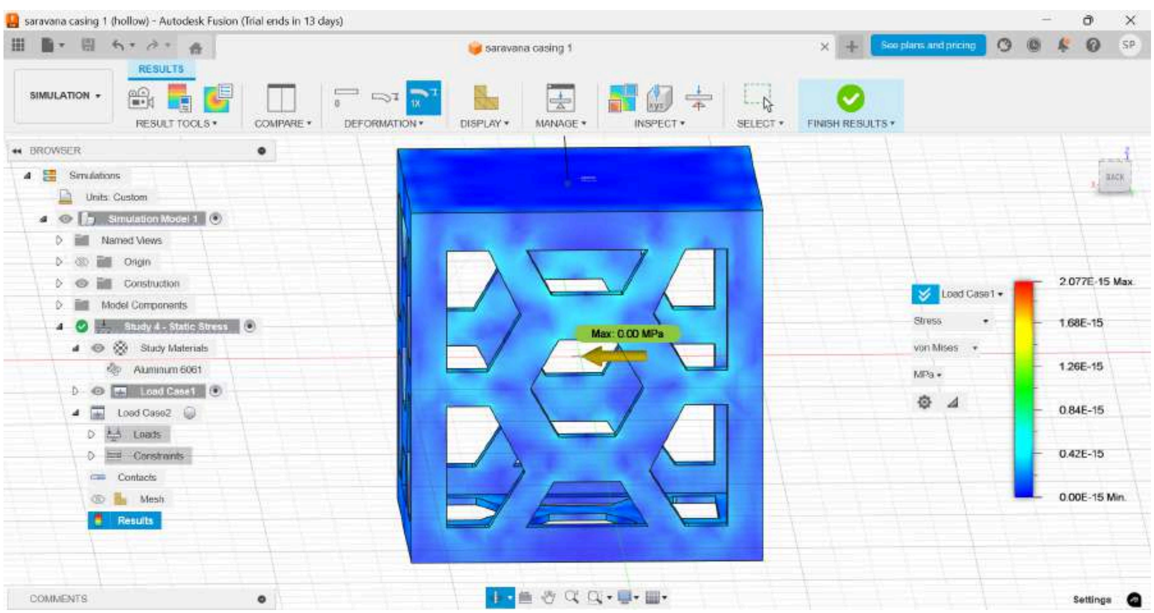
Week 5 (structural analysis) :

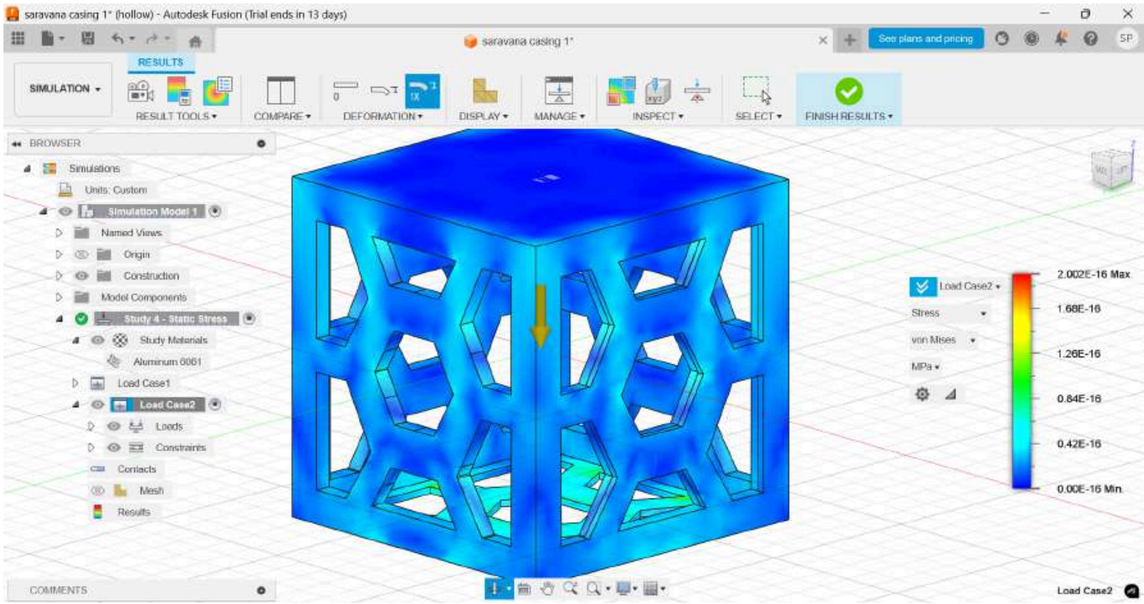
- Applied random g-forces in different directions to simulate launch stresses (e.g., 6g on the x- axis and 8g on the -z axis).
- Materials tested: Aluminium 6061 and Titanium .
- For aluminium:

PROPERTIES

Bodies (1)

Area	22575.075 mm^2
Density	0.003 g / mm^3
Mass	51.104 g
Volume	18927.452 mm^3
Physical Material	Aluminum 6061
Appearance	Aluminum - Satin

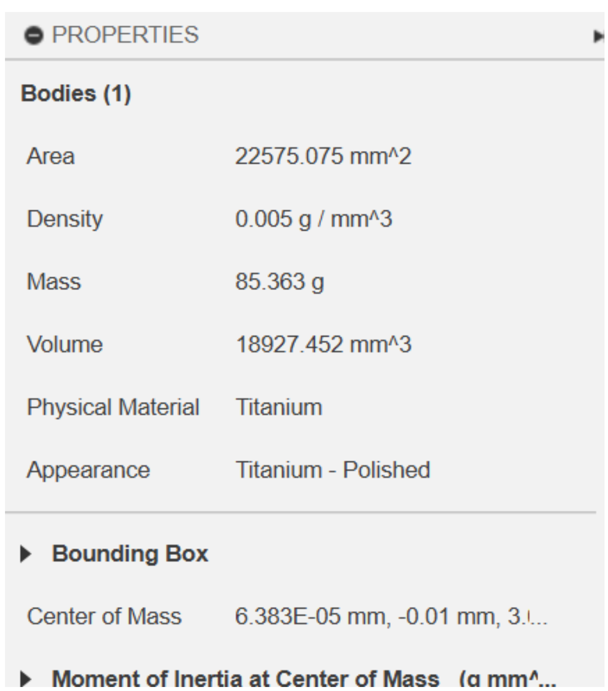




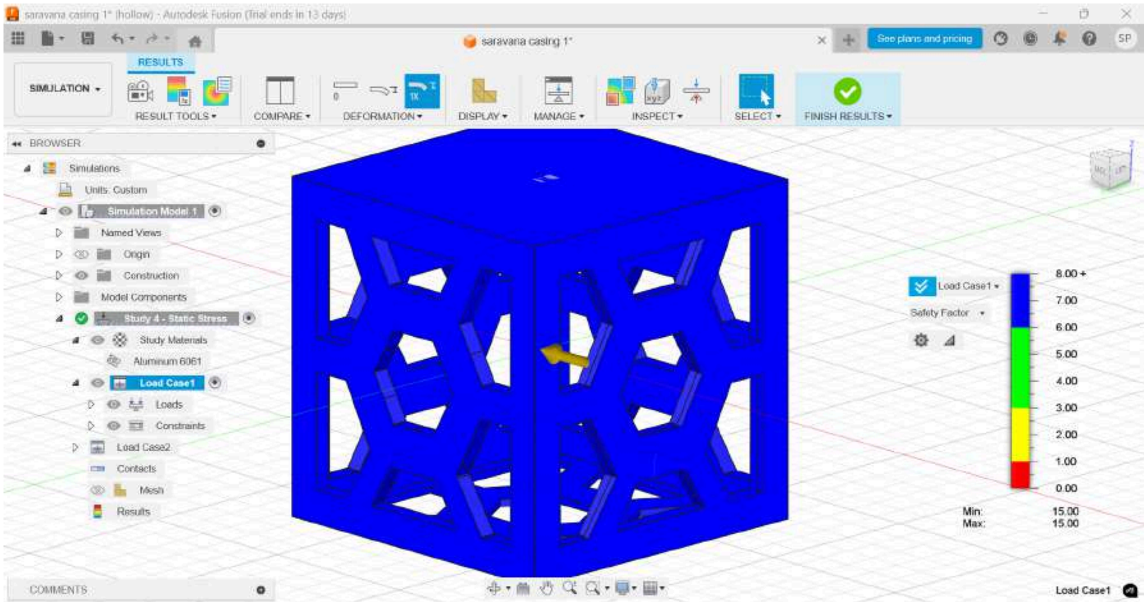
Results :

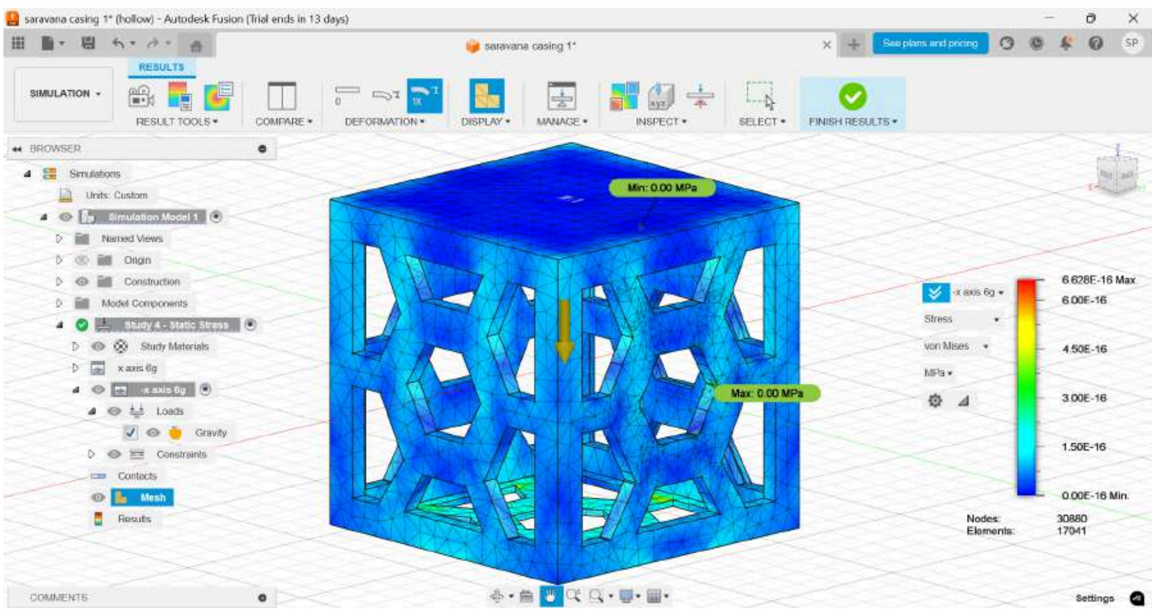
Aluminium: No significant deformations observed. Stresses remained within safe limits above the factor of safety.

- For titanium :



PROPERTIES	
Bodies (1)	
Area	22575.075 mm^2
Density	0.005 g / mm^3
Mass	85.363 g
Volume	18927.452 mm^3
Physical Material	Titanium
Appearance	Titanium - Polished
Bounding Box	
Center of Mass	6.383E-05 mm, -0.01 mm, 3....
Moment of Inertia at Center of Mass (g mm^...	





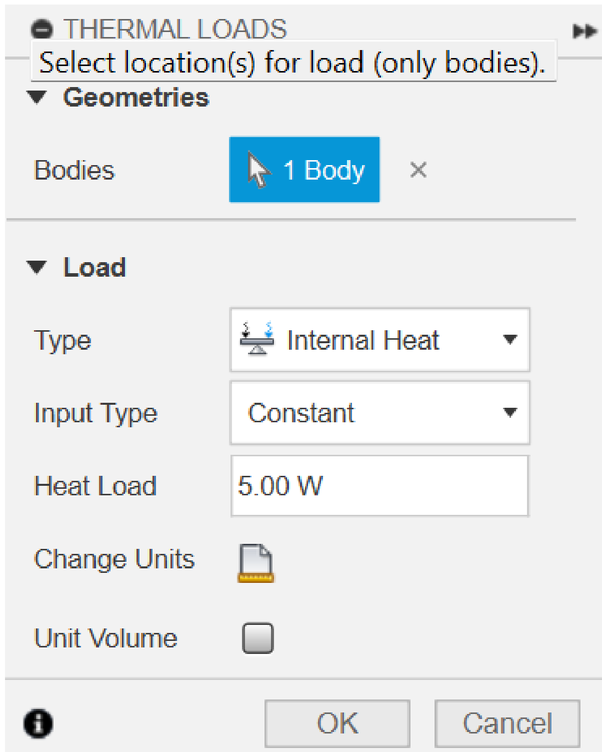
Titanium: Similar outcome, with no major deformations. Factor of safety was satisfied .

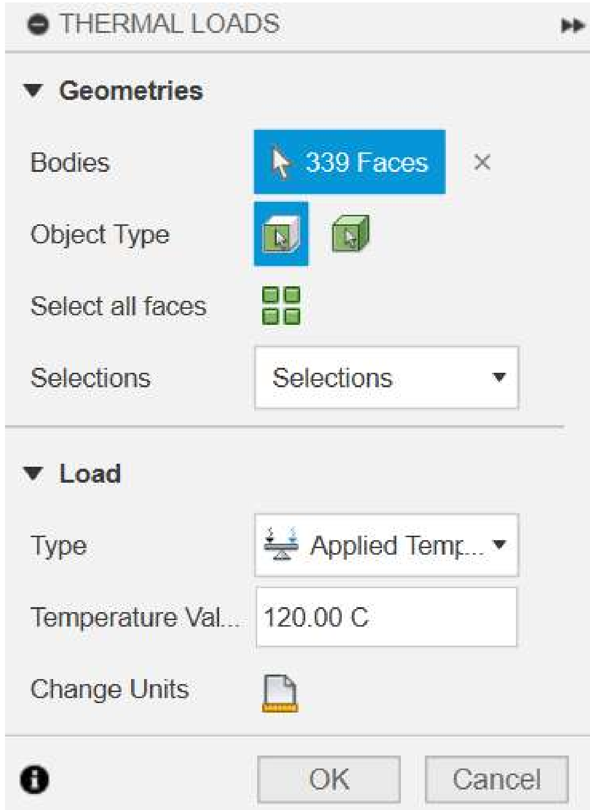
Week 6 (Thermal analysis) :

Simulated extreme thermal conditions typical of Low Earth Orbit (LEO): -150°C to +120°C roughly.

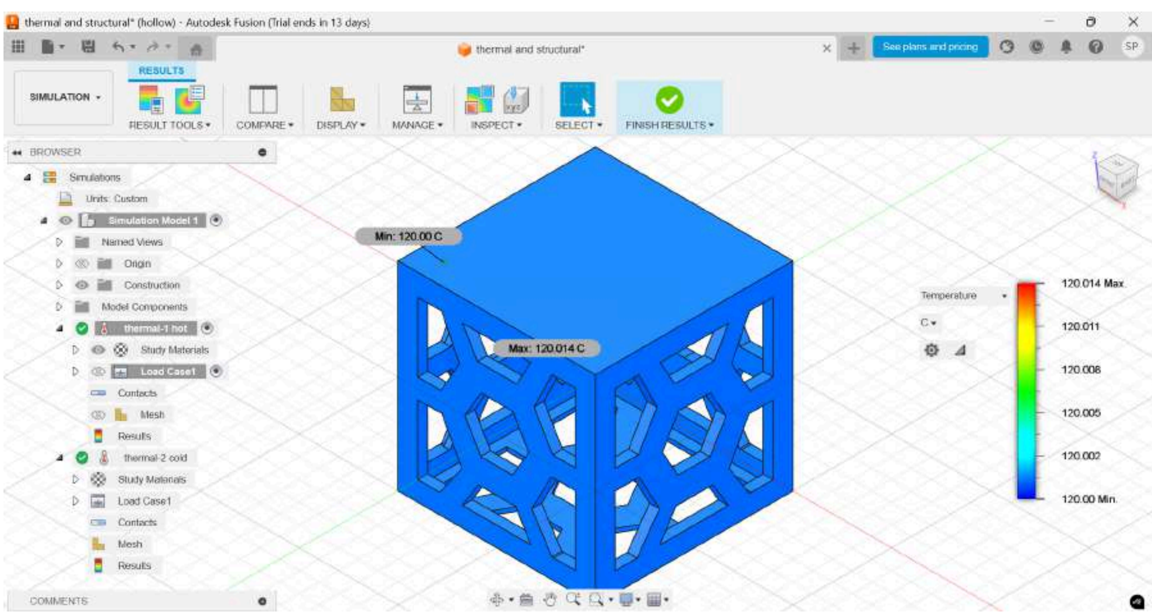
Applied a 5W internal heat source to represent onboard component heating..

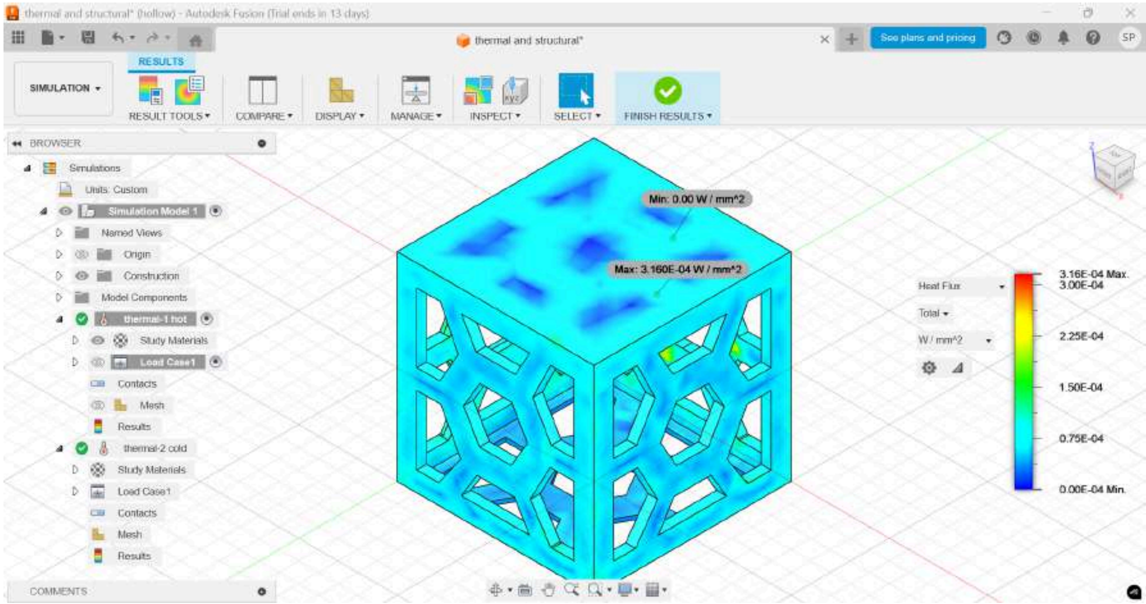
- Thermal loads

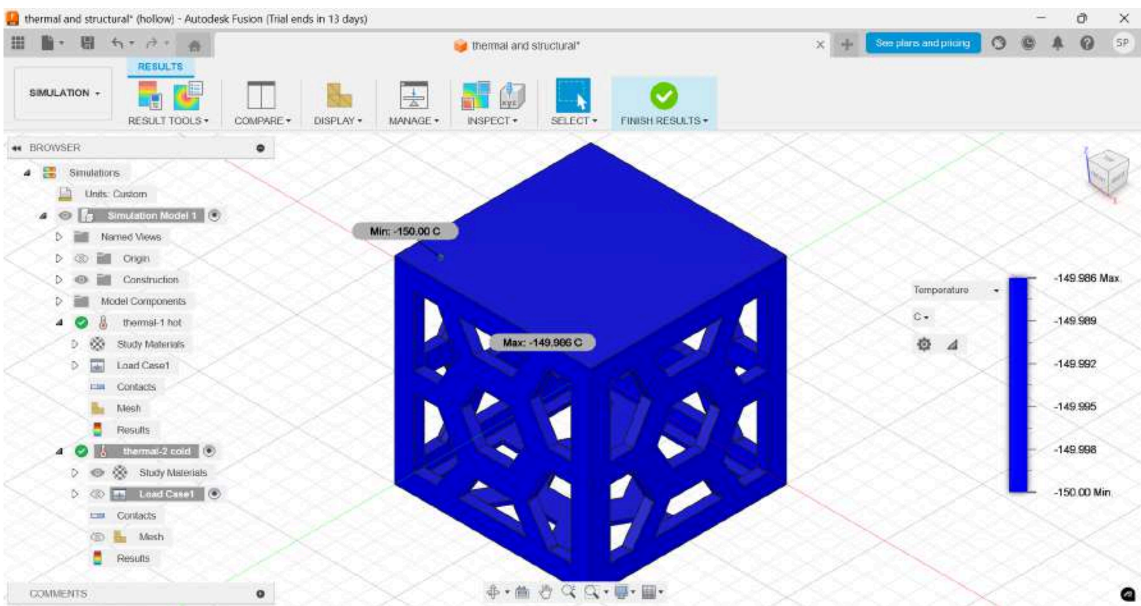




- For aluminium:




thermal and structural* (hollow) - Autodesk Fusion (Trial ends in 13 days)
thermal and structural*
See plans and pricing
RESULTS
SIMULATION
RESULT TOOLS
COMPARE
DISPLAY
MANAGE
INSPECT
SELECT
FINISH RESULTS
BROWSER
Simulations
Units: Custom
Simulation Model 1
Named Views
Origin
Construction
Model Components
thermal-1 hot
Study Materials
Load Case1
Contacts
Mesh
Results
thermal-2 cold
Study Materials
Load Case1
Contacts
Mesh
Results
COMMENTS
Min: 0.00 W / mm^2
Max: 3.160E-04 W / mm^2
Heat Flux
Total
W / mm^2
3.16E-04 Max.
3.00E-04
2.25E-04
1.50E-04
0.75E-04
0.00E-04 Min.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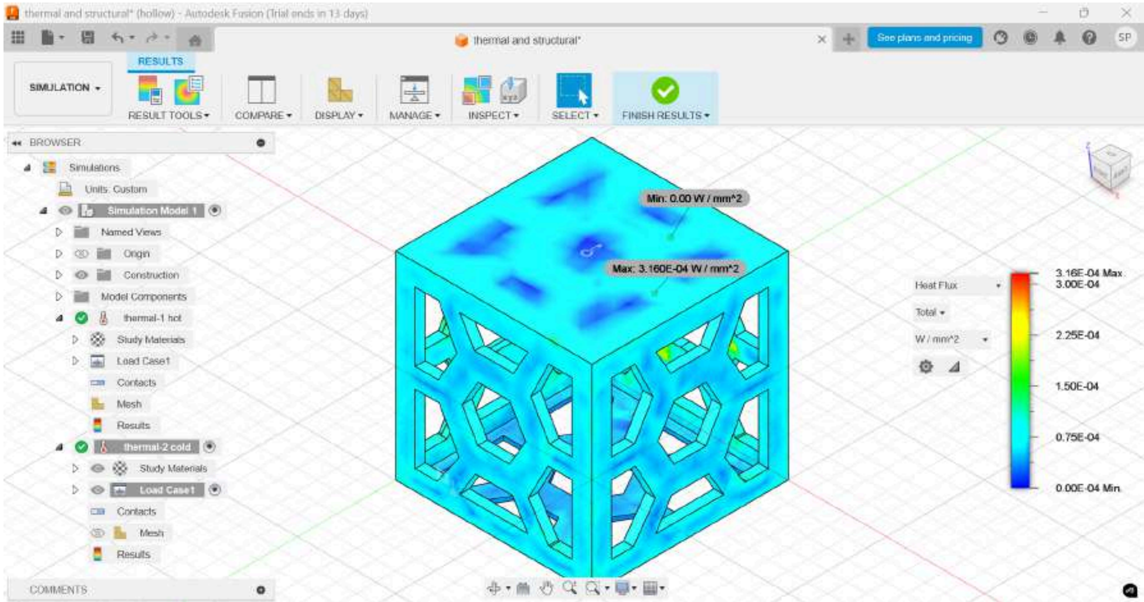
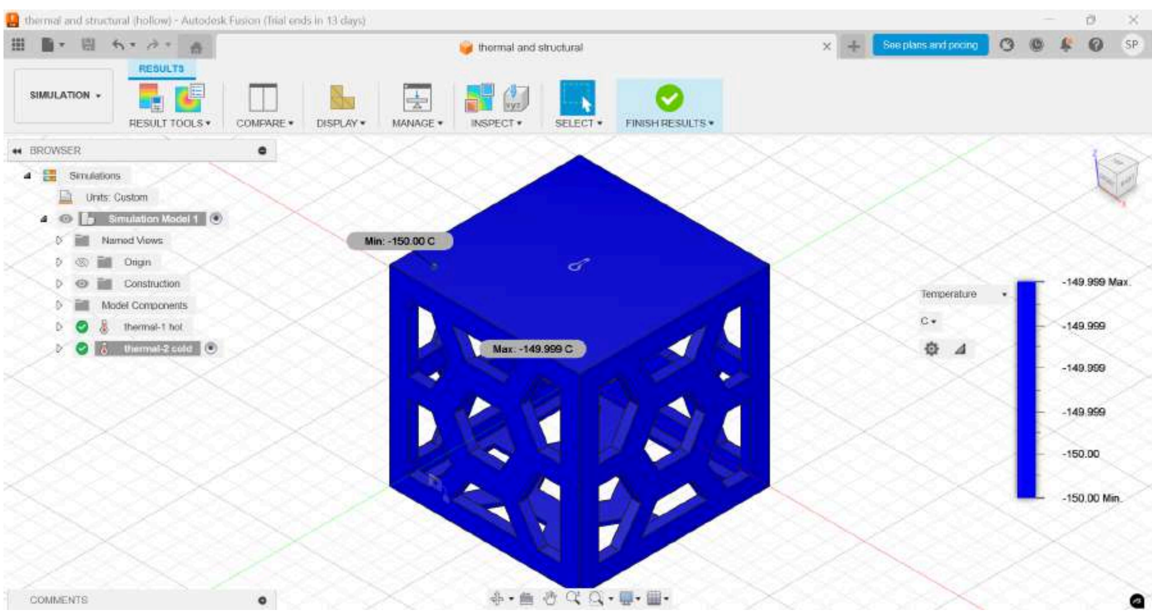
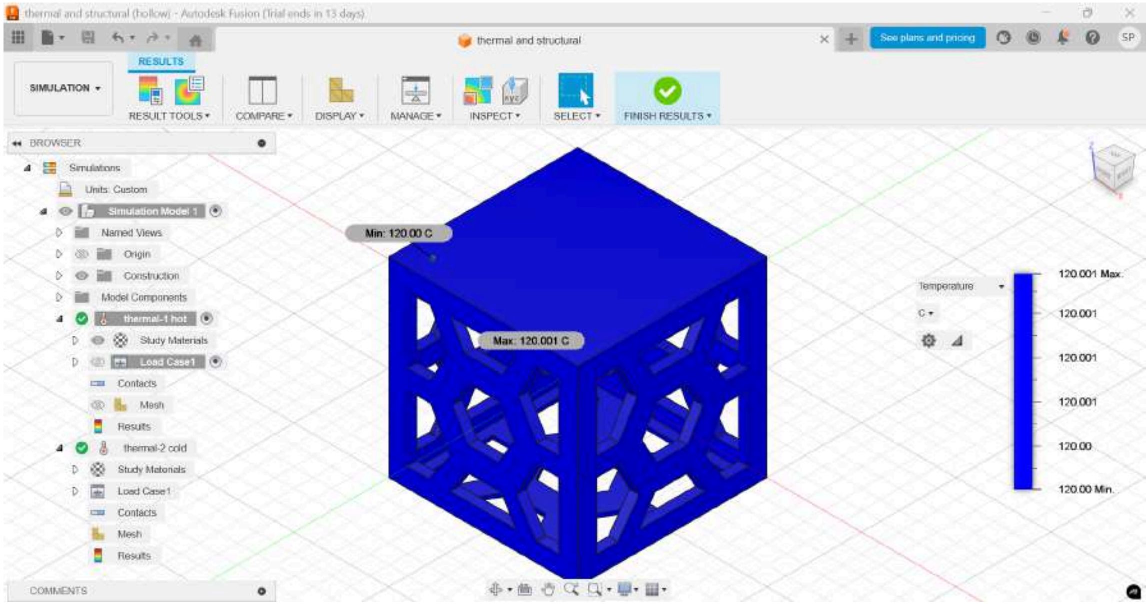
Results
COMMENTS
Min: -150.00 C
Max: -149.986 C
Temperature
C
-149.986 Max.
-149.989
-149.992
-149.995
-149.998
-150.00 Min.



- For titanium :

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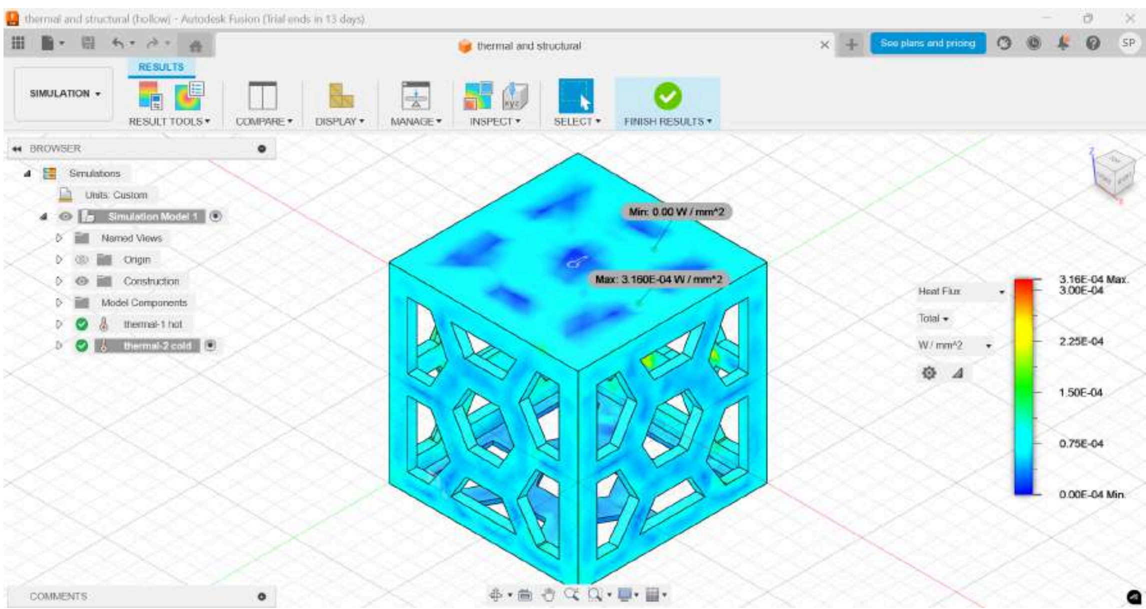
COMMENTS
Min: 120.00 C
Max: 120.001 C
Temperature
120.001 Max.
120.001
120.00
120.00 Min.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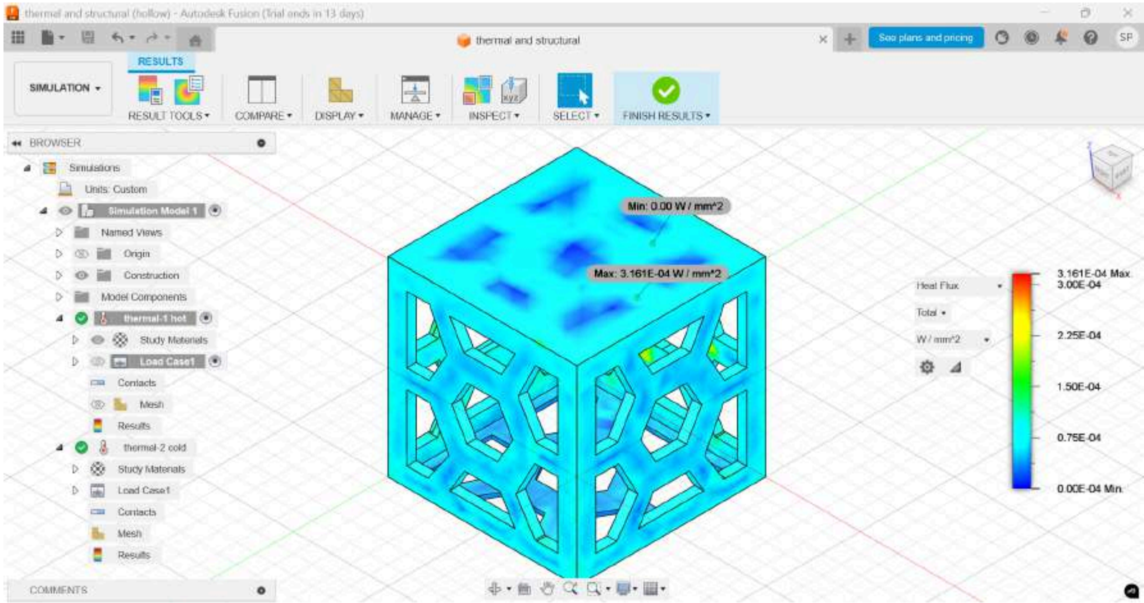
2.25E-04
1.50E-04
0.75E-04
0.00E-04 Min.



Conclusion :

- Both aluminium and titanium casings withstood temperature extremes.
- Titanium exhibited lower thermal conductivity compared to aluminium making it incompatible of affecting actual payloads inside.
- Aluminium's hinger conductivity suggests that thermal management components, such as thermal pads, may be necessary for optimal performance.

Conclusion :

This project provided valuable hands-on experience in satellite design, structural testing, and thermal analysis. Beginning with only a conceptual idea, I progressed through research, design, and simulation stages, gaining both technical skills and problem-

solving ability.

The structural analysis demonstrated that both aluminium and titanium casings can withstand the g- loads associated with launch. Thermal analysis revealed aluminium's superior heat dissipation, suggesting that thermal management components should be considered for titanium designs

Beyond technical findings, the project taught me how to independently learn advanced tools like Fusion 360, apply engineering simulations, and validate design choices with data. These experiences strengthened my foundation in aerospace engineering and aligned with my long-term goal of contributing to satellite systems design