Title: Lattice Structure Optimization for Mechanical Test Samples

1. Introduction

Additive manufacturing (AM) has enabled the creation of complex lattice structures that offer high strength-to-weight ratios, tailored mechanical performance, and material efficiency. In engineering applications—from aerospace to biomedical implants—optimized lattice architectures can significantly improve mechanical properties while reducing overall mass.

This competition challenges students to design and optimize lattice structures for standard mechanical test samples. Using stainless steel 316L as the base material, participants will apply principles of mechanics, simulation, and additive manufacturing to create the most efficient lattice-reinforced designs. The goal is to develop samples that maximize **strength-to-weight ratio** while satisfying geometric and testing constraints.

2. Problem Statement

To design lattice-enhanced 316L stainless steel samples for the following **two standard mechanical tests**

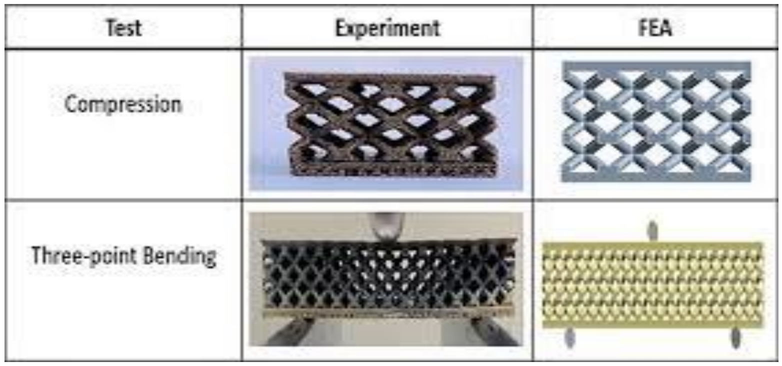
a. Compression Test
b. 3-point bending Test

The purpose is to achieve the **maximum possible strength-to-weight ratio** while remaining manufacturable through metal additive manufacturing.

Each team must create lattice structures that fit within the defined standard geometries and withstand mechanical testing on a Universal Testing System (UTS). Students should consider lattice topology, cell type, cell size, orientation, wall thickness, and connectivity to achieve optimal performance.

3. Design Specifications

Sr no.	Attribute	Details	Remarks
1	Material	316L SS	
2	Manufacturing Type	Selective Laser Melting (SLM)	
3	Lattice Type	Any lattice type that can provide highest strength to weight ratio	Should be continuous lattice. (connected throughout the geometry)
4	Minimum printable feature	0.4mm	
5	3 Point Bending Sample	**ASTM C393** Sample Size: 12mm x 50mm x 9.7mm (X Y Z)	Please refer to the standard for drawing
6	Compression Test Sample	**ASTM C365** Sample Size: 12mm x 12mm x9.7mm (X Y Z)	Please refer to the standard for drawing
7	Printing orientation	Horizontal for all the test samples	



Sample Picture for the test specimen

4. Mechanical Simulation Report

Following are the features that must be included in the mechanical simulation report:

Sr no.	Attribute	Details
1	Material for simulation	Correct material with material properties must be displayed in the report
2	Weight of the sample	The weight of the sample must be clearly shown
3	Compression Test Sample Simulation results	Following results must be included: - Buckling behavior (local/global) - Stress/strain curves - Plateau region (for lattice crushing) Initial stiffness, peak stress, densification strain - Stress density maps
4	3 Point Bending Test Sample Simulation results	Following results must be included: - Flexural stress distribution - Bottom surface tension / top compression zones - Load–deflection curve - Predicted flexural strength - Failure location predictions

5. Criteria for Design Approval

Following is the criteria for design approval for the design competition:

a. The Samples must be as per provided standards and lattice structure should be incorporated in those samples keeping in view the dimensions of the standard and minimum printable feature.
b. The Lattice should be designed in such a way that no support structure is needed to build those samples (45 degree overhang angle)

c. Mechanical simulation must be performed on all the 2 types of samples (3 point bending and compression) on a simulation software, clearly displaying the results.
d. The designs having the minimum mass and maximum strength will be then shortlisted for printing and mechanical testing

6. Documents to submit for design approval:

Following documents must be submitted for qualification of the design in the competition:

a. Detailed mechanical analysis report with title page clearly mentioning the names of the candidates, university name and the results of analysis as mentioned per section-4
b. CAD file (.igs/.stp) of the samples along with high quality STL file that should be ready to print using metal 3D printing.

7. Criteria for Success

Following is the criteria of success for the finalized design:

a. All the designs will be initially evaluated on the simulation results.
b. Based on these results, the top five designs with the highest load bearing capacity and lowest mass will be shortlisted for testing.
c. The shortlisted designs will be 3D printed using SLM technology and then tested on a Universal Testing Machine.
d. Top three positions will be awarded to the designs with the highest strength to weight ratio.
e. Prize money will be awarded as follows: Rs 60,000 for first place, Rs 40,000 for second place, and Rs 30,000 for third place.

8. Takeaways for Students

The following are the key takeaways that students will gain from this experience.

a. Fundamental understanding of metal additive manufacturing.
b. Ability to apply design for additive manufacturing (DFAM) principles
c. Competence in designing and modelling lattice structures
d. Development in analytical and problem-solving skills.
e. Increased confidence in participating in National and International AM Competitions.