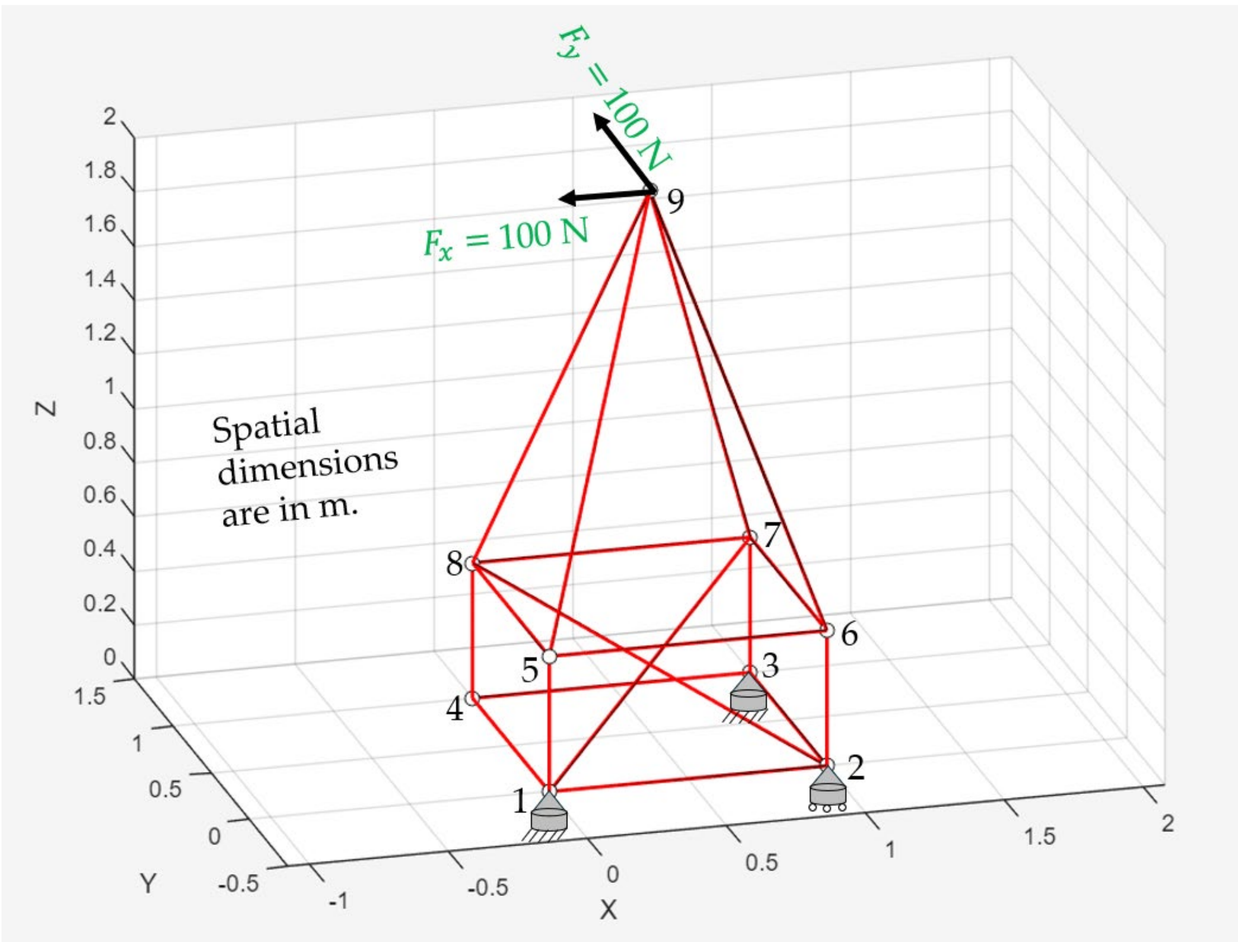
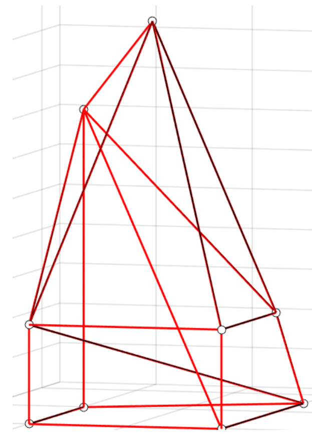
ME 260: Structural Optimization: Size, Shape, and Topology		
Assigned: Aug. 11, 2026	Homework 1	Due: Aug. 20, 2026

Problem 1 (50 points) "Understanding the importance of topology, shape, and size"

Study the planar truss problem considered in HW 1 of 2025 offering of this course. Its solution, concept, approach, and interpretation are well documented at https://mecheng.iisc.ac.in/suresh/me260/homework2025/HW1Solution.pdf. Now, you need to do the same for a space truss shown here.



Nodes 1 and 3 are fixed. Node 2 is allowed to move in the xy plane but cannot move in the z direction. Node 9 with coordinates (0.5, 0.5, 2) has forces in the x and y directions. All other nodes are free to move under the action of the applied forces. Assuming the same cross-section are of 1 cm^2 and Young's modulus of 210 GPa, this truss has volume of 0.002 m^3 and strain energy of 0.0057 J.



If you change the coordinates of the nodes, you change shape of the truss. Here, we have changed the coordinates of nodes 2 and 7. You are free to move any nodes except nodes 1, 3, and 9.

If we connect the nodes in a different way or if we introduce one or more extra nodes, we get a different topology.

Now, we can change the shape of each topology to get differently shaped trusses for that topology. And then, when we vary the areas of cross-section of the truss members, we get different response of the truss for the applied external loads.

- Choosing the right topology is topology optimization.
- Choosing the right shape is shape optimization.
- Choosing the areas of cross-sections is size optimization.

The Matlab files and input files from

https://mecheng.iisc.ac.in/suresh/me260/homework2026/truss3Dlinear.zip.

can be used to compute the volume of your changed truss and its strain energy. You need to change the contents of the four input files as per your changed truss. You can thus check how good your topology and shape are. There is a Matlab script for size optimization. You can modify that code for shape optimization too.

What you need to do:

Choose a different topology and shape and do size optimization and get as low a value of SE as possible but without changing V^*= 0.002 m^3. You cannot move points 1, 3 , and 9 at all. Point 2 may be moved only in the xy plane. You can introduce as many points as you need or wish. If you want to keep it as a statically determinate truss, then ensure that $3v - b - 6 = 0$ (Maxwell condition) where v = the number of vertices and b = the number of bars (or truss members). If you disobey the Maxwell condition, then the truss is not statically determinate. And that is okay because our truss FEA (finite element analysis) code in Matlab would still work. You can design such a truss too, but the volume of such a truss also should not exceed V^*= 0.002 m^3.

What you need to submit:

- Hand-written or typed description of how you arrived at your result. Show your work neatly.
- Four input files that contain the data of the truss you designed (node.dat, elem.dat, dispbc.dat, and forces.dat) printed neatly; also email them one zip file whose name is YourName.zip.
- Write down the results that include areas of cross-section of all truss members, strain energy, and stresses in each member.

- A picture of your optimized truss with all vertices and bars marked.

There will be bonus points for those who exceed my expectations. For instance, can you design a truss that has the same internal force (magnitude) in all its members? Or, do anything else you can think of for this data and surprise me, and get bonus points.

Enjoy the homework while you appreciate structural optimization before you learn all about it.