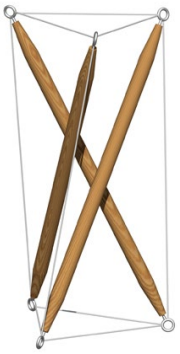
ME 254: Compliant Mechanisms		
Assigned: Jan. 31, 2023	Homework 2	Due: Feb. 9, 2023

The Matlab codes that will be useful are already given to you on the course website.

Question 1 (10 points)



(a) You were given the Matlab code to compute the force-equilibrium and compatibility matrices of 2D (i.e., planar) trusses. Now, write 3D (i.e., spatial) trusses. Like the 2D truss code, your 3D truss code should be general enough to take any number of vertices (i.e., nodes) and any type of connectivity (i.e., truss members). It should also be able to draw the nullspace modes of degree of freedom (DoF) and states of self-stress (SoSS).

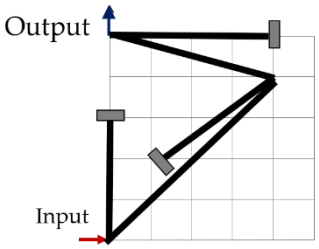
(b) Try your code with whatever examples you wish to but submit it for the following 3-prism tensegrity shown on the right.

(c) Add a tenth cable between two vertices that are not yet connected and re-do the DoF and SoSS analysis.

(d) Extra 5 points if you build this tensegrity with straws and string or whatever else.

(Image from https://en.wikipedia.org/wiki/Tensegrity#/media/File:Tensegrity_3-Prism.png.)

Question 2 (10 points)



A Displacement-amplifying Compliant Mechanism (DaCM) is shown on the right. It has five beam segments and three fixed supports. Each grid unit is 2 cm.

(a) Simulate this mechanism using linear and nonlinear beam Matlab codes to analyze the deformation behaviour. Assuming Young's modulus to be 2 GPa, in-plane width to be 2 mm, and out-of-plane thickness to be 5 mm for all beams, apply input force such that the output displacement is more than 2 cm in the output DoF direction.

(b) Simulate the same mechanism using continuum finite elements in COMSOL Multiphysics and compare the results of the Matlab code for geometrically nonlinear analysis.

(c) With the help of the TA for the course (Mr. Shreyas Dixit; shreyasdixit@iisc.ac.in), 3D-print your mechanism. Measure the input and output displacements by sticking your mechanism on a sheet of paper with grid markings. When you 3D-print it, you should add the fixed supports to stick to a flat surface like plexiglass. How close is the deformation behaviour to finite element analysis results? Can you measure the forces applied in your prototype? *Be resourceful and imaginative.*