ME 254: Compliant Mechanisms		
Assigned: Jan. 17, 2023	Homework 1	Due: Jan. 24, 2023

Mechanisms shown in this homework will be brought to the class for you to examine them.

Question 1 (10 points)

Shown in Fig. 1 is a cabinet hinge with two gas-springs.

a. Use the Grübler's formula to count its DoF (degrees of freedom).
b. Is it underactuated in its use?
c. Would you classify it as a compliant mechanism? If so, why? If not, why not?

Fig. 1: A cabinet hinge mechanism

Question 2 (10 points)

Two photographs of a Bricard linkage are shown In Figs. 2a-b. It is made of six regular tetrahedrons joined together at six edges to form six revolute joints (hinges).

a. Compute its DoF using the Grübler's formula.
b. Compute its DoF using the Maxwell's rule. Show your interpretation using 3D truss members.
c. Up to 10 extra points if you make this mechanism using cardboard or otherwise.

(a)  (b) 

Fig. 2: A Bricard linkage made with six regular tetrahedrons each of whose four faces are colored (a) two faces seen (b) one other face seen. The fourth color is not seen in either picture.

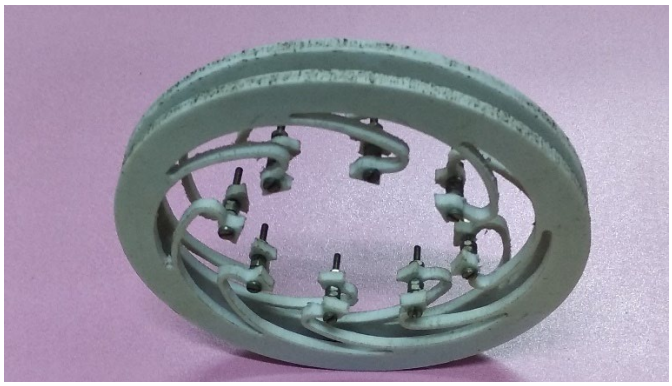
Question 3 (10 points)

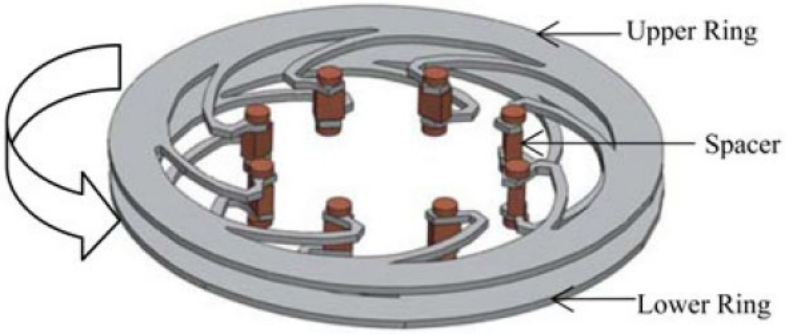
A radially deployable compliant mechanism is shown in Figs. 3a-b in its top and side views. It is made in two parallel layers wherein each layer is flipped relative to the other.

There are hinges at the places where we see screw-nut joints at which the two rings are connected to each other. Figure 3c shows the detail of the arrangement.

a. Compute its DoF using the extended Grübler's formula.
b. Interpret the DoF in terms of actuating this mechanism.
c. Re-compute the DoF if the eight hinges are replaced with fixed connections and this making it a fully compliant single-piece compliant mechanism.
d. Would your interpretation of DoF as actuations change now? Please comment.

(a) 

(b) 



(c)

Fig. 3 A radially deployable compliant mechanism. There are hinges where screws are seen. (a) Top view, (b) Side view, and (c) geometric model.

Question 4 (10 points)

Consider Model 8 in the M2D2 Compliant Mechanisms Collection. You can see how it works at this website: https://mecheng.iisc.ac.in/m2d2/CMcollection/8.html. Figure 4 is a snapshot from the website.

a. Use the extended Grübler's formula to compute its DoF. Consolidate beam segments into rigid segments if there is no relation motion among them.
b. Do you need virtual rigid segments in this case? Argue why or why not.
c. Interpret its DoF as actuations.

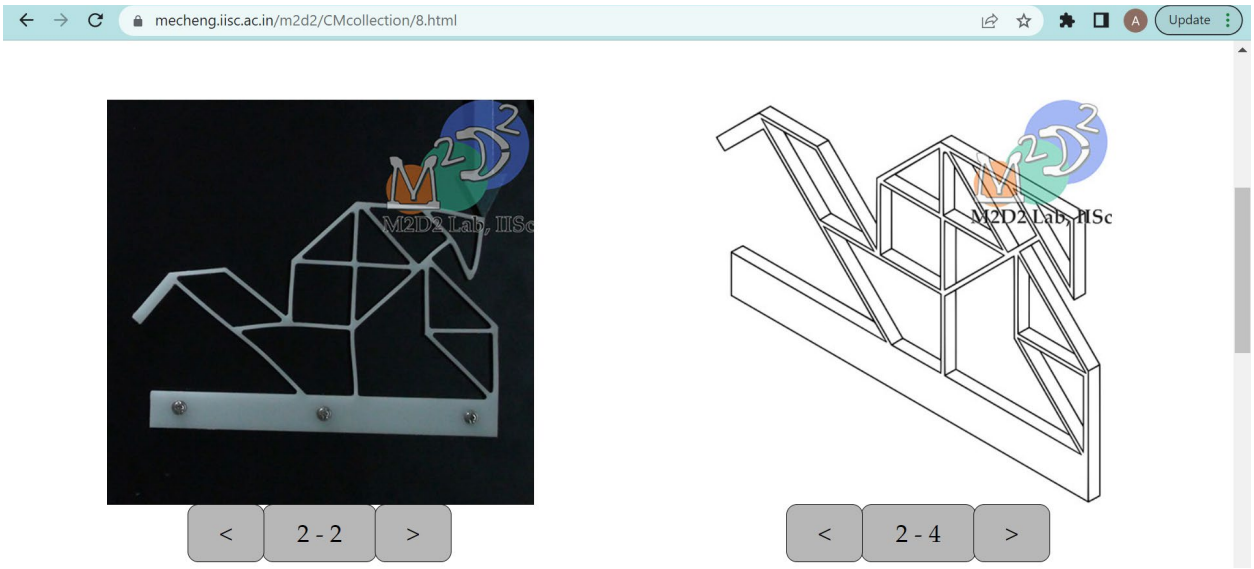


Fig. 4: A Displacement-amplifying Compliant Mechanism (DaCM)

Question 5 (10 points)

A tensegrity structure is shown in Fig. 5. The thick black lines are tubes (considered to be rigid) and red lines are flexible strings.

a. Use Maxwell's formula or the Maxwell-Calladine formula to analyze its DoF and SoSS (states of self-stress).
b. Would you classify this as a compliant mechanism. Argue why or why not.

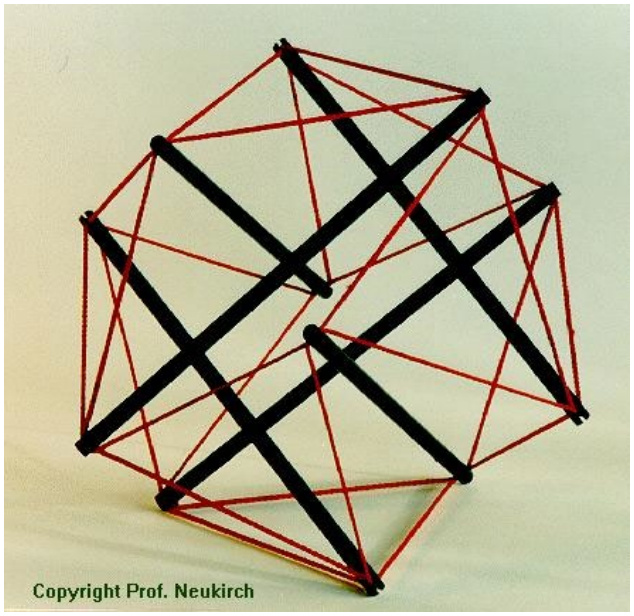


Fig. 4: A tensegrity structure