ME 254: Compliant Mechanisms		
Assigned: Jan. 16, 2025	Homework 1	Due: Jan. 23, 2025

If you use AI-agents, include your prompts just like would cite any references that you use.

Question 1 (8 points)

Rummage the internet or systematically search the published literature to find mechanical elements (not devices or machines or large systems) used today but did not exist before 1900. This exercise helps you understand the context of compliant design in addition to giving you an idea of new developments in the 20th century and the first quarter of the 21st century. List at least two but not more than three, each with a neat sketch (not downloaded photographs or images) and a short description in your own words (not more than 100 words).

Question 2 (12 points)

We considered a planar XY-decoupling compliant mechanism conceived by Awtar and Slocum as the first case-study in the course. We understood that eight instances of a folded-beam compliant slider arranged in a particular way provide the ability to separate X and Y motions of the central platform. We also introduced a Displacement-amplifying Compliant Mechanism (DaCM). These two were combined to create a single-piece compliant mechanism that has both the functionalities of decoupling X and Y motions as well as amplifying them. See:

> Dinesh, M. and Ananthasuresh, G.K., "Micromechanical Stages with Enhanced Range," *International Journal of Advances in Engineering Sciences and Applied Mathematics*, Vol. 2, No. 1-2, 2010, pp. 35-43. (The mechanism in this is arranged in two parallel layers and is used as an actuator.)
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> Khan, S. and Ananthasuresh, G. K., "Improving the Sensitivity and Bandwidth of In-plane Capacitive Micro-accelerometers using Compliant Mechanical Amplifiers," *IEEE Journal of Microelectromechanical Systems*, 23(4), 2014, pp. 871-887. (The mechanism in this arranged in a single layer and is used as a sensor.)

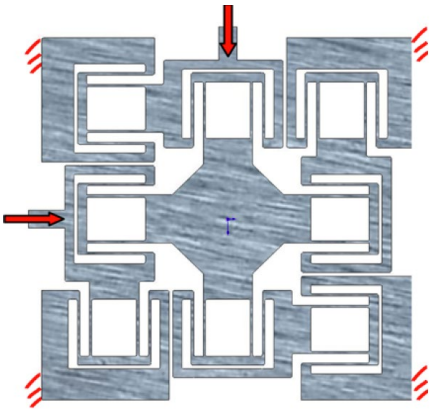
Both papers are sent to you by email.

a. Analyze one of the two mechanisms in the above paper using the linear beam finite elements in Matlab. Compute the stiffness matrix of the mechanism relating the two forces and moment applied on the central platform to two in-plane translations and out-of-plane rotation.
b. Analyze also using the nonlinear beam finite elements in Matlab.
c. Compare linear and nonlinear results and record your observations.
d. 3D-print the mechanism you have chosen for an additional 10 points.

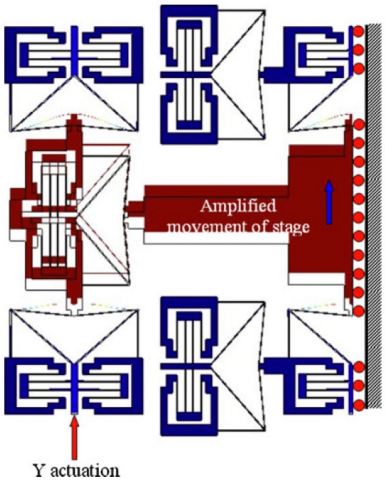
Some figures are attached for your reference.

What you need to submit for Questions 2:

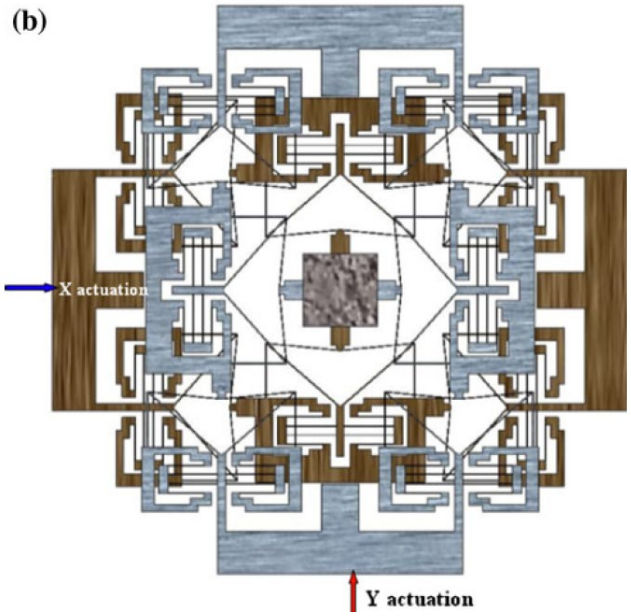
1. Paper copy of your results clearly written down with all details
2. Graphs and pictures of your results with proper annotation (paper copy)
3. Four data files for FEA beam code in Matlab of your chosen XY-compliant mechanism.
4. Your 3D-printed compliant mechanism (optional for an extra 10 points)



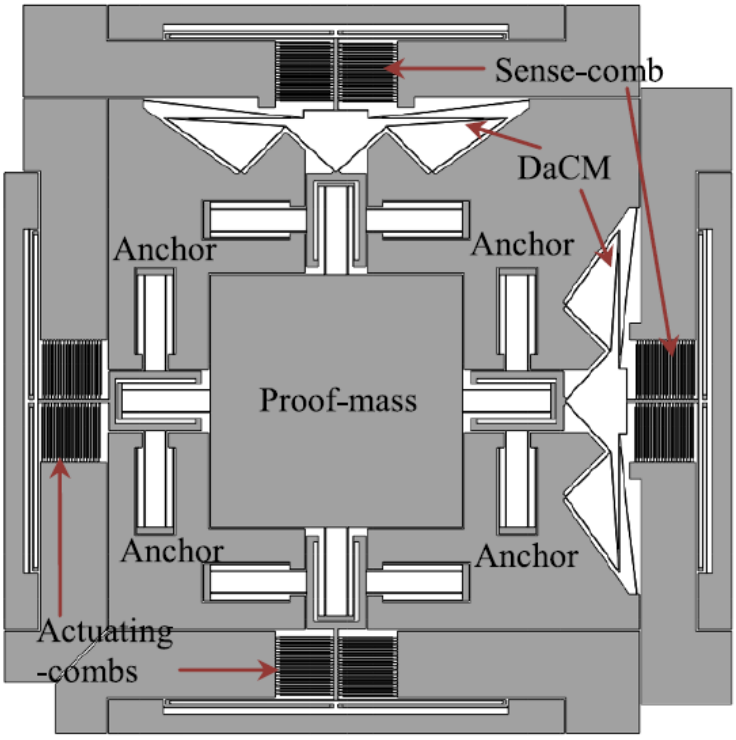
(Awtar and Slocum)



(Mana and Ananthasuresh)



(Mana and Ananthasuresh)



(Khan and Ananthasuresh)