ME 254: Compliant Mechanisms		
Assigned: Jan. 8, 2026	Homework 1 (40 points)	Due: Jan. 19, 2026

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

Question 1 (20 points)

A Displacement-amplifying Compliant Mechanism (DaCM) is shown in Fig. 1. Its four data files and Matlab beam finite element analysis (FEA) codes (linear and nonlinear) are also made available.

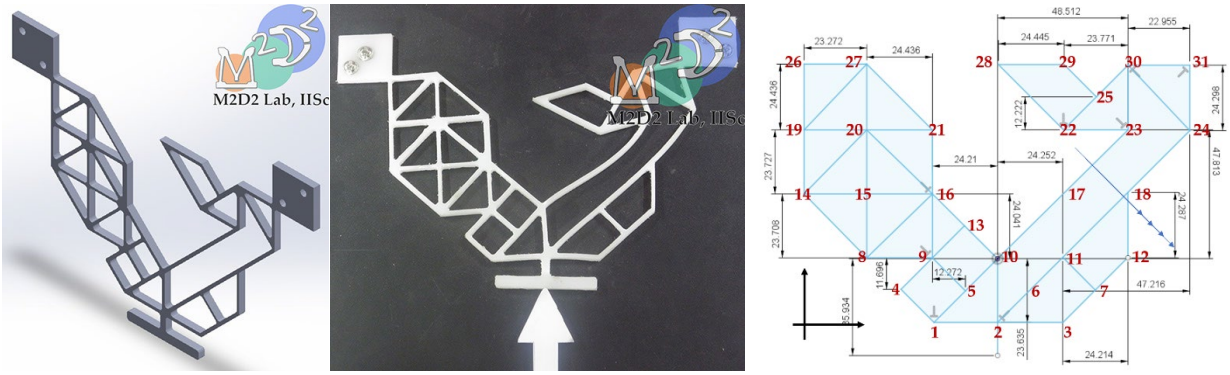

Figure 1. A DaCM shown in perspective (CAD model) and deformed (real prototype) views in the first and second images. The third image shows the dimensions and node numbers.

a. Run the FEA code and compute the Displacement Advantage (DA) as the ratio of the output displacement to the input displacement for various values of input forces (within a reasonable range) using the linear and nonlinear FEA codes. Plot DA against input force in the same graph for the purpose of comparison.
b. Plot also a few representative deformed plots to discern the differences between linear and nonlinear FEA results.
c. Modify the DaCM to improve DA. You can add or remove elements. You can move the nodal coordinates. You can also change the cross-section parameters of the beam elements (note that only rectangular cross-section is permitted in the Matlab codes).
d. In the same graph, plot DA of the original and modified DaCM using linear and nonlinear FEA codes.
e. Plot the undeformed and deformed configurations of the modified DaCM.

Question 2 (20 points)

A Force-amplifying Compliant Mechanism (FaCM) is shown in Fig. 2. Node 1 is assumed to be fixed. An input force is applied on node 7 in the positive x direction. Positive y displacement at node 15 is the output as it closes the gap between nodes 15 and 1 to apply

force on the workpiece held between them. If the workpiece fills the entire gap between nodes 15 and 1, then output node (i.e., node 15) is given zero y displacement. If the workpiece is small than the gap, the y displacement of node 15 should be positive and equal to the gap after inserting the workpiece.

Now, do all the things that are asked in Question 1 for the FaCM but the difference is that you are concerned here with Mechanical Advantage (MA) rather than DA. MA is defined as the ratio of the output force to the input force. We could have called it Force Advantage (FA) but MA is popular and is well understood by all.

Note that output displacement is to be kept zero when the workpiece is large enough to fill the gap.

Additionally, explore what happens when the workpiece is smaller than the gap. How does MA differ then? Comment on the trends of MA that you see with varying size of the workpiece. (Extra points 10).

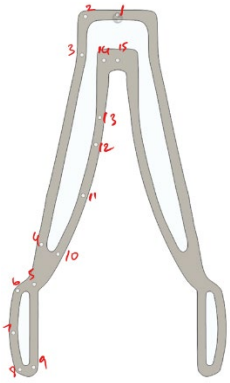

Figure 2. An FaCM with node numbers. The data files for Matlab FEA code consider only the left symmetric half with symmetry boundary condition imposed. Input force is applied on node 7 to the right. The output node is 15 and it supposed to move upwards to apply force on a workpiece held between nodes 15 and 1. Node 1 is assumed to be fixed.

What you need to submit:

1. A 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 modified compliant mechanisms.
4. Your 3D-printed compliant mechanisms (optional for an extra 10 points)