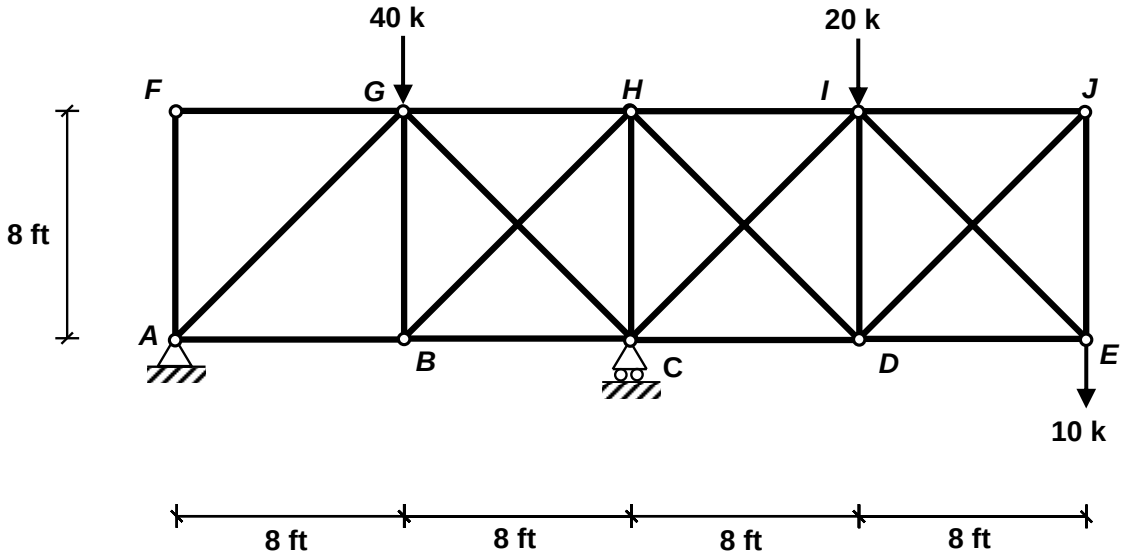
1) [30 points] Each element of the truss structure shown below is made out of steel (Young's modulus for steel = 30,000 ksi) and has a cross-sectional area of 10 in^2. Three vertical loads are applied at nodes *E*, *G*, and *I*.

a) Is the structure stable? Is it statically determinate? If it is not statically determinate, what is its degree of statical indeterminacy?

b) Find the member forces <u>approximately by assuming that diagonal members cannot carry compressive loads</u>.

Note: The hollow circles at the nodes indicate frictionless pin joints. Support *A* is a pinned support and support *C* is a roller support. Note that diagonal members *GC*, *BH*, *HD*, *CI*, *IE*, and *DJ* are single piece elements.



2) [35+5 points]

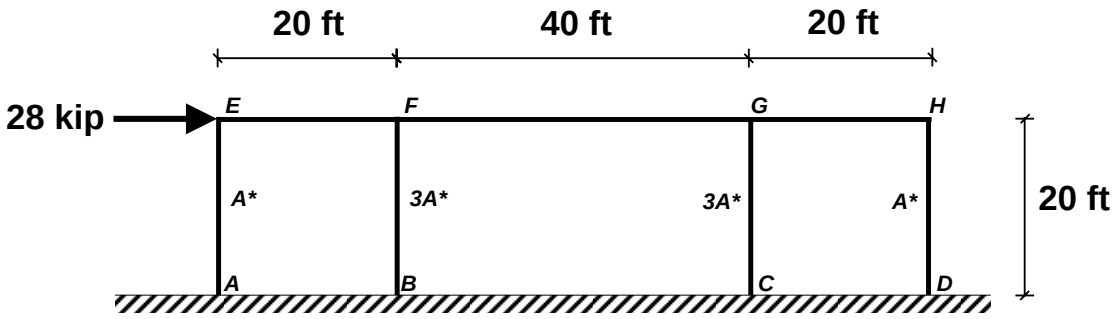
The single-story three-bay frame structure shown below has fixed connections at base nodes *A*, *B*, *C*, and *D*. Assume that all elements are made out same material. The cross-sectional areas of the interior columns (*BF* and *CG*) are three times that of the exterior columns (*AE* and *DH*), as indicated on the figure as 3*A** and *A**, respectively. All beam sections are identical. Beam-column connections are rigid. Ignore self-weight.

A 28 kip point load is applied on the structure at node *E*, as shown on the figure.

a) Using the cantilever method of approximate analysis, carry out necessary calculations to draw the bending moment diagram for the structure.

b) Sketch the deflected shape.

c) [Bonus] What would have been the bending moments in the columns if all of the columns were pinned (instead of fixed) at their bases?



3) [35 points]

A bent-frame + truss steel structure supports a sign that weighs 15 kip.

The bent-frame is a single continuous element. It is pinned at *A*. Joint *B* is rigid. The bent-frame is made out of a steel tube that has 24-in outer diameter and 23-in inner diameter (moment of inertia of 2,550 in^4).

The truss is pinned to the ground at *D* and attached to the bent-frame at *B* through a frictionless hook. The cross-sectional area of the truss is 2 in^2.

Young's modulus for steel is 30,000 ksi.

For the frame element, ignore the shear and axial deformations, i.e., consider only flexural response.

Find the vertical displacement of the tip, i.e. point *C*.