ME 202 Spring 2023
Tutorial 3
24 Jan 2023

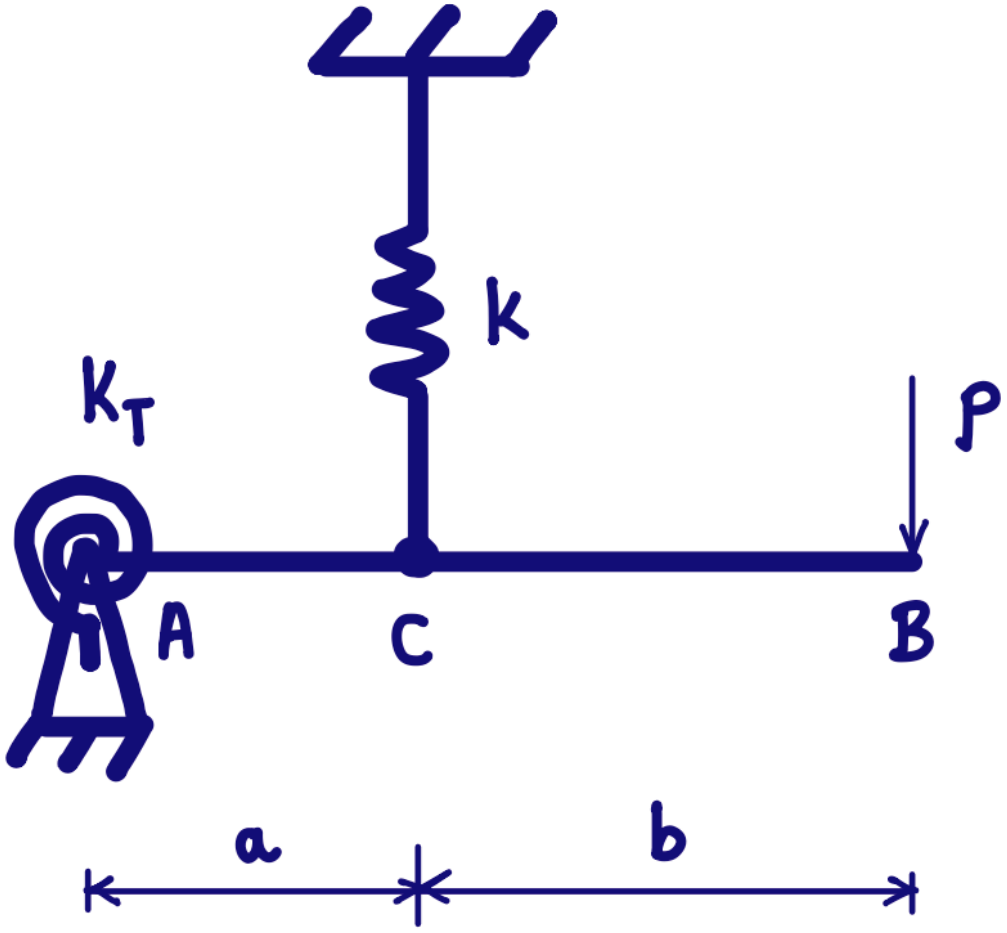
Solve all problems using only the principle of minimum potential energy (PMPE). Assume small angles where applicable. In each case, identify the number of degrees of freedom (DOFs) i.e. the number of displacement variables that completely characterize the system configuration.

Problem 1

Consider the rigid bar AB connected to a pinned joint at A through a torsion spring of stiffness kT. A linear spring of stiffness k is attached to the bar at C as shown.

Find the deflection of the point B under the applied force P.

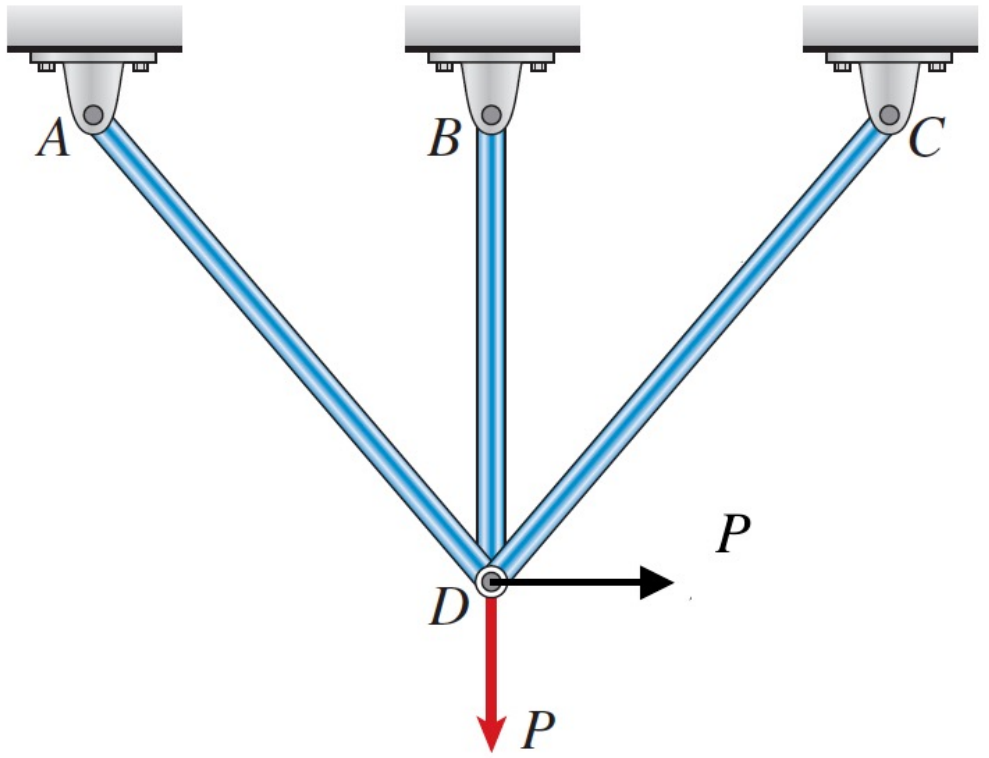
Note: AC and CB are NOT two different bars connected at C but one single bar.



Problem 2

A framework consisting of three pin-connected bars is loaded by two forces each of magnitude P (see figure). Points A, B, C are in one line. Angle BAD = 60 deg, angle CBD = 90 deg, angle BCD = 45 deg, length BD = L.

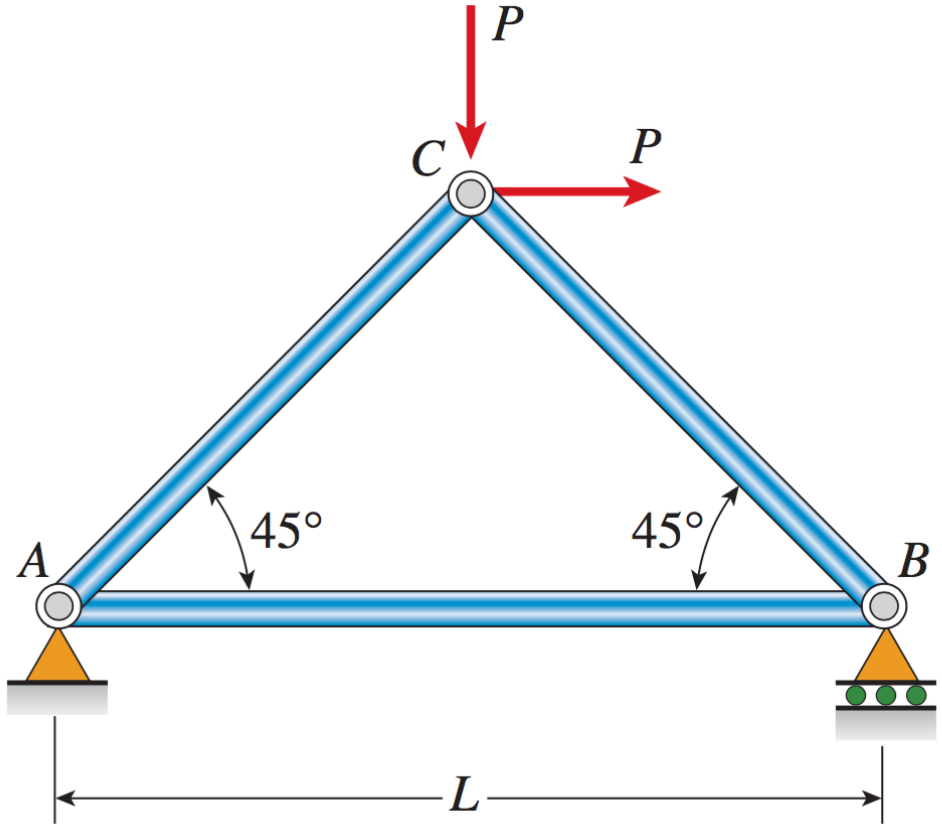
If the elastic modulus and cross-sectional area of each bar are E and A respectively, find the horizontal and vertical deflections of the point D.



Problem 3

The three-bar truss ABC shown in the figure has a span L = 3 m and is constructed of steel pipes each having cross- sectional area A = 3900 mm^2 and modulus of elasticity E = 200 GPa. Identical loads P act both vertically and horizontally at joint C, as shown.

If P = 650 kN, what is the horizontal displacement of joint B? What is the maximum permissible load Pmax if the displacement of joint B is limited to 1.5 mm?



Problem 4

Consider the six elastic bars connected by pin joints as shown below. Forces $\mathrm{F}_1, \mathrm{F}_2, \mathrm{F}_3, \ldots, \mathrm{F}_6$ act as shown and the displacements $\mathrm{u}_1, \mathrm{u}_2, \mathrm{u}_3, \ldots, \mathrm{u}_6$ are in the directions of the respective forces.

Use only the principle of minimum potential energy to find all the components of the 6×6 stiffness matrix K that satisfies the linear system $\mathrm{Ku} = \mathrm{F}$, where u is the TBD 6×1 displacement vector and F is the given 6×1 force vector.