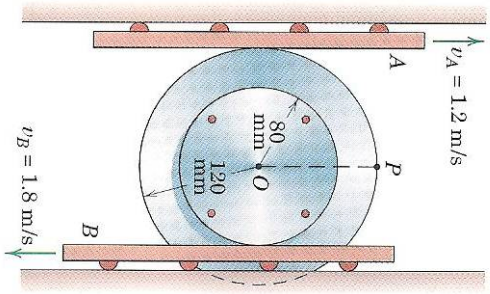
EN 4
Dynamics and Vibrations

Homework 9: Rigid Body Motion

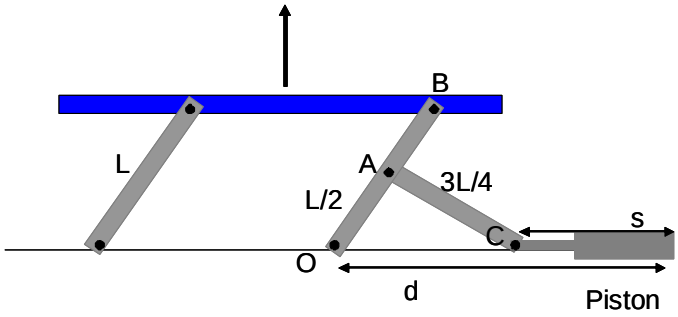
1. Basic Kinematics

We discussed this problem briefly in class. Determine the velocity of the center of mass O of the integral hub when the motion of the velocities of the two side plates are as shown.

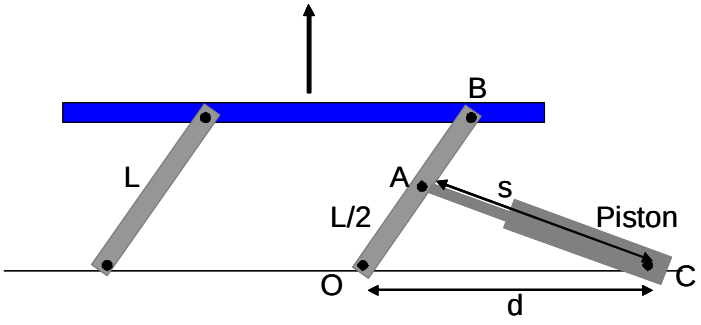


2. Control of a Lift Platform

A piston is used to raise and lower a platform. L and d are fixed in both. All connection points are freely-rotating joints. If the piston extends at a rate $\dot{s}$, what is the vertical velocity of the platform? Express the result in terms of the various given quantities (L, s, d). Points O, A,B and C are shown for guidance.



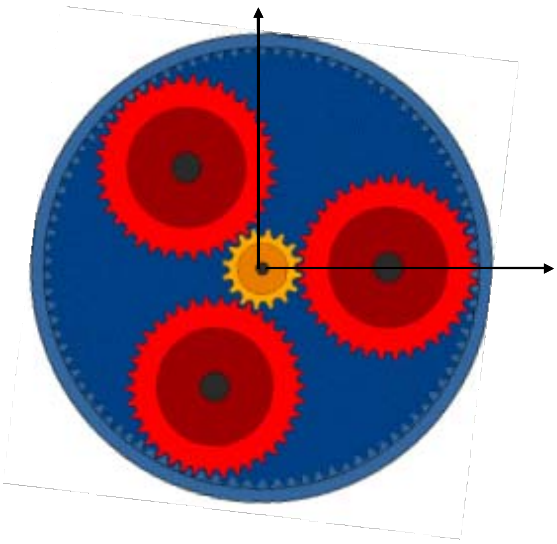
Another design for the piston is also shown. If the piston extends at a rate $\dot{s}$, what is the vertical velocity of the platform? Note that "body" AC is not a rigid body. Also note that $\dot{s}$ is not directly equal to the speed at point A.



1. In both cases, trigonometry is needed, and the law of cosines may be useful.
2. If you can establish geometric relationship(s) between various lengths, then time derivative(s) of those relationship(s) can yield a relation between $\dot{s}$ and other quantities.
3. Do you see any advantages to one design over the other? This is not a quantitative question, but if you plot out the vertical platform speed versus $\dot{s}$, perhaps you may find something that is advantageous in one case over the other.

3. Planetary Gear Assembly

The planetary gear consists of a sun gear, planet gears, and an outer ring gear. The radii of the gears are $r_s, r_p, r_r = r_s + 2r_p$. The planet gears are attached to a plate that rotates as determined by the motion of the centers of the three planet gears. A set of axes are provided, so that you can focus your analysis on planet gear along the x axis.



a. Holding the ring gear fixed $(\omega_r = 0)$ and rotating the sun gear at rate ω_s, determine the rotation rate of the planet gear plate ω_{pp} in terms of ω_s and the various diameters.

b. Holding the planet *plate* fixed (the planet *gears* still rotate) and rotating the sun gear at rate ω_s, determine the rotation rate ω_r of the ring gear in terms of ω_s and the various diameters.