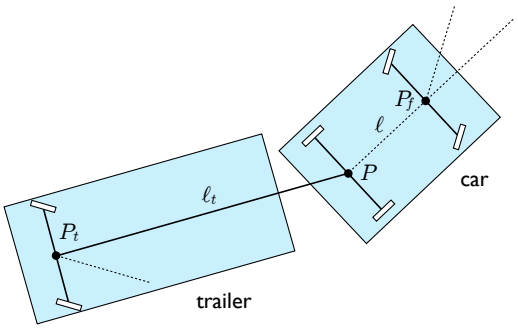
Autonomous and Mobile Robotics
Class Test no. 1, 2010/2011

Problem 1

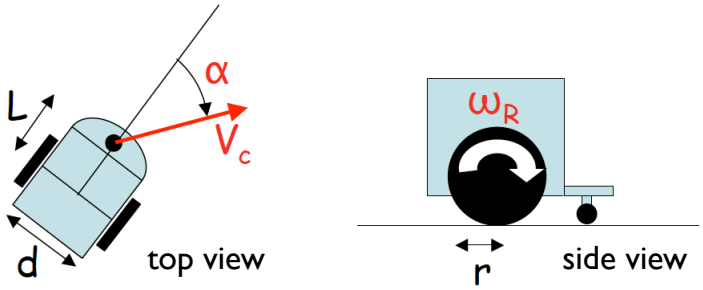
Consider the tractor-trailer system shown in figure, often referred to as the *firetruck* in the robotics literature. The tractor is a rear-wheel-drive car-like vehicle, while the trailer is a rigid body with an axle carrying two *steering* wheels, and is connected to the midpoint of the tractor rear axle through a revolute joint. The fact that the trailer wheels can be steered increases the maneuverability of the vehicle, which can thus negotiate sharp turn in spite of its size.



1. Find a set of generalized coordinates for the robot, and show them on the drawing.
2. Write the Pfaffian kinematic constraints to which the robot is subject (two-wheel axles can be assimilated to a single wheel located at the midpoint of the axle).
3. Derive a kinematic model of the system.

Problem 2

Consider the differential-drive robot shown below, where a passive sphere is used as a caster wheel.



Assume that we want to impose to the caster a velocity V_c directed as in figure. Compute the angular speeds ω_R and ω_L required to achieve this objective, using the following numerical data: $L = 0.3$ m, $d = 0.4$ m, $r = 0.15$ m, $\alpha = 45°$, $\|V_c\| = 0.1$ m/s [*Hint: you need a mapping between the velocity inputs ω_R, ω_L of the differential-drive robot and the velocity of a point located along the sagittal axis at a distance L from the midpoint between the wheels...*].

[1 h 45 mins]