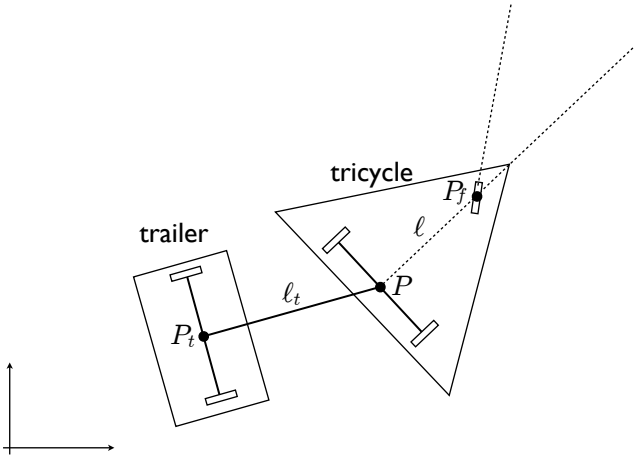
Autonomous and Mobile Robotics
Class Test no. 1

Problem 1

Consider the mobile robot shown in figure, obtained by attaching a trailer to a rear-wheel drive tricycle. The trailer is a rigid body with an axle carrying two fixed wheels, and is connected to the midpoint of the tricycle rear axle through a revolute joint. Both two-wheel axles can be assimilated to a single wheel located at the midpoint of the axle.



1. Find a set of generalized coordinates for the robot, and clearly indicate them on the drawing.
2. Write the Pfaffian kinematic constraints to which the robot is subject.
3. Derive a kinematic model of the system.

Problem 2

Consider the kinematic model of the rear-wheel drive car-like robot

$$\begin{pmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \\ \dot{\phi} \end{pmatrix} = \begin{pmatrix} \cos\theta \\ \sin\theta \\ \tan\phi/\ell \\ 0 \end{pmatrix} v + \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix} \omega$$

with the appropriate meaning for x, y, θ, ϕ, ℓ, v, ω.

In analogy to the case of the unicycle, identify a point B whose cartesian coordinates y_1, y_2, when taken as outputs of the system, allow to perform an input/output linearization via feedback [*Hint: you need to visualize a point, not necessarily on the robot body, that moves independently when the two control inputs v, ω are separately applied to the robot*]. Use this approach to derive a control law that achieves tracking of an arbitrary trajectory $(y_{1d}(t), y_{2d}(t))$.

[90 mins]