

Homework 1

CSCI 3302 :: Introduction to Robotics

1. What are the degrees of freedom of a standard, four-wheel, hand-pushed lawnmower like the one pictured? Why are you still able to mow an entire lawn?



2. What are the maximum degrees of freedom for objects driving on the X-Y plane?

3. (a) Calculate the angle between vectors $(\cos 45^\circ, -\sin 45^\circ, 0)^T$ and $(\sin 45^\circ, \cos 45^\circ, 0)^T$.

(b) Provide a third vector that forms a coordinate system with the other two.

4. (a) Write out the entries of a rotation matrix ${}^A_B R$ assuming basis vectors X_A, Y_A, Z_A , and X_B, Y_B, Z_B .

(b) Express $X^B = [0, 1, 0]^T$ in frame {A}.

(c) Write out the entries of rotation matrix ${}^B_A R$.

5. Consider a tricycle with two independent standard wheels in the rear and a steerable, actuated front-wheel. Assume r to be the radius of the front wheel and l to be the distance between the front and rear axle. Chose a suitable coordinate system and use ϕ as the steering wheel angle and $\dot{\omega}$ as angular velocity (only the front-wheel is driven). Provide the forward kinematics of the mechanism.



6. A robot using a local coordinate frame B detects an object Q at position $(8, -4)$. In coordinate frame A , the robot shows odometry readings of $(6, 10, 135)$. Using a homogenous transform, find the position of Q in coordinate frame A .

