1. **Spatial Velocity:** A cylinder rolls without slipping in the $\hat{x}_0$ direction on the $\hat{x}_0 - \hat{y}_0$ plane. The cylinder has a radius of r and a constant forward speed of v. Let $^0C=[C_x(t),0,0]^T$ be the position of the contact point at time t. Let $^0A=[A_x(t),0,0]^T$ be the position of the instantaneous top of the cylinder at time t.

   (a) What is the linear velocity of the point C? (hint: just need to compute $\frac{d}{dt}C_x(t)$)?

   (b) What is the linear velocity of the point A?

   (c) What is velocity of the body-fixed point currently coincides with C?

   (d) What is velocity of the body-fixed point currently coincides with A?

   (e) What is the spatial velocity of the cylinder in {0}-frame?

   (f) What is the spatial velocity of the cylinder in frame {C}? ({C} has the same orientation as {0}, while its origin is at the contact point C)

   Note: The first 4 questions are all referring to the inertia frame {0}
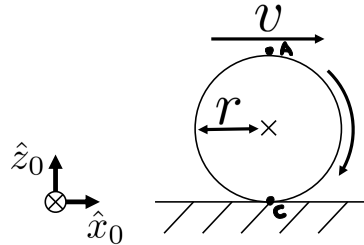
2. Modern Robotics: Exercise 3.21

3. Modern Robotics: Exercise 3.28

4. Modern Robotics: Exercise 5.5

5. Modern Robotics: Exercise 5.6