## MECH 230 Dynamics Homework 9

## Dr. Theresa Honein

Due Wednesday December 4, 2024

## 1. Read the problem statement of MKB 06-076.

6/76 The truck, initially at rest with a solid cylindrical roll of paper in the position shown, moves forward with a constant acceleration *a*. Find the distance *s* which the truck goes before the paper rolls off the edge of its horizontal bed. Friction is sufficient to prevent slipping.



Take the origin so that the position vector from the origin to the center leftmost edge of the truck bed is

$$\mathbf{r}_T = s \mathbf{E}_x.\tag{1}$$

Label the center of mass of the cylinder by C and its point of contact with the truck bed at P, so that

$$\mathbf{r}_{C} = \mathbf{r}_{T} + x \mathbf{E}_{x} + R \mathbf{E}_{y},$$
  
$$\mathbf{r}_{P} = \mathbf{r}_{T} + x \mathbf{E}_{x}$$
(2)

so that x(t = 0) = d, and  $\mathbf{E}_x$  points in the direction of motion of the truck,  $\mathbf{E}_y$  points vertically upwards, and  $\mathbf{E}_z$  points along the axis of rotation of the cylinder to complete the right handed triad.

2. Verify that

$$\mathbf{a}_C = (a - \alpha R) \mathbf{E}_x \tag{3}$$

Compiled on 11/28/2024 at 11:21am

1

where  $\boldsymbol{\alpha} = \alpha \mathbf{E}_z$  is the angular acceleration of the cylinder.

3. Use the appropriate balance laws applied to the cylinder to show that

$$\alpha = \frac{2}{3} \frac{a}{R}.$$
(4)

- 4. Solve for  $\ddot{x}$  then for x(t).
- 5. Find the distance s which the truck goes before the paper rolls off the edge of its horizontal bed.