# Theoretical Mechanics, Lab 3: KIN PLANE2

Plane motion

Innopolis University

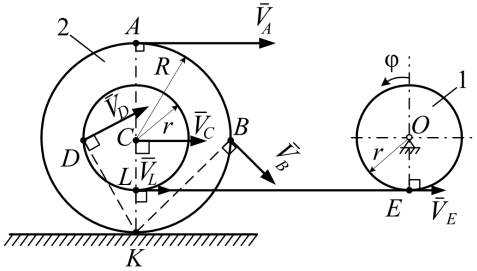
# Questions from the class

“Нах..я мы это делаем, все это? Если бы сказал, что повторяем физику - нет проблем. Но ты не объяснил” (с)

# Task 1 (yours): solution in subfolder

The shaft **1** has radius $r = 0.1$. It rotates around $O$ axis by law $\varphi = \varphi(t) = 2t$. Step roller **2** with radii $R = 0.2$, $r = 0.1$ associated with the shaft, wrapped in an unbreakable rope and rolling without sliding over horizontal plane.

Determine the velocities of points $A$, $B$, $C$, $D$, $K$ and angular velocity of $\omega_2$.

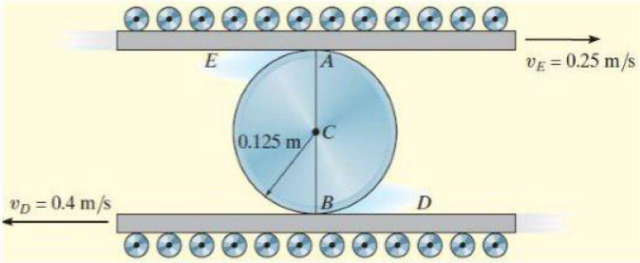



Task 1

# Task 2 (yours)

**Example**

The cylinder rolls without slipping betn the two moving plates. Determine the location of IC and calculate the angular velocity of the cylinder and velocity of its center *C*.



# Task 2 (yours): tip

**The algorithm for determining IC**

1. Check whether the body rolls over a fixed surface. If it rolls, then the point of contact of the body with the surface is IC.

2. Otherwise, it is necessary to draw the lines of action of the velocities of two points belonging to the body, then construct the perpendiculars to the action lines. There are three possible cases.

2.1. Perpendiculars intersect. The point of intersection is IC.

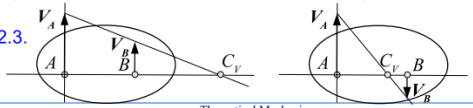
2.2. The perpendiculars are parallel. IC is in infinity.

2.3. The perpendiculars coincide. In this case, it is required:

- to find the values of the velocities of this two points,
- to show the velocity vectors in the figure in scale, and
- to draw a line connecting the end points of the vectors.

The point of intersection of this line with the perpendiculars is IC.

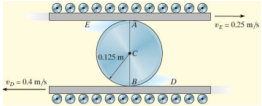
Ex. #2.3.



# Task 2 (yours): solution

Instantaneous Center of Zero Velocity

**Example:** Solution:



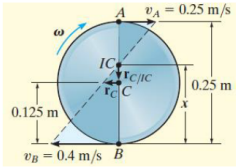

$$v_B = \omega x; \qquad 0.4 \text{ m/s} = \omega x$$

$$v_A = \omega(0.25 \text{ m} - x); \qquad 0.25 \text{ m/s} = \omega(0.25 \text{ m} - x)$$

Dividing one eqn by other to eliminate $\omega$:

$$0.4(0.25 - x) = 0.25x$$

$$x = \frac{0.1}{0.65} = 0.1538 \text{ m}$$



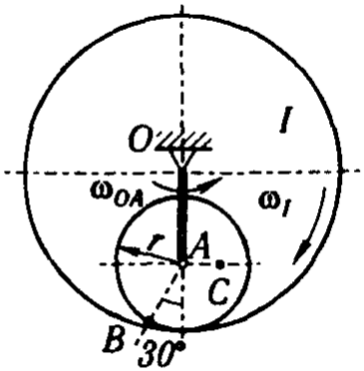

$$\omega = \frac{v_B}{x} = \frac{0.4 \text{ m/s}}{0.1538 \text{ m}} = 2.60 \text{ rad/s} \circlearrowright$$

$$v_C = \omega r_{C/IC} = 2.60 \text{ rad/s}\,(0.1538 \text{ m} - 0.125 \text{ m})$$

$$= 0.0750 \text{ m/s} \leftarrow$$

# Task 3 (mine)

The goal is to find velocities and accelerations (both direction and magnitude) of $A$, $B$, $C$ if you know all dimensions of the mechanism, $\omega_{OA} = 2$, $\omega_1 = 1.2$, $\varepsilon_{OA} = 0$.




Task 3

# Deserve “A” grade!

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Room 105 (Underground robotics lab)