5-5 Instantaneous Center of Zero Velocity
5.5 ICZV

1. Introduction

- For a moving body, *at each instant of time*, there is always a point with zero velocity.
- This point is called the Instantaneous Center of Zero Velocity or ICZV.

Examples:
- A rotating link
- A train on a circular track
1. Introduction

NOTES:

- ICZV is a point on the body that, at that instant, has zero velocity.
- ICZV may be on the body or anywhere else.
- ICZV may be located at infinity.
- ICZV will usually not be the same point on the body all the time.
- ICZV can be used to calculate velocity only.
- The body will appear to rotate about ICZV.
- Acceleration of the ICZV will not be zero.
5.5 ICZV

2. Locating ICZV

- 1. Fixed Axis Rotation

- Pure rotation, $C = \text{ICZV}$

- $\vec{v}_A = \vec{v}_C + \vec{v}_{A/C}$

- $\vec{v}_C = 0$

- $\vec{v}_{A/C} = \vec{\omega} \times \vec{r}_{C\rightarrow A}$

- $\vec{v}_A = \vec{\omega} \times \vec{r}_{C\rightarrow A}$

See that $\vec{v}_A$ must be $\perp$ to $CA$

See that $v_A$ must be proportional to its distance from $C$
5.5 ICZV

2. Locating ICZV

- 2. General Plane Motion

- Suppose, \( \vec{v}_A \) and \( \vec{v}_B \) are known
- Draw a line \( \perp \) to \( \vec{v}_A \) and \( \vec{v}_B \) passing through \( A \) and \( B \)
- The intersection is ICZV.

- **At this instant**, the body is rotating around the ICZV.

- In general, \( a_C \neq 0 \)
- \( C = \text{ICZV} \)
- \( \vec{v}_A = \vec{v}_C + \vec{v}_{A/C} \)
- \( \vec{v}_C = 0 \)
- \( \vec{v}_{A/C} = \vec{\omega} \times \vec{r}_{C\to A} \)

- See that \( \vec{v}_A \) must be \( \perp \) to \( CA \)
- See that \( v_A \) must be proportional to its distance from \( C \)
5.5 ICZV

2. Locating ICZV

- 2. General Plane Motion

If $\vec{v}_A = \vec{v}_B$ then ICZV is at $\infty$ (i.e., body in translation).
Example 1: Find the ICZV’s

a) 

\[
\begin{align*}
A & : 150 \text{ mm} \\
D & : 200 \text{ mm} \\
B & : 150\sqrt{2} \text{ mm} \\
O' & : \\
O & : \\
\theta & = 45^\circ
\end{align*}
\]

b) 

\[
\begin{align*}
A & : \\
G & : \\
\theta & \\
v_A & = \text{constant}
\end{align*}
\]

c) 

\[
\begin{align*}
100 \text{ mm} \\
G & : \\
\omega & = 125 \text{ mm}
\end{align*}
\]

d) 

\[
\begin{align*}
A & : \\
\theta & = \\
v_A & = 2 \text{ m/s} \\
B & : 120 \text{ mm} \\
O & : 160 \text{ mm}
\end{align*}
\]
5.5 ICZV

Example 2: Rolling Wheel

The wheel rolls to the right without slipping, with its center $O$ having a velocity $v_O = 3$ m/s. Locate the instantaneous center of zero velocity and use it to find the velocity of point $A$ for the position indicated.

- Where is the ICZV?
- Roll without slipping, ICZV = point on the body that is in contact to the ground.
- Seen from the ground, the wheel is not rotating about the center point! But about the ICZV on the ground!
Example 3: Four-Bar Linkage

Arm OB of the linkage has a clockwise angular velocity of 10 rad/s in the position shown where \( \theta = 45^\circ \). Determine the velocity of A, the velocity of D, and the angular velocity of link AB for the position shown.