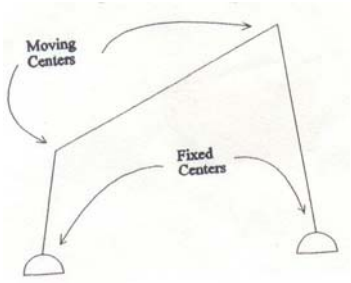
INSTANT CENTERS OF VELOCITY (Section 6.4 in Norton)

Instant Center - denotes the center of rotation of a body at an *instant* in time. The center of rotation doesn't necessarily have to lie within the link itself.

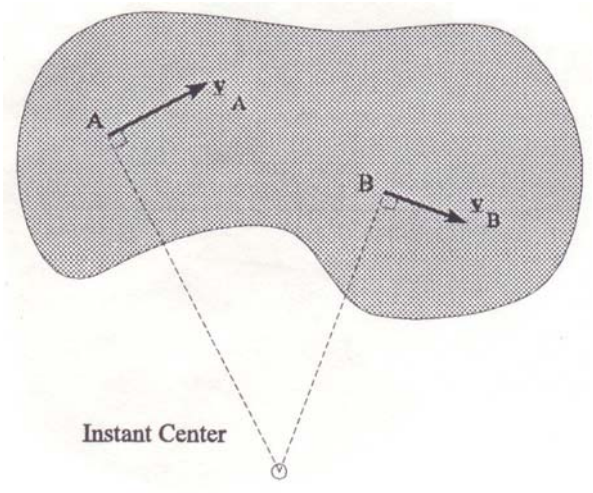
1. It is a point in one body about which some other body is permanently or instantaneously rotating about.

2. It is a point common to 2 bodies where the velocity of the two bodies are the same. i.e., a point where there is zero relative velocity between the two bodies.

Example: In a four-bar linkage each pin connection is an instant center (IC).



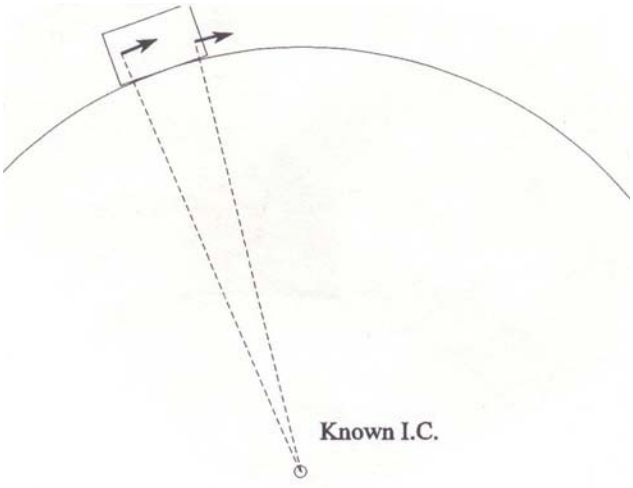
Any two bodies moving relative to one another have an instant center.



To find the instant center for a single body when the velocities of 2 points are known we take advantage of the fact that the linear velocities of all points in a rotating body are perpendicular to their radii of rotation.

The two points A and B along with their known velocity vectors $\underline{\mathbf{v}}_A$ and $\underline{\mathbf{v}}_B$ determine the I.C. If the two velocity vectors are equal (i.e., same magnitude and direction) then the I.C. is a point at infinity, and the body's motion is in pure translation.

As a body moves, its I.C. may be changing at each instant, or snap shot, in time. This is why we call it an Instant center.

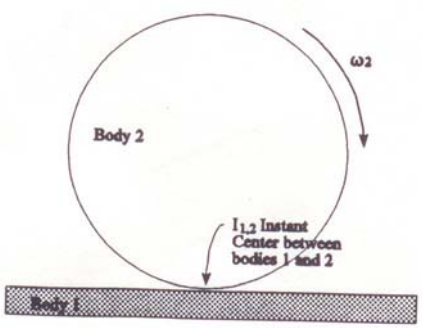


I.C. for a sliding body

Inverse case: If we know a point on the body and we know the instant center of that body's motion, we can determine the direction that the body is moving. Note: What happens if the known location of the I.C. is a point at infinity?

I.C. for a rolling body

The instant center for a rolling body occurs at the point of contact between the two bodies. The instant center between bodies 1 and 2 is defined as $I_{1,2}$.



For **2** bodies moving with respect to one another there is **1** instant center.
For **3** bodies moving with respect to one another there are **3** instant centers. *(Kennedy's theorem)*
For **n** bodies moving with respect to one another there are **n(n–1)/2** instant centers.

KENNEDY'S THEOREM

If three bodies have plane motion relative to one another, then there are three instant centers, and the three instant centers all lie on the same line.

Using Circle Diagrams for Locating Instant Centers

1. Locate (i.e., identify) *primary* instant centers. E.G., pin connections, sliding bodies, and rolling bodies with no slipping.
2. Draw a circle and mark evenly spaced ticks to represent each link in the mechanism.
3. Draw solid lines identifying each of the known *primary* instant centers.
4. Draw dashed lines between each point (i.e., link) to represent the remaining instant centers to be found.
5. Apply Kennedy's theorem to find the unknown instant centers.

EXAMPLE: Four-bar Linkage