Interconnections and Linkages (Sec. 4.3)

Connections between bodies constrain their motion

constraint equations - kinematical representation of the constraints

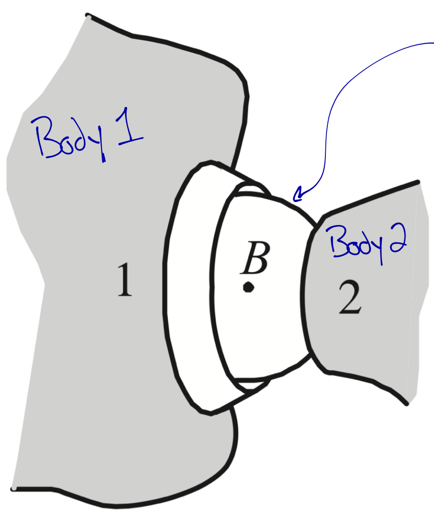
Constraint forces or reactions - impose/enforce constraints

One common simplifying constraint is enforcing planar motion.

Q: To maintain planar motion, what must be true about angular velocity?

$\bar{\omega} \perp$ plane of motion to maintain motion only in that plane

Ball-and-socket Joints

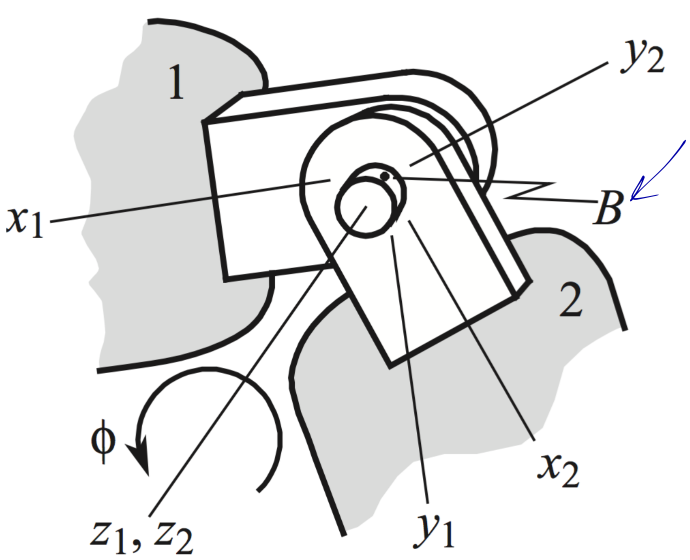


center of the ball and socket are the same

$\bar{v}_{B1} = \bar{v}_{B2}$ and $\bar{a}_{B1} = \bar{a}_{B2}$

Because B moves identically on bodies 1 and 2, the velocity and accel. must be equal.

Pin Connections



Point B is shared between the bodies

① $\bar{v}_{B1} = \bar{v}_{B2}$ and $\bar{a}_{B1} = \bar{a}_{B2}$

② Also a constraint on rotation

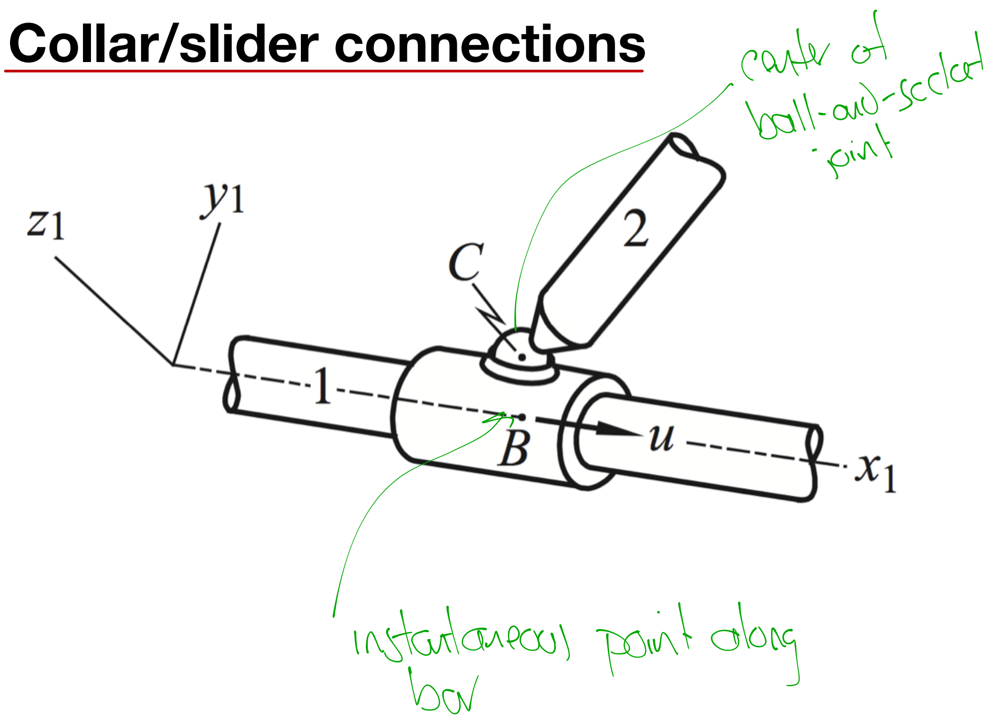
$$\bar{\omega}_2 = \bar{\omega}_1 + \dot{\phi}\bar{k}_1$$

and

$$\bar{\alpha}_2 = \bar{\alpha}_1 + \ddot{\phi}\bar{k}_1 + \dot{\phi}(\bar{\omega}_1 \times \bar{k}_1)$$

Interconnections and Linkages (cont.)

Collar/slider connections



Assume $\bar{r}_{C/B} \approx 0$

collar moves in x_1 direction

Let $\dot{u}$ = relative velocity of the slider

$$(\bar{v}_C)_{x_1y_1z_1} = \dot{u}\,\bar{i}_1$$

So, $\bar{v}_C = \bar{v}_B + \dot{u}\,\bar{i}_1$ and $\bar{a}_C = \bar{a}_B + \ddot{u}\,\bar{i}_1 + 2\bar{\omega}_1 \times \dot{u}\,\bar{i}_1$

The collar could also be connected to the slider by a pin or clevis, which add additional constraints. See the book for more

Fully constrained system – = number of kinematic variables and equations

Portially constrained – number of kinematical variables exceeds number of kinematic eq.

· number of "extra" variables = # of degrees-of-freedom.