- HW 4 (1.6/1.7) due tonight
- HW 5 (1.8/1.9) due Monday

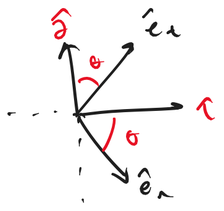
Last time: 1.C Joint Description

$\vec{v} = \dot{x}\hat{\imath} + \dot{y}\hat{\jmath} = v\hat{e}_t = \dot{r}\hat{e}_r + r\dot{\theta}\hat{e}_\theta$

$\vec{a} = \ddot{x}\hat{\imath} + \ddot{y}\hat{\jmath} = \dot{v}\hat{e}_t + \frac{v^2}{\rho}\hat{e}_n = (\ddot{r} - r\dot{\theta}^2)\hat{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\hat{e}_\theta$

Three step: 0) writing the relevant kinematics
1) writing conversions between unit vectors
2) Use projection (dot product) or motion coefficients

Example (1)

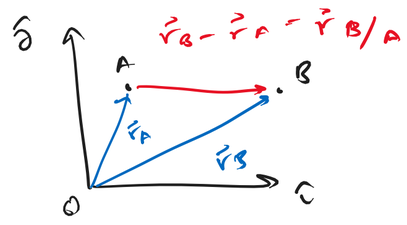


$\hat{e}_t = \sin\theta\,\hat{\imath} + \cos\theta\,\hat{\jmath}$
$\hat{e}_n = \cos\theta\,\hat{\imath} - \sin\theta\,\hat{\jmath}$
$\Rightarrow$
$\hat{\imath} = \sin\theta\,\hat{e}_t + \cos\theta\,\hat{e}_n$
$\hat{\jmath} = \cos\theta\,\hat{e}_t - \sin\theta\,\hat{e}_n$

	$\hat{\imath}$	$\hat{\jmath}$
$\hat{e}_t$	$\sin\theta$	$\cos\theta$
$\hat{e}_n$	$\cos\theta$	$-\sin\theta$

1.D Kinematics: Relative & Constrained Motion

1.D.I Relative Motion



The vector $\vec{r}_{B/A}$ is the vector pointing from A to B and indicates the position of B relative to A

- Position $\quad \vec{r}_{B/A} = \vec{r}_B - \vec{r}_A$

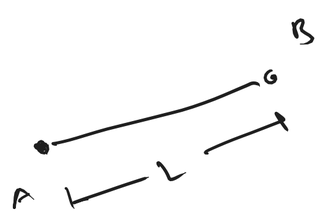
- Velocity $\quad \frac{d\vec{r}_{B/A}}{dt} = \frac{d}{dt}\vec{r}_B - \frac{d}{dt}\vec{r}_A \Rightarrow \vec{v}_{B/A} = \vec{v}_B - \vec{v}_A$

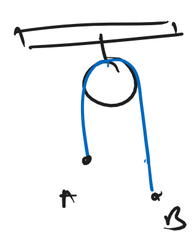
- Acceleration $\quad \frac{d\vec{v}_{B/A}}{dt} = \frac{d}{dt}\vec{v}_B - \frac{d}{dt}\vec{v}_A \Rightarrow \vec{a}_{B/A} = \vec{a}_B - \vec{a}_A$

Where $\vec{v}_{B/A}$ and $\vec{a}_{B/A}$ are the velocity and acceleration of B wrt. A

1.D.II Constrained Motion

Often the relative motion between two points A and B is constrained such that the motion of A depends on the motion of A common example is when two points are connected by a taut inextensible cable





- Inextensible → L does not change
- Even though L is constant, the distance between A and B does change

Steps

1. Define coordinates
2. Write an expression for L in terms of the coordinates defined in step 1
3. Differentiate dL/dt and d^2L/dt^2 to find velocity and acceleration constraints
4. Repeat 2 & 3 for each cable in the system