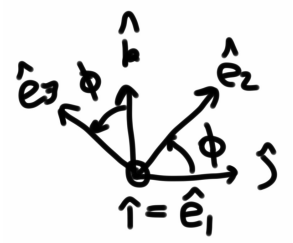
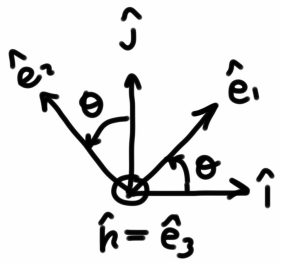
SYEN 3371. Engineering Dynamics Kinematics Homework
Assigned: 9/2/2014

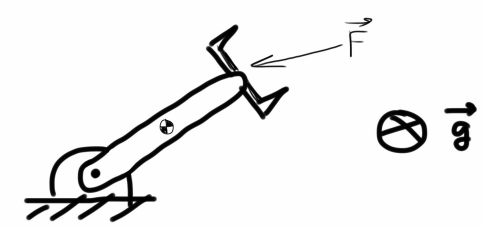
For a vector, $\vec{r}=\vec{r}_0+\vec{r}_1$, where $\vec{r}_0$ is usually expressed in inertial coordinates and $\vec{r}_1$ is expressed in time-varying coordinates that are related to inertial coordinates through a coordinate transformation matrix whose angular velocity is $\vec{\Omega}$, the absolute velocity is given by $\vec{v}=\vec{v}_0+\vec{v}_{rot}+\vec{\Omega}\times\vec{r}_1$ and the absolute acceleration is given by $\vec{a}=\vec{a}_0+\vec{a}_{rot}+\vec{\alpha}\times\vec{r}_1+2\vec{\Omega}\times\vec{v}_{rot}+\vec{\Omega}\times\vec{\Omega}\times\vec{r}_1$. The vector, $\vec{\alpha}$, is the angular acceleration, the vector, $\vec{v}_{rot}$, is the derivative of the components of $\vec{r}_1$, and $\vec{a}_{rot}$ is the second derivative of the components of $\vec{r}_1$.

1. Write down the Coordinate Transformation Matrices and angular velocity vectors for each of the coordinate systems shown.





2. Free Body Diagram
Draw a Free Body Diagram for the attached figure. Put a coordinate system of your choice on the figure. Assume the arm's mass is m and don't forget about gravity. Write a list of the vector forces acting on the body.



3. Given a vector, $\vec{r}=r(t)\hat{e}_r$, which is related to inertial coordinates $(\hat{i},\hat{j})$ through the coordinate transformation matrix, $\begin{bmatrix}\cos\theta & \sin\theta\\ -\sin\theta & \cos\theta\end{bmatrix}$, with $\theta=at^2$, where $a=0.2\,\frac{rad}{s^2}$. The radius is given by $r(t)=b\cos(ct)$, where $a=2.0\,m$ and $c=0.4\,\frac{rad}{s}$. What are the absolute velocity and acceleration for this vector? Leave the answer in polar coordinates.