Example

Two bugs are on a rotating turntable. The one at $P$ is stationary on the turntable while the one at $Q$ is moving radially away from $P$ at a uniform speed. (the rate of change of $r$, the magnitude of $PQ$, is constant).

Choose $\theta = 0$.

Let both $P$ and $Q$ be instantaneously coincident, but $Q$ is moving radially outward.
Example

The motor housing and its bracket rotate about the Z-axis at the constant rate $\Omega = 3 \text{ rad/s}$. The motor shaft and disk have a constant angular velocity of spin $p = 8 \text{ rad/s}$ with respect to the motor housing in the direction shown. If $\gamma$ is constant at $30^\circ$, determine the velocity and acceleration of point $A$ at the top of the disk and the angular acceleration $\alpha$ of the disk.

$I$ – inertial frame  
$E$ – bracket  
$M$ – motor housing  
$D$ – disk  
$XYZ$ – fixed to the bracket  
\hspace{2cm} (unit vectors – $e_i$)  
$xyz$ – fixed to the motor (unit vectors – $m_i$)
A disk of radius $r$ is mounted on an axle $OG$ of negligible mass. The disk rotates counter-clockwise rolling on the flat plate (fixed to the inertial frame) at the constant rate $\omega_1$ about $OG$.

Determine the angular velocity and angular acceleration of the disk in an inertial frame.

Find the acceleration of the contact point $P$. 
Example

A gyroscope consists of a rotor with its mass center fixed in space but which can spin freely about its geometric axis and assume any orientation.

• From a reference position with gimbals and a reference diameter of the rotor aligned, the gyroscope may be brought to any orientation through a succession of three steps:
  1) rotation of outer gimbal through $\phi$ about $AA'$,
  2) rotation of inner gimbal through $\theta$ about $BB'$,
  3) rotation of the rotor through $\psi$ about $CC'$.

\[ \dot{\phi} = \text{rate of precession} \]
\[ \dot{\theta} = \text{rate of nutation} \]
\[ \dot{\psi} = \text{rate of spin} \]

Determine the angular velocity and angular acceleration of the rotor in an inertial frame.