GYROSCOPE

Gyro: Circular Motion **Cross Product:** $\vec{a} \times \vec{b} = \lvert\vec{a}\rvert \cdot \lvert\vec{b}\rvert \sin\theta\, \hat{\eta}$		$\hat{\boldsymbol{\imath}}$		
	$\hat{\boldsymbol{K}}$	$\boldsymbol{CW}: +\boldsymbol{ve}$	$\boldsymbol{CCW}: -\boldsymbol{ve}$	$\hat{\boldsymbol{\jmath}}$
Linear Momentum: $\vec{P} = m\vec{V}$	**Angular Momentum:** $\vec{L} = \vec{r} \times \vec{P} = I\,\vec{\omega}$			

Newtons 2nd Law of Motion: $\vec{\tau} = \dfrac{d\vec{L}}{dt} = \dfrac{d(\vec{r} \times \vec{P})}{dt} = \dfrac{d(I\vec{\omega})}{dt} = \dfrac{d(I\omega\,\hat{\omega})}{dt}$		Magnitude: $\lvert\vec{L}\rvert = I\omega$	Direction: $\hat{L} = \hat{\omega}$
		$\boldsymbol{Precision\,Velocity}: \dfrac{d\hat{\omega}}{dt} = \overrightarrow{\omega_P}$	
CASE-I: Let the direction of angular velocity remains same w. r. t. time. only it's magnitude is changing. $\vec{\tau} = \dfrac{d(I\omega\,\hat{\omega})}{dt} = I\,\vec{\alpha}\,\hat{\alpha}$		**CASE-II:** Let the magnitude of angular velocity remains same w. r. t. time. only it's direction is changing. $\vec{\tau} = \dfrac{d(I\omega\,\hat{\omega})}{dt} = I\omega\dfrac{d\hat{\omega}}{dt} = I[\overrightarrow{\omega_P} \times \vec{\omega}] = \begin{matrix} Gyroscopic \\ Active\,Torque \end{matrix}$	
Acceleration: $\hat{\alpha} = \hat{\omega}$	Retardation: $\hat{\alpha} = -\hat{\omega}$	$Reactive\ Gyroscopic\ Torque: \vec{T} = I[\vec{\omega} \times \overrightarrow{\omega_P}]$	
		Magnitude: $T = I\,\omega\,\omega_P$	Direction: $\hat{T} = \hat{\omega} \times \widehat{\omega_P}$

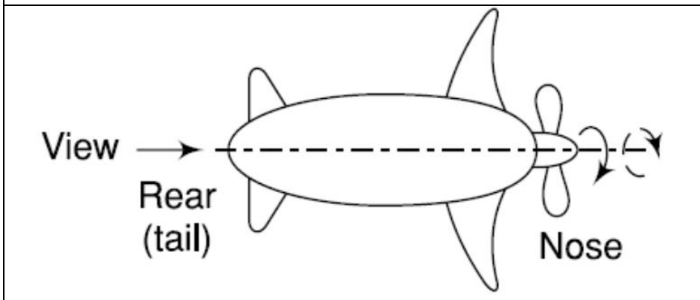
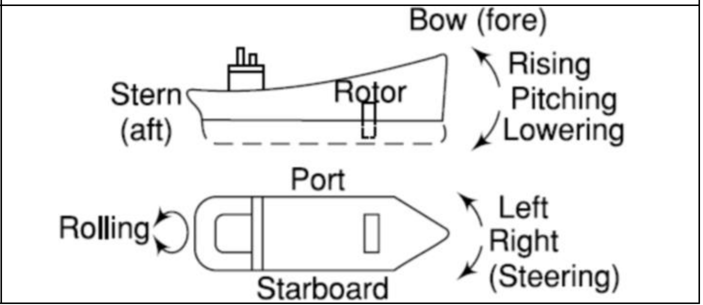
Newtons 3rd Law of Motion: Every action has equal and opposite reaction. Hence, for all Active gyroscopic, Reactive gyroscopic Will be present in the system.

GYROSCOPIC PHENOMENON:

Spin ($\vec{\omega}$): Direction of Angular Momentum
Precession ($\overrightarrow{\omega_P}$): Direction about which direction of angular momentum changes.
Reactive Gyroscopic Torque: $\vec{T} = I[\vec{\omega} \times \overrightarrow{\omega_P}]$

	Axis	**Planes**
$\vec{\omega}$		
$\overrightarrow{\omega_P}$		
$\vec{\omega} \times \overrightarrow{\omega_P}$		

DIAGRAM METHOD: It's almost same as table method with Torque diagram. This diagram will give the active gyroscopic torque direction. Reactive Gyroscopic torque will be opposite to Active Gyroscopic torque.

AEROPLANES	NAVAL SHIP
	

FOR NAVAL SHIP:

1. **Steering:** Turning of the ship either towards starboard side or port side in known as steering.
2. **Pitching:** Oscillation of the ship about horizontal transverse axis is known as pitching. Bow will rise or fall.
3. **Rolling:** Oscillation of the ship about longitudinal axis.

NOTE:

1. Sometime Pitching is given in SHM.

$x = x_0 \sin\omega t$	$\omega = 2\pi/Time\ Period$

2. There will be no gyroscopic effect due to Rolling.