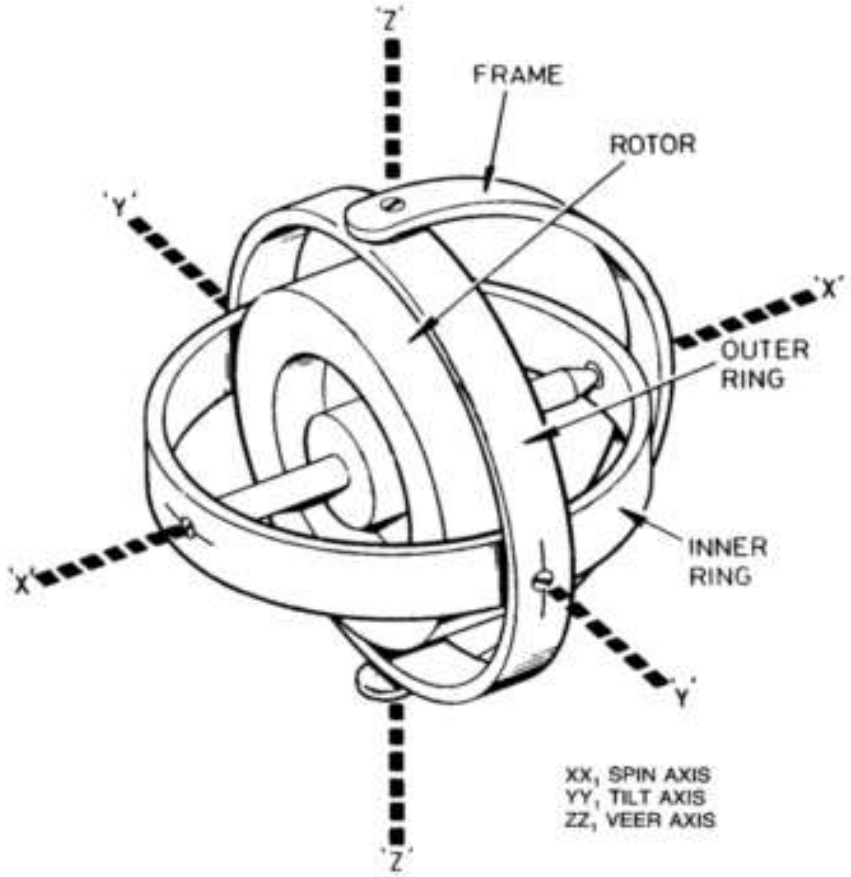
E230 Aircraft Systems

Spinning Wonder

6th Presentation

School Of Engineering

Gyroscope Elements and Axes



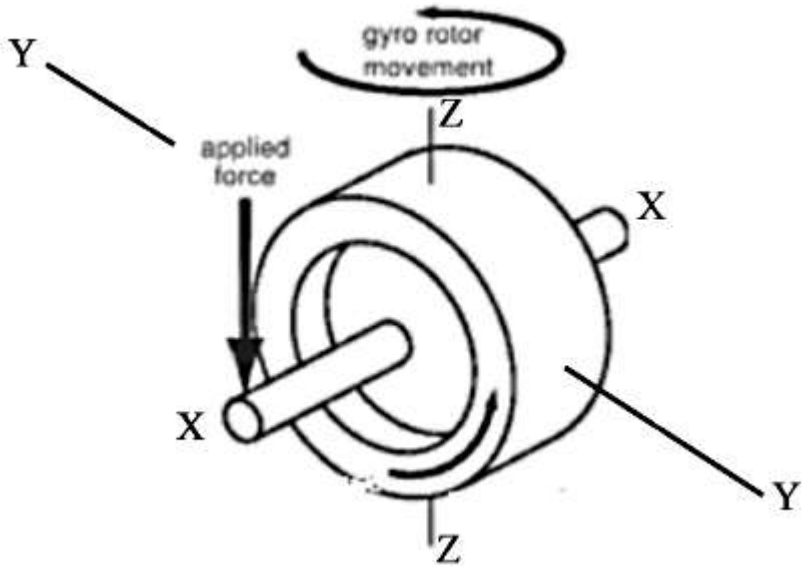
- Assembly of rotor and inner / outer rings known as the gimbal system
- Only works when rotor is spinning
- In normal operations, all axes are at right angles to one another

Gyro Property 1 – Rigidity

- Based on Newton's First Law
- A spinning rotor's axis will tend to point at a fixed direction, unless an external force acts on it to change its orientation
- Dependent on three factors
  - Mass of rotor
  - Speed of rotor rotation
  - Distance at which the mass acts from the centre, i.e. radius of gyration

Gyro Property 2 - Precession

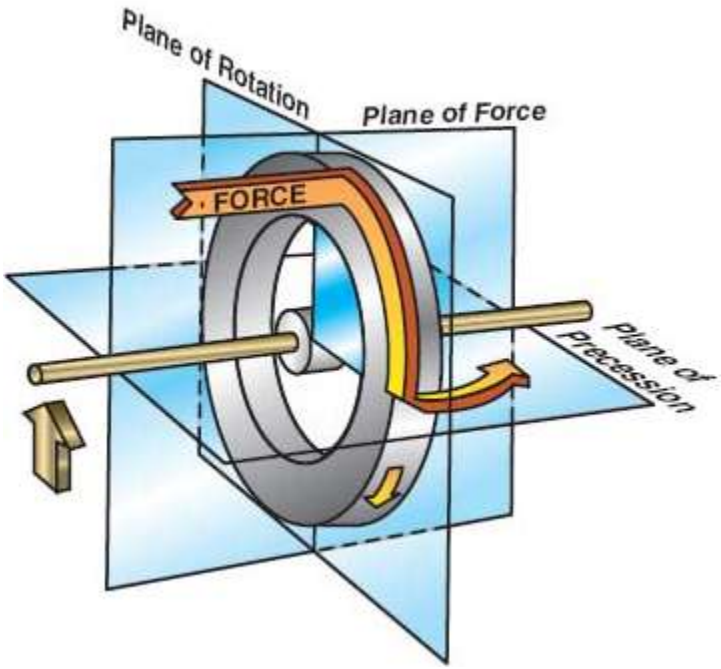
- A gyro is spinning about axis X-X and a force is applied as shown.
- It will resist the applied force and also rotate about the Z-Z axis.



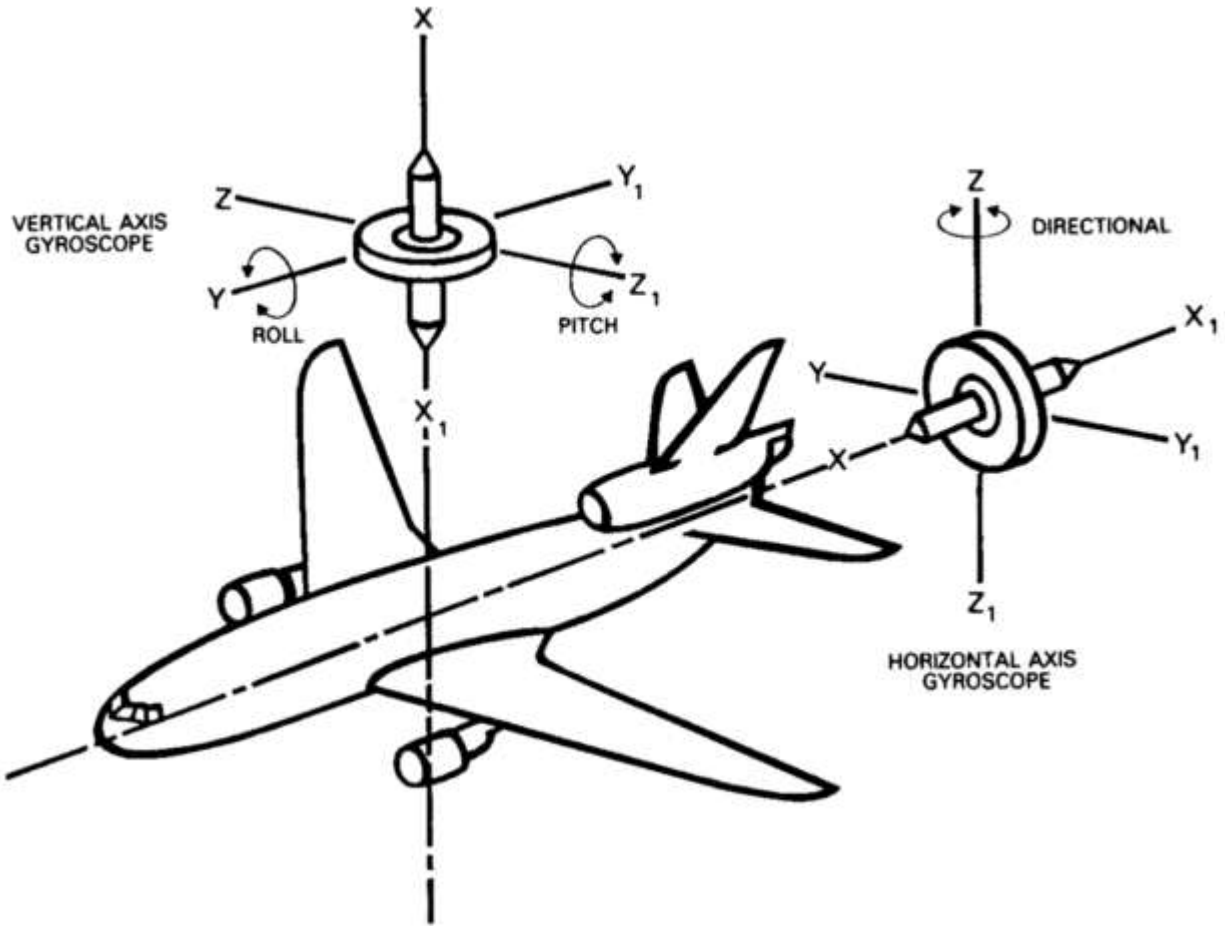
Gyro Property 2 - Precession

- Rate of precession dependent on 3 factors
  - Strength and direction of applied force
  - Mass of rotor
  - Rotation speed of rotor

- Precession will continue until the plane of rotation becomes coincident with the force



Aircraft Reference Using Gyros



Gyroscopic Wander

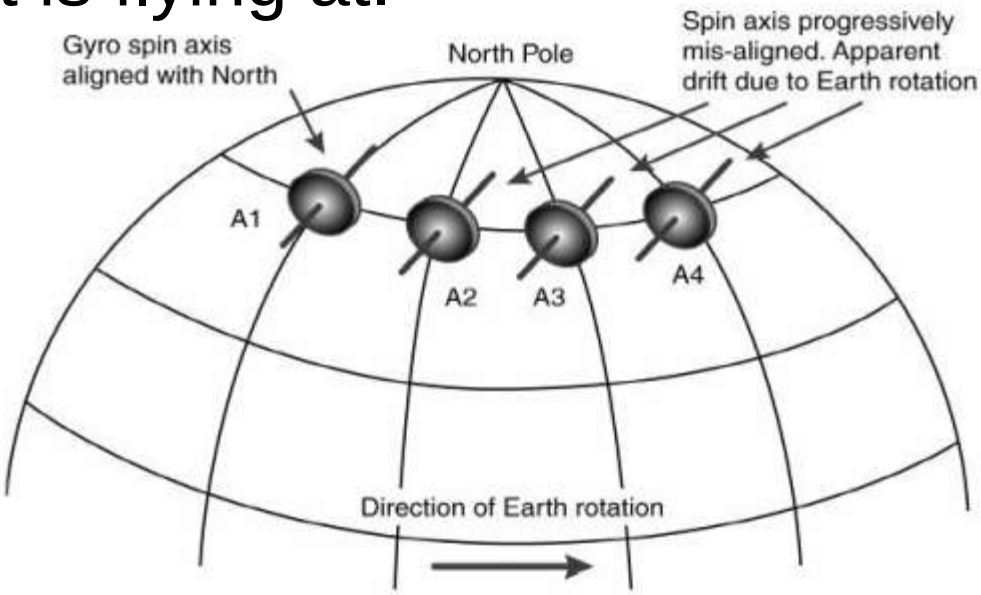
- Refers to a shift in the gyro axis in free space away from its original reference
- Topple is rotor axis wander in the vertical plane.
- Drift is rotor axis wander in the horizontal plane.
- Wander can be either Real or Apparent

Real Wander

- Real wander is due to imperfections from the gyros such as bearing friction and gimbal system imbalance.
- These external forces acting on the gyro cause precession.

Apparent Wander

- Apparent wander is a result of the Earth's rotation
- The amount of wander depends on the latitude that the aircraft is flying at.



Gimbal Lock

- Occurs when the gyro spin axis is coincident with one or other of the axes.
- This causes the gyro to precess or topple when the system as a whole is turned.

Vacuum-driven Gyros

- Used mainly in small aircrafts
- Vacuum is created by a vacuum pump that is driven by either
  - Engine crankshaft
  - Engine accessory shaft

Electrical-driven Gyros

- Gyros are adaptations of AC or DC motors
- Driven by the aircraft power supply
  - Attitude indicator normally driven by AC power
  - Turn-and-bank indicators normally driven by DC power

Learning objectives

- Discuss types of gyroscopes found on aircrafts and their advantages and disadvantages
- Describe effects of gimbal lock on a gyroscope
- Explain how the gyroscopic properties of rigidity and precession are used to provide flight information such as attitude, heading etc
- Explain meaning of apparent drift and its impact on navigation