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EE C247B - ME C218 Introduction to MEMS Design Spring 2016

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Lecture Module 15: Gyros, Noise, & MDS

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Lecture Outline

- Reading: Senturia, Chpt. 14, Chpt. 16, Chpt. 21
- Lecture Topics:
 - ↳ Gyroscopes
 - ↳ Gyro Circuit Modeling
 - ↳ Minimum Detectable Signal (MDS)
 - Noise
 - Angle Random Walk (ARW)

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Gyroscopes

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Classic Spinning Gyroscope

- A gyroscope measures rotation rate, which then gives orientation → very important, of course, for navigation
- Principle of operation based on conservation of momentum
- Example: classic spinning gyroscope

Gyroscope frame, Spin axis, Gimbal, Rotor

Rotor will preserve its angular momentum (i.e., will maintain its axis of spin) despite rotation of its gimballed chassis



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Vibratory Gyroscopes

- Generate momentum by vibrating structures
- Again, conservation of momentum leads to mechanisms for measuring rotation rate and orientation
- **Example:** vibrating mass in a rotating frame

Mass at rest

Driven into vibration along the y-axis

y-displaced mass

Capacitance between mass and frame = constant

Rotate 30°

Get an x' component of motion

$C(t_2) > C(t_1)$

$C(t_1)$

$C(t_2)$

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Basic Vibratory Gyroscope Operation

Principle of Operation

- Tuning Fork Gyroscope:

Input Rotation

Driven Vibration @ f_0

Coriolis (Sense) Response

Coriolis Torque

Side View

Top View

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