ECE 6422 – Interface IC Design for MEMS and Sensors

Topical Outline

Review of Integrated MEMS Technologies and Applications

1. Integrated MEMS Applications: Microsensors, Microactuators, RF, and Biomedical
2. Integrated MEMS Processes and schemes: System-On-Chip, and System-On/In-Package
3. Bulk Micromachining Processes (low and high temperature)
4. Surface Micromachining Processes (low and high temperature)
5. Mixed-Mode Micromachining Processes
6. Integrated MEMS-CMOS Processes
7. MEMS Packaging Techniques

Integrated Transducers and Electro-Mechanical Mechanisms

1. Micro-Electro-Mechanical Sensor Design and Modeling
2. Signal Transduction Mechanism and Modeling:
3. Amperometric and voltammetric techniques
4. Biochemical sensing techniques
5. Sensor Noise Sources, Electro-Mechanical Mechanisms, and Modeling: Brownian noise, pull-in voltage, comb-drives, electrostatic stiffness, nonlinearities, etc.
6. Static (off-resonant) vs Resonant Sensors/Devices
7. Quality factor and its fundamental limiting sources

Interface IC techniques for low-frequency MEMS and Sensors

1. Small Signal Models
2. Continuous and Sampled-Data Systems
3. Switched Capacitor Charge Amplifiers and Integrators
4. Capacitive AC Bridges
5. Various Noise Sources, Noise in IC's
6. Noise and Offset Cancellation Techniques: CDS, chopper stabilization
7. Fully-Differential Op-Amps
8. Low Noise Op-Amps
9. Low-Noise Transimpedance Amplifiers
10. Biasing techniques
11. Distortion Analysis
12. Effect of Feedback on Noise and Distortion

High Frequency MEMS Devices and their Interface ICs

1. RF MEMS Passives: Micromechanical switches, High-Q inductors, Tunable capacitors
2. MEMS Resonators and Frequency Scaling
3. Flexural and bulk acoustic modes resonators, modeling
4. Oscillator design principles
5. MEMresonator-based Oscillator Design
6. Phase Noise
7. MEMresonator/oscillator sensors
8. MEMS Filter Design
9. Loss Sources and Mechanisms

Future Directions and Developments

1. Integrated Nano-Electro-Mechanical Systems (NEMS)
2. NEMS oscillators and sensors
3. Emerging applications