1. ECE 569/MECH 569: Micro-Electro-Mechanical Devices

2. 3 credits: 2-75 minute lecture sessions/week

3. George Collins

4. Microsystem Design. Senturia, S. D. 2001.
    a. The MEMS Handbook. Gad-el-Hak, M. 2002.
    b. Fundamentals of Micro Fabrication and Nanotechnology. Madou, M. 2011.

5. Course Information
    a. Micro-electro-mechanical processes and applications in sensors, optics, and structures
    b. Prerequisites: ECE 331 with a C or higher or MECH344 with a C or higher
    c. Selected Elective: Electrical Engineering; Computer Engineering

6. Goals for the Course
    a. Course Learning Objective
        i. Examine the use of fundamental concepts of both electrical R-L-C and mechanical M-B-K approximations on the micron scale to achieve micro electro-mechanical system models of micro electro-mechanical systems (MEMS)
        ii. Analyze both the technical and cost the advantages of MEMS acting in concert with wireless communication to form internet of sensor/control activator systems in applications as varied as: 3-D printers, full color gamut pico-projectors, strain gauges, accelerometers, gyroscopes, pressure sensors, and flow meters
        iii. Apply optical spectroscopy, wireless communications, and micro fluids to allow: laboratory on an IC chip MEMS systems for blood analysis, DNA analysis on a chip to reduce cost of human DNA sequencing to below $1000, and health monitors of critical signs such as heart rhythms, oxygen content in blood, blood pressure for under $ 100 on a wrist band
        iv. Evaluate in depth the dynamic response of MEMS based: two million independent mirror arrays on a chip for range and velocity detection of objects surrounding a driverless car as well as accelerometer and gyroscope time dependent effects in self- driving autos and portable smart phones
        v. Create Simulink and Cadence computer models for conducting dynamic analysis of both mechanical structures and electronic amplifiers that include noise in 1-4 above
    b. Student Outcomes
        1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
        2. An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and welfare, as well as global, cultural, social, environmental, and economic factors
        3. An ability to communicate effectively with a range of audiences

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability acquire and apply new knowledge as needed, using appropriate learning strategies t

7. Topics Covered

Introduction to MEMS design issues: architecture and high level design
Standard CMOS IC processing
Integrated MEMS and CMOS processes
Commercial MEMS Systems: ink jets, Pressure sensors, accelerometers, digital mirror arrays, and DNA and protein diagnostic chips
Future trends in nano scale MEMS