Fundamentals of MEMS
(Micro-electromechanical Systems)
Course Number: ME-585
(Fall 2015) – San Diego State University
(Professor Sam Kassegne)

Course Description:

Micro-electro-mechanical systems, or MEMS, is an emerging area with applications to a variety of engineering fields such as mechanical, electrical, aerospace and biomedical engineering. This course is an introductory course and forms the first part of a 2-series MEMS course at SDSU. This introductory part concentrates in educating students the manufacturing techniques (micromachining), materials, physics and simulation issues in MEMS. The course work is complemented with a comprehensive design project and a review paper of a MEMS technology of the student's choice.

Course Objectives:

Upon completion of the course work, the students will:

- Know in detail the fundamental micromachining processes such as lithography, surface and bulk micromachining.
- Know how to do layout for MEMS using CAD and then populate a wafer with these layouts.
- know simulation of MEMS devices.
- develop and exercise critical thinking in microengineering design issues such as fabrication, packaging and testing.
- have an understanding of microscale physics for use in designing MEMS system applications
- review current MEMS and BioMEMS applications

This is a graduate level course open to aerospace, electrical, computer, mechanical and biomedical students.

Instructor:

Dr. Kassegne is a professor of mechanical engineering at the Mechanical Engineering department of SDSU. He was previously at Marc Madou's BioMEMS Research Group at UC Irvine and had also worked at Microfabrica, a MEMS start-up company and Nanogen, a San Diego based DNA-chip Company. He conducts research in the areas of microarrays, microfluidics, sensors and actuators for applications in the life sciences and next generation lithography. He has taught several courses in FEA, computational modeling, numerical prototyping and MEMS and has over ten years of industrial experience.

E-mail: kassegne@mail.sdsu.edu
Web-site: http://www.digitaladdis.com/sk
Telephone: 619-594-1815
Office Hours: Monday 1 – 4 PM.
Cleanroom Location: A Lot
Office Location: PS-127

Grading and Assignments:

1 Mid-Term	40%
Final Design Project:	30%
Howe works	15%
Research Review Paper	15%

1. **Review Paper**

This will involve reviewing an existing MEMS technology in such areas as Micro-mirrors, Inertial Sensors, Pressure Sensors, Accelerometers, DNA chips/arrays, Biosensors, Microfluidics, Optoelectronics, RF MEMS, etc. .

The graduate student is expected to critically examine the core IP of an application, its engineering (including manufacturing) and business sense and market potential/performance. Some of the examples are:

Analog Devices, Microfabrica, QMT (Qualcomm MEMS Technology), Genoptix, Nanogen, Intel, Aviva Biosciences, CapitalBio, Gamera Biosciences, Bosch, Honeywell, Kionix, Microfabrica, Agilent, Hewlett Packard – Inkjet, Agilent – Gene Chip, Affymetrix, Coventor, IntelliSense, MEMSCap, etc.

2. Design Project

The design project involves a group work on the complete engineering of a MEMS device. Included are the physical layout (using Tanner, Coventorware, AutoCAD, etc) and simulation/modeling (FEMLAB, Coventorware, ANSYS, etc). Some aspects of micromachining and testing will be done at the ME 685 level.

Lecture Outline

Session Number	Date	Topic	Note
1		MEMS Introduction	
2		MEMS Microfabrication Technology - Introduction	
		Holiday	
3		MEMS Microfabrication – Microfabrication Methods + Surface micromachining	Design teams assigned
4		MEMS Microfabrication – Next Generation Lithography, Process Integration	
5		Mask Layout using MEMS CAD.	Review paper topic due
6		Physics of MEMS – Scaling Laws, Heat Transfer, Mechanics, and Electrostatics.	
7		Mask Layout using MEMS CAD – Lab Class 1	
8		Mid-Term 1	Review paper progress report
9		Mask Layout using MEMS CAD – Lab Class 2	
10		Microfluidics	Design project abstract due
11		Engineering in Microfluidics	
12		Materials for MEMS – Silicon, Silicon Oxide, Silicon Nitride, Metals, Polymers.	Review paper due. Design project progress report due
13		Packaging and Electronic Interface Design	
14		Clean Room Visit @ SD	
15		MEMS Design Application – Accelerometer & Gyroscopes (IMU)	
16		MEMS Design Application – RF MEMS	
17		MEMS Design Application – BioMEMS (Possibly a Guest Lecturer)	
16		Design Project Presentation	Design Presentation and Poster due