

**Department of Biomedical Engineering**  
**BME 479-001 – Introduction to Microfabrication of Bio Micro-Electro-Mechanical Systems (BioMEMS)**

**Description:**

The goal of the course is to provide students with the basic techniques for the microfabrication of biomedical micro-electro-mechanical devices (BioMEMS) and integrated systems. The course introduces the student to the silicon microelectronics technologies, photolithography, chemical etching, thin film depositions, diffusion, ion implantation, wafer bonding, hot embossing/injection molding using silicon microfabricated templates and some characterization techniques.

**Prerequisites:** Chem 125, Chem 126, Phys 111, Phys 121, senior standing, and permission of instructor

**Co requisite:** none

**Textbook(s)/Materials Required:**

“Introduction to Microfabrication”, Sami Fransila, Class lecture notes

**Objectives:**

1. Provide basic ideas about the design, principle of operation, and fabrication techniques of miniaturized biomedical devices, simple integrated circuits, and bioMEMS using microelectronics technologies such as thin films, photolithography, chemical etching, wafer bonding, diffusion, and ion implantation.
2. Stimulate development of research and critical thinking skills while developing an understanding of principles of device design, miniaturization, micro- and nano-fabrication using cleanroom technologies.
3. Develop multi-disciplinary skills involving biomedical devices design, electrical engineering, chemistry of silicon, glass, metal, polymer, and ceramic materials used for the fabrication of bioMEMS as well some elements of the device solid state physics.

**Topics:**

Miniaturization of biomedical devices  
Silicon, glass, polymer, and ceramic wafers  
Chemical etching of bulk materials and thin films  
Photolithography  
Ion implantation and Diffusion  
Oxidation of silicon wafers  
Thin film deposition using chemical vapor deposition techniques  
Metallization using sputtering and electron beam evaporation  
Wafer bonding  
Characterization methods for testing materials and devices  
Basic concepts of design and fabrication of bioMEMS  
Market and economics of the fabrication of miniaturized devices for biomedical application

**Schedule:** 2 hour lecture; twice per week

**Professional Component:** Biomedical Engineering Core Topics

**Prepared By:** Prof. Dentcho Ivanov **Date:** 6/20/07

Performance Criteria	Specific Activity During the Course	Assessment Methods/Metrics
<b>Course Objective 1:</b> Provide basic ideas about the design, principle of operation, and fabrication techniques of miniaturized biomedical devices, simple integrated circuits, and bioMEMS using microelectronics technologies such as thin films, photolithography, chemical etching, wafer bonding, diffusion, and ion implantation.		
J-2) Demonstrate broad and contemporary knowledge to evaluate important implications of a biomedical engineering application/solution.	Study various microelectronics fabrication processes and identify appropriate methods for the fabrication of miniaturized biomedical devices.	Process Flow Design, Home Work, Class Work
K-2) Demonstrate the ability to use modern technology and/or instrumentation in engineering.	Competitive analysis and identifying microfabrication techniques that will affect the performance of a biomedical sensor including selectivity, sensitivity, response time, dynamic range, cost, safety, testing with animals or human subjects.	Constraint Analysis, Traveler Development
O-1) Demonstrate the ability to critically analyze an existing or proposed biomedical engineering device/material/system based on the assessment of known and potential interactions between a non-living material and living tissues.	Develop the process flow, select base materials appropriate for the microfabrication, analyze cleanroom compatibility, safety, and contamination issues, discuss in class figures of merit, and device performance	Final Contract Book, Competitive Analysis
<b>Course Objective 2:</b> Stimulate development of research and critical thinking skills while developing an understanding of principles of device design, miniaturization, micro- and nano-fabrication using cleanroom technologies.		
C-3) Demonstrate the ability to test the proposed design solution to determine if it meets the required needs.	Analysis of specific microfabrication operations, design and optimize photolithography masks, select methods for thin film deposition and patterning.	Homework essay, Discussions in Class, Tests
E-2) Present a suitable solution and/or logical answer to an engineering problem.	Prepare travelers involving microfabrication processes for the fabrication of an integrated biomedical sensor, calculate etch and deposition rates, evaluate silicon wafer parameters	Competitive Analysis, Individual work with a traveler, Masks layouts presentataion
<b>Course Objective 3:</b> Develop multi-disciplinary skills involving biomedical devices design, electrical engineering, chemistry of silicon, glass, metal, polymer, and ceramic materials used for the fabrication of bioMEMS as well some elements of the device solid state physics.		
M-1) Demonstrate the ability to model physiological or biological systems using math, science and engineering concepts to gain an advanced understanding of living systems.	Analysis of microfabricated integrated devices used in biological systems involving basic systems such as optical waveguides, electromechanical resonant systems, electrochemical sensors, piezoelectric actuators, microfluidic systems, and ICs.	Presentation evaluation sheet, Teamwork, Final Contract Book
I-2) Demonstrates the ability to self educate.	Perform some research of scientific articles related to BioMEMS microfabrication, evaluate the process, and discuss alternative methods of fabrication	Instructor's Presentation evaluation sheet
G-2 Present written communication of tech info/data	Technical writing skills	Homework essay
I-1 Recognize need to update knowledge/skills	Professional meeting attendance and identification of skills to acquire	Career Skills and Networking assignment