Course No.: 10420NEMS5101

Microsensor and Microinstrument System

Spring 2016

Instructor:
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Lecture:
Rm. 301, Delta Bldg., Thursday 9:00am – 12:00pm

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Course Description:

This course and NEMS5100 (i.e., Micro & Nano Technology) would form a series to deal with the general area of NEMS and integrated microsystems. Specially, this course covers more advanced topics and conditioning circuits of microsensors/actuators to the fundamental knowledge of NEMS5100. NEMS5100 is offered in Fall terms and introduces students to the rapidly emerging, multidisciplinary techniques, including planar thin-film process technologies, photolithographic techniques, deposition and etching techniques, and the other technologies that are crucial to NEMS/MEMS fabrication. Fundamentals of sensing and transduction mechanisms (i.e., conversion of non-electronic signals to electronic signals), design and analysis of micromachined miniature sensors and actuators using these techniques are also partially covered in NEMS5100.

This course, NEMS5101, would cover more advanced topics dealing with NEMS/MEMS technologies, transduction mechanisms (such as thermal, piezoresistive, capacitive, piezoelectric transduction), microfabricated sensors, and conditioning circuit design and measurement. Among the contents, transduction techniques, including resonant, tunneling, electromagnetic, and others might be presented (to the extent permitted by time availability). In addition, the course also reviews different types of sensors for measurement and circuitry readouts of physical parameters such as acceleration, rotation rate, pressure, as well as chemical and gaseous parameters for gas and chemical sensing applications.

Three hands-on lab practicing will be offered to students using the Electronics Lab facility of iNEMS to provide students physical instrumentation on piezoresistive, capacitive, and piezoelectric transducers taught in the class, therefore benefiting their experimental skills.

The design project is an important part of this course. It is carried out by each student who develops, simulates, and designs a device and testing configuration of his/her choice, and present the findings in a technical paper. Finite element simulations (such as ANSYS, Comsol Multiphysics, or CoventorWare) as well as circuit simulators (SPICE, Cadence, or ADS) would be practiced and used by students throughout the whole semester and would be an important part of student's design project.

Tentative Outline:

Week	**Lecture Date**	**Lecture**
1	**2/18**	**Introduction (Motivations and Examples)**
2	**2/25**	**Piezoresistive Transducers and Examples I**
3	**3/3**	**Piezoresistive Transducers and Examples II**
4	**3/10**	**Electro-Thermal Transducers I**
5	**3/17**	**Electro-Thermal Transducers II**
6	**3/24**	**Electro-Thermal Transducers III (Lab I)**
7	**3/31**	**Capacitive Transducers and Examples I**
8	**4/7**	**Capacitive Transducers and Examples II**
9	**4/14**	**Capacitive Transducers and Examples III (Lab II)**
10	**4/21**	**Micromachined Motion Sensors**
11	**4/28**	**Midterm Exam**
12	**5/5**	**Design Project Midterm Presentation**
13	**5/12**	**No Class due to 2016 IEEE IFCS**
14	**5/19**	**Piezoelectric Transducers I**
15	**5/26**	**Piezoelectric Transducers II (Lab III)**
16	**6/2**	**Microfluidics**
17	**6/9**	**No Class due to Dragon Boat Festival**
18	**6/16**	**Design Project Final Presentation**

Textbook:

(1) Class Notes.

References – Books:

(1) "Microsystem design," Stephen D. Senturia, Kluwer Academic Publishers, 2000.

(2) "Sensors and Signal Conditioning", R. Pallas-Areny and J. G. Webster, 2nd edition, John Wiley and Sons, Inc.
(3) "AIP Handbook of Modern Sensors," J. Fraden, AIP, 1993.

Prerequisite:

While there is no specific course prerequisite, students should be aware that this course is not fully self-contained, i.e., students lacking background will have to do some reading on their own. Basic knowledge of microelectronics and microfabrication techniques will definitely be helpful. In particular, the students should have some level of familiarity with topics such as IC fabrication technologies (diffusion, oxidation, ion implantation, lithography); basic opamp concepts (biasing, offset, voltage gain, input and output impedance, transconductance amplifier, adder, differentiator, and integrator). However, I would like to encourage students having non-EE background to take this course and you would find out it is very useful if you have multidisciplinary knowledge for your future career.

Grading Policy: (subject to revision)

Homework 20%, Lab 10%, Midterm 30%, Design Project 40%