BME581/ECE526/ME597
Fundamentals of MEMS and Micro-Integrated-Systems
Spring 2020

Instructor: Prof. Chi Hwan Lee
Contact Info: lee2270@purdue.edu, Tel: 7654946212
Lecture Info: TBD
Office Hours: By appointment, MJIS 2086

Prerequisite:
Sr. or Graduate standing plus consent of instructor; Calculus and Differential Eq., Fundamentals of Physics (Mechanics, Optics, Electricity and magnetism), Fundamentals of Inorganic Chemistry.

Textbooks:
- Stretchable Electronics, Takao Someya, WILEY-VCH. ISBN: 978-3-527-32978-6 (2013). (This book is available to download free in Purdue library. Handouts will be distributed when lecture topics are not included in the book.)

Handbooks (Optional):

Course Descriptions:
Key topics in micro-electro-mechanical systems (MEMS) and micro-integrated system will be presented. Properties of useful materials will be discussed in context to MEMS and BioMEMS. Micro-electronics process modules used in the design and fabrication of MEMS and micro-integrated systems will be presented. Applications of these systems in a variety of sensors and transducers for broad ranges of implantable biomedical applications will be described. Recent advances in wearable biomedical applications of MEMS and bioMEMS will also be discussed in detail.

On Line Resources: Blackboard will be used to communicate, track grades, post lectures (when available), document assignments, and updates to readings. Please check Blackboard often.

Course Outcomes: Upon completion of the course each student will be able to
1. Determine appropriate materials and fabrication procedures to construct MEMS and BioMEMS devices that can be used for implantable or wearable biomedical applications.
2. Apply appropriate structural layouts and mechanics to design MEMS and BioMEMS devices.
**Academic Conduct:** You are expected to behave in a professional and ethical manner. Plagiarism or cheating will result in a zero for that particular assignment. If an individual behaves unethically during the semester, the instructor reserves the right to fail the student. For more information, see Purdue University Student Conduct Code at: [http://www.purdue.edu/odos/administration/codeconduct.htm](http://www.purdue.edu/odos/administration/codeconduct.htm).

**Grading:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Attendance</td>
<td>10%</td>
</tr>
<tr>
<td>4 Homework Assignments</td>
<td>20%</td>
</tr>
<tr>
<td>Midterm</td>
<td>30%</td>
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<tr>
<td>Final Project</td>
<td>40%</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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**Grade Scale:** The following grading scale is just for your reference. Based upon ensemble class performance, final grades will be curved up by the instructor if appropriate. The instructor will update on how to curve up the grades after each exam. Students are welcome to discuss his/her progress with the instructor throughout the semester.

- >95%     A+
- 90-95%   A
- 87-90%   A-
- 85-87%   B+
- 80-85%   B
- 78-80%   B-
- 75-78%   C+
- 70-75%   C
- 65-68%   C-
- 60-65%   D
- <60      F

**Campus Disruption**

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. In such an event, information will be provided through Blackboard Learn.

**Homework:** Four homework assignments will be evenly distributed throughout the semester. All assignments MUST be submitted with hardcopies at the start of the class lecture. *No late assignments will be accepted unless specific arrangements are made.* Students are required to complete the homework independently. Students are requested to submit clear and complete solutions. The homework will be evaluated mainly based on the correctness and completeness of the solutions. Clarity is also an important factor. Students will be asked to take full responsibility for any detected plagiarism.
**Midterm:** Midterm exam is intended to assess the understanding and integration of the course materials from lectures. This allow you to think about theories discussed in class and consider their applications in biomedical devices.

**Final project:** A final project will require you to integrate and apply knowledge and skills obtained throughout the course to investigate an area of MEMS and BioMEMS and their novel applications in biomedical devices. These projects will be completed over the last month of the course. A formal presentation of the findings will be presented to the class during the final week(s) of lectures. The final presentations will be evaluated by your peers, and the instructor for clarity, logical progression, in-depth understanding, correctness and significance of findings, in such order. The final project report (5 pages in maximum including figures, 12 pts, Times New Roman, double-spacing, references cited in the last page which is not included in the page limit) will be evaluated by instructor.

**Regrade Policy:** Students have the right to contest any grades throughout the semester. In the event that a student feels an assignment has been inappropriately graded, the student must provide a clear explanation for the regrading submission along with the original assignment. Students have 1 week after the return of a graded assignment to protest a grade; after this time grade disputes will not be accepted.

**Online Evaluation:** During the last two weeks of the semester, you will be provided an opportunity to evaluate this course and your instructor(s). To this end, Purdue has transitioned to online course evaluations. On Monday of the fifteenth week of classes, you will receive an official email from evaluation administrators with a link to the online evaluation site. You will have two weeks to complete this evaluation. Your participation in this evaluation is an integral part of this course. Your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system and will provide to-be-determined incentive.

**Tentative Course Outline and Schedule (This can be modified throughout the semester):**

- Introduction to MEMS/BioMEMS (I)
- Introduction to MEMS/BioMEMS (II)
- Materials for MEMS/BioMEMS (I)
- Materials for MEMS/BioMEMS (II)
- Micro/Nano-Positioning/Manipulation (I) (HW1 Issued)
- Micro/Nano-Positioning/Manipulation (II)
- MEMS Process: Microfabrication Technology
- MEMS Process: Photolithography (HW1 Due)
- MEMS Process: Deposition and Doping I
- MEMS Process: Deposition and Doping II (HW2 Issued)
- MEMS Process: Etching
- Polymer MEMS I
- Polymer MEMS II (HW2 Due)
Midterm
Spring Break
Soft MEMS and Robotics
Flexible MEMS I: Transfer Printing Methods
Flexible MEMS II: Modern Transfer Printing Methods
Wearable MEMS I: Materials and Design Layouts
Wearable MEMS II: Fabrications and Applications
Mechanics Design for MEMS Devices (Final Project Issued)
Biomimetic MEMS
Skin-mountable MEMS Devices: Basics
Skin-mountable MEMS Devices: Clinical Implementations
Implantable MEMS Devices: Basics
Implantable MEMS Devices: Clinical Implementations
Energy Harvesting for BioMEMS
BioMEMS Case Studies I
BioMEMS Case Studies II
Final Project