I. Course Objectives

Upon successful completion of this course, you will be able to:
  • explain the physical mechanisms and relative advantages of the fabrication techniques commonly used to create micro-/nano- devices;
  • describe the leading mechanisms used for sensing and actuating at the small scale;
  • analyze the performance aspects of microdevices with mechanical, biological, aero/astro-nautical, chemical, optical, electrical, and/or fluidic functionality;
  • understand current and emerging applications of microsystems technologies; and
  • design a microdevice, including development of a reasonable route for fabrication.

II. Instructor

Professor Joshua Hertz
Spencer Labs 329
302-831-2778
hertz@udel.edu
Office hours: M, W 1 – 2; other times by appointment; “open door policy”

III. Class Sessions

Mondays, Wednesdays, and Fridays from 3:35 – 4:25 in ISE Lab Room 207.
Attendance is expected at all sessions in order to participate in group work.

IV. Course Description†

This course uses a problem-based learning (PBL) format. A series of problems will be posed to you throughout the semester. For each problem, you will work in a small group to formulate a solution and present it in written and oral formats. You will identify the many topics that you need to learn (“learning issues”), you will discover the answers outside of class using reputable references, and then you will use these to craft a unique solution. Most of our class time will be devoted to discussion and discovery within permanent groups of about 4 students. Brief descriptions of the context of each problem and lists of instructor-generated learning issues provide intellectual continuity and assure that we address the major objectives of the course. The problems have been planned and designed to help you achieve a breadth of knowledge in microsystems.

The mark of a professional scientist or engineer is to be able to approach a new, open-ended technical problem and deliver a quantitative solution on time and with sufficient data to corroborate your claims. Often, we don't even know what the solution should look like when we start working. As will happen in your future career, in this class you will not be given enough information to solve the problems, nor will any of the problems have a “right answer.” There will be an infinite number of good solutions, and the “correct” ones are simply the ones that you can successfully defend against reasonable critique. In this course, you will learn a lot about microsystems, but more importantly you will learn to apply your past education and experience to new areas. To do this, we will consider devices that you have probably never built, seen, or even really thought about, but that you no doubt rely upon for your entertainment, communication, safety, and health every day of your life.

V. Communications

A class email list and website is set up using Sakai. Official announcements will be communicated and resources will be distributed using these tools. In-person and electronic communication with the instructor is strongly encouraged (email replies are guaranteed within 72 hours, but not necessarily sooner).

VI. Academic Honesty

Discussions between classmates and the properly cited use of academic-quality reference material are strongly encouraged. Plagiarism—any unattributed use of another’s work—is forbidden. Suspected instances of academic dishonesty will be dealt with according to UD policy (see www.udel.edu/judicialaffairs/ai.html).

VII. Texts

Required text:

**Introductory MEMS: Fabrication and Applications** (ISBN 0387095101)
Provided at: www.springerlink.com/content/978-0-387-09510-3/contents/

A number of other useful books are located in the library in sections TK7875 and TK7836. A wide range of introductory textbooks in Physics, Chemistry, Materials Science, and Biology would be useful. During class, texts will be available for loan. In addition, an Internet connection would be useful for quick reference (e.g., Wikipedia).

Journals (with electronic access on campus):

VIII. Grades

Project Primers (5 * 5%):
On the first day of each project, you will submit a written solution to an engineering estimation problem that anticipates the group project topic.

Peer Analyses (5 * 2%):
On the fifth day of each group project, your group will analyze a complete draft of another group’s memo. After the class, your group will draft and send an analysis email with recommendations for improvement.

Group Projects (5 * [6% written + 3% oral]):
On the final day of each group project, your group will submit for grade an extended memo and give an ~5 minute summary presentation to the class.

Individual Quiz (10%):
A quiz will consist of a single problem with an open-response format. Any notes, books, on-line references, etc. may be used. A calculator will be needed.

Group Quiz (10%):
A group quiz will be given with a format similar to the individual quiz.

IX. Course Schedule

<table>
<thead>
<tr>
<th>Day(s)</th>
<th>Topics</th>
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<tbody>
<tr>
<td>Aug. 28</td>
<td>Introduction, Group Estimation Activities</td>
</tr>
<tr>
<td></td>
<td>Topic Overview</td>
</tr>
<tr>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Sept. 2</td>
<td>No class (Labor Day)</td>
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<tr>
<td>4, 6, 9, 11, 13, 16, 18</td>
<td><strong>Project 1:</strong> Can a Diving Board Detect Cancer? <em>(scaling laws)</em></td>
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<tr>
<td>20, 23</td>
<td><strong>Project 2:</strong> If You Build It, They Will Hum <em>(microfabrication)</em></td>
</tr>
<tr>
<td>25, 27</td>
<td>Photolithography Hands-On; Clean Room Tour</td>
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<tr>
<td>30, Oct. 2, 4, 7, 9</td>
<td><strong>Project 2</strong>, cont’d.</td>
</tr>
<tr>
<td>11</td>
<td>Individual Quiz</td>
</tr>
<tr>
<td>14, 16, 18, 21, 23, 25, 28</td>
<td><strong>Project 3:</strong> What’s the Sense in That? <em>(sensors)</em></td>
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<tr>
<td>30, Nov. 1, 4, 6, 8, 11, 13</td>
<td><strong>Project 4:</strong> Me and My Nano-Army <em>(actuators &amp; power)</em></td>
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<tr>
<td>15, 18, 20, 22, 25</td>
<td><strong>Project 5:</strong> Some Like It Hot <em>(thermal &amp; chem/bio transduction)</em></td>
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<tr>
<td>27, 29</td>
<td>No class (Thanksgiving)</td>
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<tr>
<td>Dec. 2, 4</td>
<td><strong>Project 5</strong>, cont’d.</td>
</tr>
<tr>
<td>T.B.D.</td>
<td>Group Quiz</td>
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*Primer problem due*

*Peer analysis (draft 1) due*

*Presentations to the class (final draft) due*