**ENEE 313 – Introduction to Device Physics**  
**Spring 2018**  
**University of Maryland, College Park**

**Professor**  
Neil Goldsman  
neil@umd.edu  
AVW 2307  
301-405-3648  
240-432-6535 (Cell)  
Office Hours: See Class Website  
Also, by appointment; please don’t hesitate to call or email me. If I’m not swamped, I will make the time to see you.

**Teaching Assistants**  
Chris Darmody  
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**Required Texts:**  
1) *Semiconductor and Device Physics: A Concise Introduction*, Neil Goldsman  
   (Download from class website, no charge)  

**Class website:**  
All materials, including homework, solutions and this syllabus may be found at [http://www.ece.umd.edu/~neil/enee313](http://www.ece.umd.edu/~neil/enee313). Be sure to check the website regularly as announcements will be posted there.

**Course Description:**  
The course provides you with basic knowledge that will allow you to adapt to the rapid advances in micro and nano electronics that will occur throughout your career. As technology scales down an understanding of device physics becomes more critical to a circuit designer. (Integrated circuits with 22nm characteristic dimensions are now commercially available.) This course covers the nature and conduction processes of semiconductors followed by a detailed investigation of pn junction diodes, metal oxide field effect transistors and bipolar junction transistors.

**Course Policies:**

**Grading:**  
The points available are broken down as follows:  

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework</td>
<td>20%</td>
</tr>
<tr>
<td>Midterm 1</td>
<td>22%</td>
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<tr>
<td>Midterm 2</td>
<td>22%</td>
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<tr>
<td>Final Exam</td>
<td>33%</td>
</tr>
<tr>
<td>Class Participation</td>
<td>3%</td>
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**Homework:** Homework should be turned in on the due-date at the start of class. The HW grade counts as 20% of the overall grade. Providing a final answer without showing your thought process will result in a 0 for that question. You are allowed to collaborate on homework, but copying is not acceptable.

**Exams:** There will be three exams: two midterms and a final.
**Class Participation:** Students are encouraged to attend class, ask questions and provide feedback in both lecture and recitation section. This will count 3% toward your grade. Remember, there is no such thing as a foolish question about the course material. If you’re not sure about something, ask!

**Recitation Section:** During the discussion section the TA will work through problems, answer questions on the homework and material presented in the lecture. There may also be supplemental materials handed out during the recitation session.

**Course Topics**

1. **Course Overview & Crystal Properties**
   - Crystal structure

2. **Atoms and Electrons**
   - Bohr model
   - Intro to quantum mechanics

3. **Energy Bands and Charge carriers in semiconductors**
   - Energy bands in solids
   - Charge carriers in semiconductors and carriers concentrations
   - Drift of carriers in fields

4. **Excess carriers**
   - Luminescence and carrier lifetime
   - Drift and diffusion, built in fields
   - Recombination and the continuity equation

5. **The p-n junction and some of its properties**
   - Depletion, fields and potentials
   - Behavior of the p-n junction under applied voltage
   - Depletion capacitance
   - Diffusion capacitance
   - Current flow through the p-n junction
   - Diode equation

6. **Bipolar Junction Transistors (BJTs)**
   - BJT Physics
   - Forward current gain

7. **Metal Oxide Semiconductor Field Effect Transistors (MOSFETs)**
   - Sub-threshold behavior
   - Thresholds
   - Triode and saturated operation
   - Capacitance
   - Physical structure and scaling laws.

**Material and Textbook Sections:** Course will cover first my class notes, virtually all of my short downloadable text (*Semiconductor and Device Physics: A Concise Introduction*), and material from the textbook (Streetman and Banerjee). Textbook material is largely from sections: 1.1, 1.2, 2.1, 2.2, 2.3, 2.4, 2.5, 3.1, 3.2, 3.3, 3.4, 4.1, 4.4, 5.2, 5.3, 5.4, 6.4. The textbook should be used as a valuable reference and support material for my class notes and my text. Many homework problems will be taken from the textbook.