Electronics (I)

Course Information

Course instructor: Liang-Hung Lu 呂良鴻

Office: BL-622
Phone: 02-3366-3608
Email: lhlu@ntu.edu.tw
Lectures: Thursdays 2:20 pm to 4:20 pm; Fridays 2:20 pm to 4:20 pm
Office hour: by appointment

Course focus and format:
In this semester, we will discuss the fundamentals of signals, solid-state devices and circuit analysis/applications. Most of the lectures will refer to the chapters (1–6 and 13) of the textbook. The slides used for the class are posted and can be downloaded from the course website http://cc.ee.ntu.edu.tw/~lhlu/eeecourses.html. Reading assignment is essential for this class and will be assigned weekly. Students are supposed to finish the assigned reading before the next class meeting.

Textbook: Microelectronics Circuits 7th edition by Sedra/Smith

Prerequisite: Physics

Grading:
- Quiz 1 (homework problems): 7.5%
- Quiz 2 (homework problems): 7.5% Midterm: 35%
- Quiz 3 (homework problems): 7.5%
- Quiz 4 (homework problems): 7.5% Final: 35%

Homework:
- Introduction to Electronics:
  1.42, 1.46, 1.50, 1.66, 1.70
- Operational Amplifier Applications:
  2.7, 2.18, 2.23, 2.24, 2.32, 2.39, 2.47, 2.65, 2.70, 2.76, 2.80, 2.104, 2.108, 2.112, 2.115, 13.35, 13.41, 13.46, 13.47, 13.53, 13.61, 13.63, 13.64
- Semiconductors and Diodes:
- MOSFETs and Transistor Amplifiers:
  5.11, 5.17, 5.19, 5.40, 5.45, 5.49, 5.50, 5.52, 6.6, 6.9, 6.22, 6.27, 6.30, 6.57, 6.62, 6.71, 6.85, 6.94, 6.110, 6.112
- BJTs and Transistor Amplifiers:
  4.26, 4.30, 4.46, 4.52, 4.55, 4.59, 6.118, 6.120, 6.121
- Building Blocks of Integrated-Circuit Amplifiers
  7.6, 7.8, 7.44, 7.45, 7.50, 7.51, 7.69, 7.74, 7.83, 7.86
## Course Outline

1. **Introduction to Electronics**
   - Signals (Chapter 1.1)
   - Frequency spectrum of signals (Chapter 1.2)
   - Analog and digital signals (Chapter 1.3)
   - Amplifiers (Chapter 1.4)
   - Circuit models for amplifiers (Chapter 1.5)
   - Frequency response of amplifiers (Chapter 1.6)

2. **Operational Amplifier Applications**
   - The ideal op amp (Chapter 2.1)
     
     **Amplifier Applications**
     - The inverting configuration (Chapter 2.2)
     - The noninverting configuration (Chapter 2.3)
     - Difference amplifiers (Chapter 2.4)
     - Integrators and differentiators (Chapter 2.5)
     - Effect of finite open-loop gain and bandwidth (Chapter 2.7)
     - Large-signal operation of op amp (Chapter 2.8)
     
     **Filter Applications**
     - First-order and second-order filter functions (Chapter 13.4)
     - The second-order LCR (Chapter 13.5)
     - Second-order active filters based on inductor replacement (Chapter 13.6)
     - Second-order active filters based on two-integrator-loop biquad (Chapter 13.7)
     - Single-amplifier biquadratic active filter (Chapter 13.8)

3. **Semiconductors and Diodes**
   - Intrinsic semiconductors (Chapter 1.7)
   - Doped semiconductors (Chapter 1.8)
   - Current flow in semiconductors (Chapter 1.9)
   - The pn junction (Chapter 1.10)
   - The pn junction with an applied voltage (Chapter 1.11)
   - Capacitive effects in the pn junction (Chapter 1.12)
   - The ideal diode (Chapter 3.1)
   - Terminal characteristics of junction diodes (Chapter 3.2)
   - Modeling the diode forward characteristics (Chapter 3.3)
   - Operation in the reverse breakdown region – Zener diodes (Chapter 3.4)
   - Rectifier circuits (Chapter 3.5.1-3.5.3)
4. **MOS Field Effect Transistors (MOSFETs) and Transistor Amplifiers**
   - Device structure and physical operation (Chapter 5.1)
   - Current-voltage characteristics (Chapter 5.2)
   - MOSFET circuits at DC (Chapter 5.3)
   - Basic amplifier principles (Chapter 6.1 MOSFET part)
   - Small-signal operation and models (Chapter 6.2 MOSFET part)
   - Basic configurations (Chapter 6.3 MOSFET part)
   - Biasing (Chapter 6.4 MOSFET part)
   - Discrete-circuit amplifiers (Chapter 6.5 MOSFET part)

5. **Bipolar Junction Transistors (BJTs) and Transistor Amplifiers**
   - Device structure and physical operation (Chapter 4.1)
   - Current-voltage characteristics (Chapter 4.2)
   - BJT circuits at DC (Chapter 4.3)
   - Basic amplifier principles (Chapter 6.1 BJT part)
   - Small-signal operation and models (Chapter 6.2 BJT part)
   - Basic configurations (Chapter 6.3 BJT part)
   - Biasing (Chapter 6.4 BJT part)
   - Discrete-circuit amplifiers (Chapter 6.5 BJT part)

6. **Building Blocks of Integrated-Circuit Amplifiers**
   - IC design philosophy (Chapter 7.1 MOSFET part)
   - The basic gain cell (Chapter 7.3 MOSFET part)
   - The common-gate amplifier (Chapter 7.4 MOSFET part)
   - The cascade amplifier (Chapter 7.5 MOSFET part)
   - IC biasing (Chapter 7.2 MOSFET part)
   - Current-mirror circuits with improved performance (Chapter 7.6 MOSFET part)
## Tentative Schedule (Fall, 2018)

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topics</th>
<th>Reading Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>09/13, 14</td>
<td>Introduction</td>
<td>Ch 1.1-1.6</td>
</tr>
<tr>
<td>2</td>
<td>09/20, 21</td>
<td>Op Amp</td>
<td>Ch 2.1-2.4</td>
</tr>
<tr>
<td>3</td>
<td>09/27, 28</td>
<td>Op Amp</td>
<td>Ch 2.5, 2.7, 2.8, Ch 13.4</td>
</tr>
<tr>
<td>4</td>
<td>10/04, 05</td>
<td>Op Amp</td>
<td>Ch 13.5-13.6</td>
</tr>
<tr>
<td>5</td>
<td>10/11, 12</td>
<td>Op Amp</td>
<td>Ch 13.7-13.8</td>
</tr>
<tr>
<td>6</td>
<td>10/18, 19</td>
<td>Semiconductors/Diodes</td>
<td>Ch 1.7-1.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quiz 1 (10/19)</strong></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>10/25, 26</td>
<td>Diodes</td>
<td>Ch 3.1-3.3</td>
</tr>
<tr>
<td>8</td>
<td>11/01, 02</td>
<td>Diodes</td>
<td>Ch 3.4-3.5.3</td>
</tr>
<tr>
<td>9</td>
<td>11/08, 09</td>
<td><strong>Mid-term Exam (11/09)</strong></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>11/15, 16</td>
<td>MOSFETs</td>
<td>Ch 5.1-5.3</td>
</tr>
<tr>
<td>11</td>
<td>11/22, 23</td>
<td>MOSFETs</td>
<td>Ch 6.1-6.3 (MOS part)</td>
</tr>
<tr>
<td>12</td>
<td>11/29, 30</td>
<td>MOSFETs</td>
<td>Ch 6.4-6.5 (MOS part)</td>
</tr>
<tr>
<td>13</td>
<td>12/06, 07</td>
<td>BJTs</td>
<td>Ch 4.1-4.3</td>
</tr>
<tr>
<td>14</td>
<td>12/13, 14</td>
<td>BJTs</td>
<td>Ch 6.1-6.5 (BJT part)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quiz 2 (10/14)</strong></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>12/20, 21</td>
<td>IC Building Blocks</td>
<td>Ch 7.1-7.2 (MOS part)</td>
</tr>
<tr>
<td>16</td>
<td>12/27, 12/28</td>
<td>IC Building Blocks</td>
<td>Ch 7.3-7.4 (MOS part)</td>
</tr>
<tr>
<td>17</td>
<td>01/03, 04</td>
<td>IC Building Blocks</td>
<td>Ch 7.5-7.6 (MOS part)</td>
</tr>
<tr>
<td>18</td>
<td>01/10, 11</td>
<td><strong>Final Exam (01/11)</strong></td>
<td></td>
</tr>
</tbody>
</table>