

Electronics (I)

Course Information

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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/eecourses.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:

1.79, 1.85, 3.4, 3.10, 3.21, 3.29, 3.36, 3.40, 3.45, 3.48, 3.52, 3.53, 3.57, 3.60, 3.67, 3.71, 3.81

■ 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)

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