

**ECE 342**  
**Electronics I**  
Department of Electrical and Computer Engineering  
The University of Maine  
Fall Semester 2017

## Electronics I

Course Number: ECE 342

Credits: 4

Lecture: 12:00 - 12:50 pm, Monday, Wednesday, and Friday, 119 Barrows Hall

Lab: 2:00 - 4:50 pm, Monday, Tuesday, Wednesday and Thursday, 224 Barrows Hall

Recitation: 5:00 - 7:50, Monday, 125 Barrows Hall

Prerequisites: ECE 210 Electric Circuits (grade  $\geq C^-$ ) and ECE 214 Electric Circuits Laboratory

Corequisite: ECP 342 Engineering Communication Program II

Course Website: <http://web.eece.maine.edu/kotecki/ECE342>

## Instructor

Dr. David E. Kotecki

Office: 277 Barrows / ESRB

Office Hours: 10:00 - 11:00 am Monday and Wednesday; 1:00 - 2:00 pm Tuesday and Thursday

Tel: 207 581-2248

e-mail: [kotecki@maine.edu](mailto:kotecki@maine.edu)

## Teaching/Laboratory Assistants

Thomas Leighton (e-mail: [thomas.leighton@maine.edu](mailto:thomas.leighton@maine.edu))

Spencer Desrochers (e-mail: [spencer.desrochers@maine.edu](mailto:spencer.desrochers@maine.edu))

Ahmed Almaghasilah (e-mail: [ahmed.almaghasilah@maine.edu](mailto:ahmed.almaghasilah@maine.edu))

Christopher Santos (e-mail: [christopher.santos@maine.edu](mailto:christopher.santos@maine.edu))

## Text Book

Title: [Microelectronic Circuits \(7th edition\)](#)

Authors: Adel S. Sedra and Kenneth C. Smith

Publisher: Oxford University Press

Year: 2015

ISBN: 978-0-19-933913-6

## Engineering Notebook

All students must have and maintain a proper “Engineering Notebook.” The engineering notebook should be used to record all calculations, preliminary and final designs, circuit simulation schematics and results, measured data, graphs, and analysis pertaining to the laboratory experiments.

## Goals

This is the first of a six course sequence in electronic design, integrated circuit design, and testing. You will acquire the fundamental tools to analyze, design, build and test basic analog and digital electric circuits containing diodes, MOSFETs, and BJTs.

## Calculators

It is strongly recommended that you have a calculator capable of solving simultaneous linear equations with complex variables. Calculators may be used when solving homework problems and taking exams. The most popular calculators are the TI-89, TI-89 Titanium, and the TI Nspire CX CAS. If you do not own one of these calculators, try to borrow one for use during the examinations.

## Electronic Test Equipment

The Digilent “Analog Discovery 2” 100 MS/sec oscilloscope, function generator, and logic analyzer, the BNC adapter board, a pair of BNC oscilloscope probes, and a dual-output 12 V ( $\pm 100$  mA) PowerBrick are required for the laboratory portion of this course. Instructions for ordering the test equipment and obtaining the student discount are described at: <http://web.eece.maine.edu/kotecki/ECE342/docs/Digilent>.

The “Waveforms” data acquisition software is used in conjunction with the Digilent “Analog Discovery 2” test equipment. The software is available for Windows, Mac OS X, and Linux. You should download the “Waveforms” software onto your laptop from the Digilent website: <https://reference.digilentinc.com/reference/software/waveforms/waveforms-3/start>.

## Circuit Simulation and Data Analysis

NGspice ([http://www.cppsim.com/about\\_ngspice.html](http://www.cppsim.com/about_ngspice.html)) will be used to perform circuit simulations. NGspice is an open source multi-platform circuit simulator. Everyone should install the NGspice simulator, the Sue2 schematic capture program and the NGspice Matlab<sup>®</sup> toolbox on their laptop. The easiest way to obtain the software is to install the CppSim package from <http://www.cppsim.com/download.html>.

Matlab<sup>®</sup> (version 2017a) will be used with the NGspice circuit simulator and the “Waveforms” data acquisition software for data analysis and graphing. Matlab<sup>®</sup> by MathWorks (<http://www.mathworks.com/>) is a multi-platform numerical computing environment and a programming language used for technical computing. The University of Maine provides a free Matlab<sup>®</sup> license to all students. Download Matlab<sup>®</sup> from <https://umaine.edu/it/software/matlab>.

## Homework

The homework problems are located at the end of each chapter of the textbook. The assigned homework problems are listed below. Place your solutions to the homework problems in the box labeled “ECE 342 Homework” located in Al Whitney Electronics Laboratory, 224 Barrows Hall. All homework must be submitted no later than 4:50 pm on the due date. Late homework is not normally accepted.

Not all homework problems will be graded. Only a selected number of problems from each assignment will be corrected and used to determine your homework grade. The homework score will be based on the correct method and the correct answer. Circle your final answers and be neat!

You may work on the homework problems individually or with other students in the class. You are encouraged to work together and discuss your solutions. Each student is required to submit their own homework solutions.

| <b>Homework</b> | <b>Due Date</b> | <b>Problems</b>  |
|-----------------|-----------------|--|
| #1              | 6 Sept. 2017    | 1.6, 1.10, 1.12, 1.14, 1.15, 1.19, 1.22, 1.24, 1.30, 1.35                                |
| #2              | 13 Sept. 2017   | 1.39, 1.44, 1.47, 1.50, 1.63, 1.68, 2.15, 2.25, 2.28, 2.45                               |
| #3              | 20 Sept. 2017   | 2.53, 2.57, 2.67, 2.72, 2.76, 2.83, 2.95, 2.104, 2.121, 2.123                            |
| #4              | 4 Oct. 2017     | 3.2, 3.3, 3.7, 3.11, 3.14, 3.16, 3.20, 3.23, 3.25, 3.27                                  |
| #5              | 11 Oct. 2017    | 4.2, 4.5, 4.10, 4.11, 4.16, 4.21, 4.26, 4.41, 4.45, 4.54                                 |
| #6              | 18 Oct. 2017    | 4.59, 4.62, 4.64, 4.75, 4.76, 4.85, 4.87, 4.88, 4.92, 4.96                               |
| #7              | 1 Nov. 2017     | 5.2, 5.7, 5.9, 5.14, 5.17, 5.21, 5.29, 5.34, 5.38, 5.41, 5.45,<br>5.53, 5.59, 5.63, 5.66 |
| #8              | 8 Nov. 2017     | 6.2, 6.5, 6.12, 6.18, 6.29, 6.34, 6.38, 6.50, 6.56 6.57                                  |
| #9              | 15 Nov. 2017    | 6.59, 6.61, 6.62, 6.68, 6.69   |
| #10             | 29 Nov. 2017    | 7.3, 7.4, 7.6, 7.15, 7.19, 7.24, 7.28, 7.33, 7.48 7.58                                   |
| #11             | 6 Dec. 2017     | 7.61, 7.66, 7.74, 7.82, 7.84, 7.72, 7.94, 7.103, 7.106, 7.116                            |

## Laboratory

The laboratory section of ECE 342 is based on the **Optical Link Project** developed by Prof. Nuri Emanetoglu. A description of this project is available at [http://web.eece.maine.edu/kotecki/ECE342/docs/ECE342\\_2017\\_Optical\\_Link\\_Project.pdf](http://web.eece.maine.edu/kotecki/ECE342/docs/ECE342_2017_Optical_Link_Project.pdf). There are five labs associated with this project:

Lab 1: Transimpedance Amplifier

Lab 2: Active Filter

Lab 3: Digital Logic and Ring Oscillator

Lab 4: LED Driver

Lab 5: MOSFET Voltage Amplifier

Each lab develops a particular module needed for the optical link. Do not destroy the completed labs. They will be combined together at the end of the semester to form the final optical link.

Each lab requires three weeks: (i) design and simulation, (ii) implementation and testing, and (iii) final technical report. The reporting period of one lab will overlap with the design and simulation period of the following lab. The laboratory schedule is shown on page 6. The final optical link is demonstrated during the last week of classes.

Labs will be conducted by teams of two students. If there is an odd number of students in the course, one team of three students will be allowed. Each student must keep a separate engineering notebook for calculations, simulations, designs and analysis.

Lab grades are based on documentation in the Lab Notebook and technical reports describing the circuit design, simulation, and implementation. A grading metric is included in the description of each lab.

## Teaching/Laboratory Assistants

Teaching/Laboratory assistants will be available during the laboratory periods to help answer questions and sign-off on the laboratory notebooks. Each lab requires two sign-offs: one for the design and simulation and one for the implementation and testing, a demonstration of your working circuit, and two technical report submissions. Extra points are given for early sign-offs.

To obtain full credit for the lab, you must show your completed laboratory notebooks to the TA for sign-off no later than 4:50 PM on Thursday on the due week, schedule a demonstration of your working circuit for the following week, and submit a draft technical report by 2:00 PM on Monday and a final technical report by 2:00 PM on Friday of the due week. Each group will be assigned an ECP 342 TA who will help grade the reports.

## Exams

There are four exams. Each exam is two hours, closed book, and closed notes. Only a pencil, eraser, and a hand held calculator (no tablets, phones, or laptops) may be used during the exam. The first three exams are held during the recitation periods and the fourth exam is during finals week.

The exams are designed to test your knowledge of fundamental concepts and your ability to apply those concepts to solve problems. It is important to learn and master the key concepts rather than memorize how to do individual problems. Problems on the exams will be similar or identical to the problems at the end of each chapter. All exam problems can be solved using the same concepts and techniques used to solve the homework problems.

Partial credit will be given when applicable. Correct answers to exam problems not supported by a correct method will not earn credit.

## Examination Dates

|             |                   |                |                  |
|-------------|-------------------|----------------|------------------|
| Exam 1:     | 25 September 2017 | 5:00 - 7:00 pm | Chapters 1 and 2 |
| Exam 2:     | 23 October 2017   | 5:00 - 7:00 pm | Chapters 3 and 4 |
| Exam 3:     | 20 November 2017  | 5:00 - 7:00 pm | Chapters 5 and 6 |
| Final Exam: | 13 December 2017  | 2:45 - 4:45 pm | Chapter 7        |

Anyone who is unable to attend class during one of the scheduled examination dates must notify the instructor prior to the exam. If you are excused from the exam for cause, a make-up exam will be offered during the last week of classes.

## Grading

|              |             |
|--------------|-------------|
| Laboratory   | 25%         |
| Homework     | 15%         |
| Exam 1       | 15%         |
| Exam 2       | 15%         |
| Exam 3       | 15%         |
| Final Exam   | 15%         |
| <b>Total</b> | <u>100%</u> |

## Letter Grade Assignment Floor

|             |     |
|-------------|-----|
| $\geq 90\%$ | A   |
| 88% – 90%   | B + |
| 80% – 88%   | B   |
| 78% – 80%   | C + |
| 70% – 78%   | C   |
| 68% – 70%   | D + |
| 60% – 67%   | D   |
| $< 60\%$    | F   |

# Laboratory, Homework, and Exam Schedule

Fall 2017

| SEPTEMBER |     |                        |      |    |          |    |
|-----------|-----|------------------------|------|----|----------|----|
| S         | M   | T                      | W    | T  | F        | S  |
| 27        | 28  | 29                     | 30   | 31 | 1        | 2  |
|           |     |                        |      |    | LB 1     |    |
| 3         | 4   | 5                      | 6    | 7  | 8        | 9  |
|           |     | L1 - Design            |      |    |          |    |
|           |     |                        | HW 1 |    |          |    |
| 10        | 11  | 12                     | 13   | 14 | 15       | 16 |
|           |     | Lab 1 - Design         |      |    |          |    |
|           |     |                        | HW 2 |    |          |    |
| 17        | 18  | 19                     | 20   | 21 | 22       | 23 |
|           |     | Lab 1 - Implementation |      |    | LB 2     |    |
|           |     |                        | HW 3 |    |          |    |
| 24        | 25  | 26                     | 27   | 28 | 29       | 30 |
|           |     | L2 - Design            |      |    |          |    |
|           |     |                        |      |    | Report 1 |    |
|           | E 1 |                        |      |    |          |    |

| OCTOBER |     |                     |          |    |          |    |
|---------|-----|---------------------|----------|----|----------|----|
| S       | M   | T                   | W        | T  | F        | S  |
| 1       | 2   | 3                   | 4        | 5  | 6        | 7  |
|         |     | L2 - Implementation |          |    |          |    |
|         |     |                     | HW 4     |    |          |    |
| 8       | 9   | 10                  | 11       | 12 | 13       | 14 |
|         |     |                     | L2 - Imp |    | LB 3     |    |
|         |     |                     | HW 5     |    |          |    |
| 15      | 16  | 17                  | 18       | 19 | 20       | 21 |
|         |     | L3 - Design         |          |    |          |    |
|         |     |                     |          |    | Report 2 |    |
|         |     |                     | HW 6     |    |          |    |
| 22      | 23  | 24                  | 25       | 26 | 27       | 28 |
|         |     | L3 - Implementation |          |    | LB 4     |    |
|         | E 2 |                     |          |    |          |    |
| 29      | 30  | 31                  |          |    |          |    |
|         |     | L4 -                |          |    |          |    |
|         |     | Report              |          |    |          |    |

| NOVEMBER |     |                     |        |    |          |    |
|----------|-----|---------------------|--------|----|----------|----|
| S        | M   | T                   | W      | T  | F        | S  |
| 29       | 30  | 31                  | 1      | 2  | 3        | 4  |
|          |     |                     | Design |    |          |    |
|          |     |                     |        |    | 3        |    |
|          |     |                     | HW 7   |    |          |    |
| 5        | 6   | 7                   | 8      | 9  | 10       | 11 |
|          |     | L4 - Implementation |        |    |          |    |
|          |     |                     | LB 5   |    |          |    |
|          |     |                     | HW 8   |    |          |    |
| 12       | 13  | 14                  | 15     | 16 | 17       | 18 |
|          |     | L5 - Design         |        |    |          |    |
|          |     |                     |        |    | Report 4 |    |
|          |     |                     | HW 9   |    |          |    |
| 19       | 20  | 21                  | 22     | 23 | 24       | 25 |
|          |     | L5 - imp.           |        |    |          |    |
|          | E 3 |                     |        |    |          |    |
| 26       | 27  | 28                  | 29     | 30 | 1        | 2  |
|          |     | L5 - Implementation |        |    |          |    |
|          |     |                     | HW 10  |    |          |    |

| DECEMBER |    |                       |              |       |              |   |
|----------|----|-----------------------|--------------|-------|--------------|---|
| S        | M  | T                     | W            | T     | F            | S |
| 26       | 27 | 28                    | 29           | 30    | 1            | 2 |
|          |    |                       |              |       |              |   |
| 3        | 4  | 5                     | 6            | 7     | 8            | 9 |
|          |    | Project Demonstration |              |       |              |   |
|          |    |                       |              |       | Report 5     |   |
|          |    |                       |              |       | Final Report |   |
|          |    |                       |              | HW 11 |              |   |
| 10       | 11 | 12                    | 13           | 14    | 15           |   |
|          |    |                       | Final Report |       |              |   |
|          |    |                       | FE           |       |              |   |

- LB - Laboratory Briefing
- HW - Homework
- E - Exam
- FE - Final Exam

## Tentative Lecture Schedule

| Class | Date          | Topics   | Sections  |
|-------|---------------|--|-----------|
| 1     | 28 Aug. 2017  | Course overview,; signals and amplifiers               | 1.1 – 1.3 |
| 2     | 30 Aug. 2017  | Amplifier circuit models and frequency response        | 1.4 – 1.6 |
| 3     | 1 Sept. 2017  | Ideal Op Amp   | 2.1       |
| 4     | 6 Sept. 2017  | Non-Ideal inverting and non-inverting Op Amp           | 2.2, 2.3  |
| 5     | 8 Sept. 2017  | Difference amplifiers; integrators and differentiators | 2.4, 2.5  |
| 6     | 11 Sept. 2017 | DC imperfections                                       | 2.6       |
| 7     | 13 Sept. 2017 | Performance: inite open-loop gain and bandwidth        | 2.7       |
| 8     | 15 Sept. 2017 | Large-signal Op Amp operation                          | 2.8       |
| 9     | 18 Sept. 2017 | Semiconductor basics                                   | 3.1, 3.2  |
| 10    | 20 Sept. 2017 | Current flow in semiconductors                         | 3.3       |
| 11    | 22 Sept. 2017 | pn junction (part 1)                                   | 3.4       |
| 12    | 25 Sept. 2017 | pn junction (part 2)                                   | 3.5       |
| 13    | 27 Sept. 2017 | Capacitive effects in the pn junction                  | 3.6       |
| 14    | 29 Sept. 2017 | Ideal diode  | 4.1       |
| 15    | 2 Oct. 2017   | Terminal characteristics of junction diode             | 4.2       |
| 16    | 4 Oct. 2017   | Models of the diode and reverse breakdown              | 4.3, 4.4  |
| 17    | 6 Oct. 2017   | Rectifier circuits                                     | 4.5       |
| 18    | 11 Oct. 2017  | Limiting and clamping circuits                         | 4.6       |
| 19    | 13 Oct. 2017  | Other diode types                                      | 4.7       |
| 20    | 16 Oct. 2017  | Introduction to MOSFET                                 | 5.1       |
| 21    | 18 Oct. 2017  | MOSFET I-V characteristics (part 1)                    | 5.2       |
| 22    | 20 Oct. 2017  | MOSFET I-V characteristics (part 2)                    | 5.2       |
| 23    | 23 Oct. 2017  | MOSFET biasing and circuits (part 1)                   | 5.3       |
| 24    | 25 Oct. 2017  | MOSFET biasing and circuits (part 2)                   | 5.3       |
| 25    | 27 Oct. 2017  | Body and temperature effects                           | 5.4       |
| 26    | 30 Oct. 2017  | Introduction to BJT                                    | 6.1       |
| 27    | 1 Nov. 2017   | BJT I-V characteristics                                | 6.2       |
| 28    | 3 Nov. 2017   | BJT biasing and circuits (part I)                      | 6.3       |
| 29    | 6 Nov. 2017   | BJT biasing and circuits (part II)                     | 6.3       |
| 30    | 8 Nov. 2017   | Breakdown and temperature effects                      | 6.4       |
| 31    | 13 Nov. 2017  | Basic amplifier principles                             | 7.1       |
| 32    | 15 Nov. 2017  | Small-signal operation and MOSFET models               | 7.2       |
| 33    | 17 Nov. 2017  | Small-signal operation and BJT models                  | 7.2       |
| 34    | 20 Nov. 2017  | CS and CE amplifiers                                   | 7.3       |
| 35    | 27 Nov. 2017  | CG and CB amplifiers                                   | 7.3       |
| 36    | 29 Nov. 2017  | CD and CC amplifiers                                   | 7.3       |
| 37    | 1 Dec. 2017   | Biasing  | 7.4       |
| 38    | 4 Dec. 2017   | Discrete circuit amplifiers (part 1)                   | 7.5       |
| 39    | 6 Dec. 2017   | Discrete circuit amplifiers (part 2)                   | 7.5       |
| 40    | 8 Dec. 2017   | Review   |           |
| 41    | 13 Dec. 2017  | Final Exam   |           |

## **Academic Honesty Statement**

Academic honesty is very important. It is dishonest to cheat on exams, to copy term papers, to submit papers written by another person, to fake experimental results, or to copy or reword parts of books or articles into your own papers without appropriately citing the source. Students committing or aiding in any of these violations may be given failing grades for an assignment or for an entire course, at the discretion of the instructor. In addition to any academic action taken by an instructor, these violations are also subject to action under the University of Maine Student Conduct Code. The maximum possible sanction under the student conduct code is dismissal from the University.

## **Students with Disabilities Statement**

If you have a disability for which you may be requesting an accommodation, contact Student Accessibility Services, 121 East Annex, 581.2319, as early as possible. Students who have already been approved for accommodations by SAS and have a current accommodation letter should provide a copy of the letter to me as soon as possible.

## **Course Schedule Disclaimer (Disruption Clause)**

In the event of an extended disruption of normal classroom activities, the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

## **Sexual Violence Policy: Sexual Discrimination Reporting**

The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell a teacher about an experience of sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct or any form of gender discrimination involving members of the campus, your teacher is required to report this information to the campus Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity.

If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

For confidential resources on campus: Counseling Center: 207-581-1392 or Cutler Health Center: at 207-581-4000.

For confidential resources off campus: Rape Response Services: 1-800-310-0000 or Spruce Run: 1-800-863-9909.

Other resources: The resources listed below can offer support but may have to report the incident to others who can help: For support services on campus: Office of Sexual Assault & Violence Prevention: 207-581-1406, Office of Community Standards: 207-581-1409, University of Maine Police: 207-581-4040 or 911. Or see the OSASP website for a complete list of services at <http://www.umaine.edu/osavp/>



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