Introduction

In this chapter first chapter of lecture material we overview the course from a high level. The following topics will be addressed:

- Course theme
- Why choose electronic projects as a general education course?
- The course syllabus
- Instructor policies
- Introduction to the tools
- Introduction to electronic circuits
- Discussion and Quiz 1
Course Theme: How We Communicate

• A course designed for non-engineering majors
• The principles of radio engineering are introduced through hands-on building and testing of radio circuits
• Compass curriculum emphasis features:
  – History,
  – Personalities,
  – Social and cultural impacts,
  – Economic and business impacts, and
  – Sustainability issues
• Approved for the Compass Curriculum requirement:
  – A navigate course
  – Advanced Core
  – Prerequisite a Freshman level science course
Why Choose This Course?

- Curiosity
  - Electronics is pervasive in today's society, and communications technology in particular is a big player
  - You are already a maker\(^1\) and want to go further

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## Maker culture

From Wikipedia, the free encyclopedia

The **maker culture** is a contemporary culture or subculture representing a technology-based extension of DIY culture\[^{citation needed}\]. Typical interests enjoyed by the maker culture include engineering-oriented pursuits such as electronics, robotics, 3-D printing, and the use of CNC tools, as well as more traditional activities such as metalworking, woodworking, and traditional arts and crafts. The subculture stresses a cut-and-paste approach to standardized hobbyist technologies, and encourages cookbook re-use of designs published on websites and maker-oriented publications.\[^{11}\] There is a strong focus on using and learning practical skills and applying them to reference designs\[^{citation needed}\].

- You have a desire to explore technology details at the ground floor with lots of **hands on**
  - You enjoy DIY
  - You enjoy *tinkering*
  - You have a specific project in mind and hope to get to the next level
  - You are fascinated by technology and need a push to dig deeper

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\(^{1}\)https://en.wikipedia.org/wiki/Maker_culture
The Course Syllabus

ECE 3001/Navi 3001/ECE3201

Electronic Projects

Fall Semester 2019: ENGR 230, 12:15–1:30 PM

Compass Curriculum Perspective

This course is a Navigate course in the Compass Curriculum. Navigate courses provide UCCS students with a common educational experience at the upper division level that broadly expands their perspective beyond their major discipline. An objective is to engage students actively in applying and integrating knowledge, which is drawn from a range of disciplines and includes advanced-level critical thinking.

An objective of Navigate courses is to promote curricular and intellectual connections between students’ coursework for the Compass Curriculum and the work they do for their academic majors, while providing students an opportunity to integrate their learning, ideally beyond their disciplinary area of study.

Navigate courses help you learn about:

- How academic knowledge and skills can be applied to solve practical problems outside of your disciplinary area of study. This is the “knowledge in action” component of the course.
- Intellectual and curricular intersections between your major coursework and other areas as a way to integrate and apply learning
- Explore what it takes to work with different types of people with different perspectives

Essential Learning Outcomes:

- Apply and integrate knowledge from a range of disciplines, including interdisciplinary or cross-disciplinary research
  - Gather, critically analyze and evaluate quantitative information within relevant disciplinary contexts
  - Gather, critically analyze and evaluate qualitative information within relevant disciplinary contexts
  - Demonstrate the core ethical principles and responsible methods of your discipline

Course Description

Designed for non-engineering majors. In the Fall semester, the principles of How We Communicate are introduced through hands-on building and testing of radio circuits. In the Spring semester, the principles of How We Control are introduced through hands-on building, programming, and testing of micro-controllers. The history, personalities, social and cultural impacts, economic and business impacts, and sustainability issues are integrated into the lecture material for the target technology. Approved for Compass Curriculum requirement: Advanced Core. Prer., Freshman level science course.

Semester Emphasis Details

This offering of Electronic Projects will emphasize analog circuit design for communication receivers. Practical experience in breadboarding radio circuits will be obtained starting from little or no experience in circuit theory. To take this course it is assumed that you have a strong desire to build and tinker with electronics. Today this is what is known as being a Maker. Throughout the course you will also gain experience with soldering. To start with, however, we will work with solder-less breadboards.
Detailed Syllabus for Fall 2019

Instructors: Dr. Mark Wickert  
Office: EN292  
Phone: 255-3500  
Fax: 255-3589

mwickert@uccs.edu  
http://www.eas.uccs.edu/wickert/ece3001/

Office Hrs: Mon/Wed 1:30–2:15 PM + other times by appointment


Grading:

1. Lab assignments involving circuit test and measurement 20%.
2. Writing exercises 15%.
3. Exams (mid and final) at 15% each, 30% total.
4. Final lab on receiver electronics leading to superheterodyne kit build 15%.
5. Superheterodyne radio kit PCB fully tested 20%.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Lect + Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction and Course Overview</td>
<td>1</td>
</tr>
<tr>
<td>2. Electronic circuit analysis and design using resistors</td>
<td>4</td>
</tr>
<tr>
<td>3. Electronic circuit analysis and design using resistors, capacitors, and inductors (passives)</td>
<td>4</td>
</tr>
<tr>
<td>4. Electronic circuit analysis and design with active elements</td>
<td>6</td>
</tr>
<tr>
<td>5. Radio electronics</td>
<td>6</td>
</tr>
<tr>
<td>6. Radio kit PCB assembly and test</td>
<td>4</td>
</tr>
</tbody>
</table>

Required Parts Kit

Purchased from the ECE department for $83.00 (see the last two pages of this document for details). This kit includes the radio kit you will assemble towards the end of the semester. The Analog Discovery is $179 additional expense.

Writing Exercises

**Paper 1**: How does radio/wireless technology affect your personal life. (Current view)
1.) How do you use it? Do you talk to fewer people face-to-face?
2.) What would happen if you could not use it?
3.) How do you see it changing/evolving in 10 years?
4.) How is using it changing your communication skills

**Paper 2**: How does radio/wireless technology affect your professional (college major) life. (Historical view)
1.) How is the technology used today?
2.) What was used before radio/wireless technology was invented?
Learning Outcomes

The expected learning outcomes of this course are: Soldering for circuit bread-
ing boarding; Ohm’s law and basic DC resistor circuits, both simulation and lab measurement/test; Resistor, inductor, and capacitors circuits, both simula-
tion and lab test using pulse signals and sinusoids; Basic radio circuits and
inductor/capacitor tank circuit resonant frequency, both simulation and lab test;
Radio frequency oscillators and mixers for AM radio, both simulation and lab
test; PCB assembly and test of an AM radio kit.

Parts Kit Details

<table>
<thead>
<tr>
<th>Lab #</th>
<th>Qty</th>
<th>Component</th>
<th>Value</th>
<th>Description/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Breadboard</td>
<td>$7.15</td>
<td>Include two Universal Express Part #H8523A 238303</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Needle nose pliers</td>
<td>$2.00</td>
<td>Include #482210</td>
</tr>
<tr>
<td>2-6</td>
<td>12</td>
<td>220-50Ω resistor</td>
<td>$0.30</td>
<td>1N5307</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>110Ω Motor</td>
<td>$0.30</td>
<td>Include Part # M6-5000</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Parts box</td>
<td>$2.00</td>
<td>Used plastic box for keeping components in. Include #H8523A 238303</td>
</tr>
</tbody>
</table>

**ECE 3001/ECE 3201 Fall 2018 Parts List**

In this list the required parts are cumulative over a series of 4 labs and the final radio kit build.

**ECE 3001 Electronic Projects**
The Course Syllabus

Important Deadlines: Review the Fall 2018 deadlines: https://www.uccs.edu/registrar/course-deadlines/fall-2018. Performance histograms (HW, Quiz, & Exams) will be discussed in class prior to the last day to drop, Friday October 26. Use this to decide on continuing or dropping the course – the deadline for dropping without ECE Chair signature (NOT the Dean as stated in the link above) is October 26. Only under extenuating circumstances will a late drop be considered.

Fall 2019 Cost $83

Lab #1 Component Value Description/Notes
Headphone Amplifier
1 Axial lead resistor 10 Ω 10% A 10% tolerance is OK too. Will be plugged into breadboard. Express Part #: 130091 $0.06 $0.06
1 Axial lead resistor 47 kΩ 5% Tolerance is OK too. Will be plugged into breadboard. Express Part #: 130054 $0.06 $0.06
1 Radial lead capacitor 10 μF 20% A 10% tolerance is OK too. $0.28 $0.28
1 Radial lead capacitor 560 μF 20% A 10% tolerance is OK too. $0.10 $0.10
1 Radial lead capacitor 10 μF 20% A 10% tolerance is OK too. $0.10 $0.10
1 2-pin DIP IC plug 1X386 $0.97 $0.97
Lab #2 Component Value Description/Notes
Final Project
1 Enesco AM/FM Radio Kit Capstone project. A complete AM/FM radio kit. Best price found to be Amazon. $29.99 $29.99

Total parts 60
Shipping and handling

Total Kit cost $74.43 $76.43

Fall 2019 Cost $83

Important Deadlines: Review the Fall 2019 deadlines: https://www.uccs.edu/registrar/course-deadlines/fall-2019. Performance histograms (HW, Quiz, & Exams) will be discussed in class prior to the last day to drop, Friday November 1. Use this to decide on continuing or dropping the course – the deadline for dropping without ECE Chair signature (NOT the Dean as stated in the link above) is November 1. Only under extenuating circumstances will a late drop be considered.
Instructor Policies

• As this is a very hands-on course, *lab demos* will be integrated along with the need to write lab reports

• Homework/Lab reports are due at the start of class

• If business travel or similar activities prevent you from attending class and turning in your home work, please inform me beforehand

• Grading is done on a straight 90, 80, 70, ... scale with curving below these thresholds if needed

• *Screencasts* of the lectures will be made available as soon as possible after each lecture; this may be of help to those of you that travel and to others for review purposes

• Homework/lab solutions, as is possible, will be posted on the course Web site as PDF documents with password protection

• Old exams and/or practice exams, as is possible, will be posted on the Web site prior to the midterm and final exams
Introduction to the Tools

- **Analog Discovery** portable laboratory test instrumentation (hardware) and the Waveforms software

USB to connect to PC

Fly leads to connect to circuit/system under test

WaveformsTM software V2 shown; V3 supports Mac & Linux
Chapter 1 • Introduction

- **LTspice (VI)** circuit analysis and modeling software

- Draft schematic, set simulation commands, Run and plot

- MS Excel or similar for simple calculations

- You may decide to invest in a small volt/ohm meter:

- Other tools, hardware and software, may creep in as deemed appropriate for the task at hand
Introduction to Electronic Circuits

• Consider a simple one transistor (common emitter) amplifier constructed on a solderless breadboard (original AD shown)

• The circuit schematic drawn in LTspice is shown below:
• So what is an amplifier?

\[ v_{in}(t) \rightarrow \text{Gain} G \rightarrow v_{out}(t) = Gv_{in}(t) \]

– An amplifier takes an input signal having a small amplitude and outputs a larger amplitude signal

– *Amplitude* refers to the strength of the signal or thinking of a music player, the loudness of the signal

• In the circuit diagram or *schematic*, the connection point for the input signal is labeled \( V_{in} \) and the output is labeled \( V_{out} \)

• As a test signal we apply a time varying sinusoid which we describe mathematically as

\[
v_{in}(t) = A_i \cos[2\pi(1000)t] = 0.2 \cos[2\pi(1000)t] \quad (1.1)
\]

• Consider the LTspice simulated input/output waveforms:

![LTspice simulated input/output waveforms](image)

The amplifier gain is approximately \(0.92/0.2 = 4.6\)

• We that the output waveform (signal) is indeed larger in amplitude than the input

\[
v_{out}(t) = A_o \cos[2\pi(1000)t + \phi]
\approx 0.92 \cos[2\pi(1000)t + \pi] \quad (1.2)
\]
– Don’t be intimidated by a little math; this is included to let you know that we can, when needed, use math modeling

• Bench testing and getting things to work is what this class is all about (writing down equations is not the focus here)

• Using the Analog Discovery we can apply a sinusoidal test waveform just like in the computer simulation

• We configure one of two waveform generators to produce a 200 mv peak amplitude sinusoid at 1 kHz

We then connect the two channel scope to the input and output test point of the circuit and observe the waveform:
The measured results look amazingly very much like what the circuit simulator predicted!

What do you think?
A Peek at What Lies Ahead

- Two significant milestones are:
  - Build a tuned radio frequency (TRF) AM radio
  - Build a superheterodyne AM (FM) radio
Quiz 1

- Finding out more about you!