ECE 401 - Senior Design I

ECE 401 Senior Design I

Week #1

Please visit Bison Academy for corresponding lecture notes,
homework sets, and videos
www.BisonAcademy.com

Course Information:

Instructor:	Jeff Erickson, Jake Glower
Class Times	We 3pm, ECE 125 & Zoom
Office Hours	Mo/Tu/We/Th 9-10am (Erickson), ECE 209
	Tu/Th 11am - noon (Glower), ECE 201 & zoom
Text:	none

On-Line Reference:
www.BisonAcademy.com

Bulletin Description:

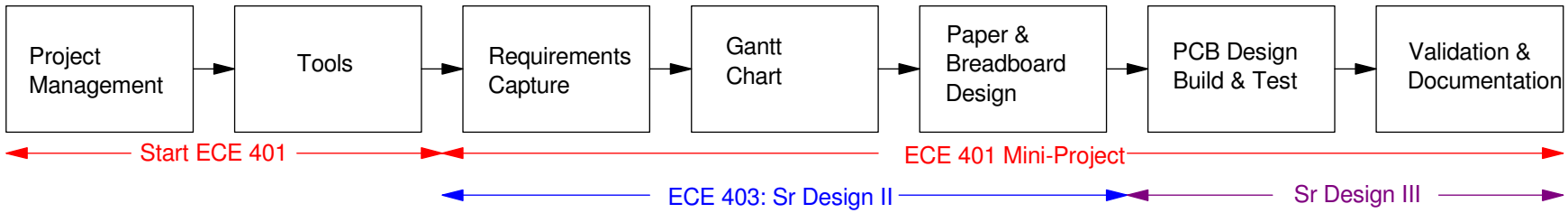
Capstone experience in formulation and design of a system or device.

Prereq: EE 206

Senior Design 1, 2, & 3

Senior Design is a three-semester sequence at NDSU.

- Senior Design I presents the tools for taking an idea from concept through a working prototype. A mini-project is used to allow students to apply these techniques and tools to a concrete example.
- Senior Design 2 and 3 then take the tools and techniques presented in Senior Design I to take a larger, more complex project through the design process. The goal of this is to allow each student a chance to demonstrate
  - *That he/she can apply knowledge of ECE to an original working device, and*
  - *That he/she is able to use tools related to ECE (such as oscilloscopes, function generators, etc.)*



Tools and techniques used in Senior Design I will be used in Senior Design II and II

Expectation of Students for ECE 401:

- Use of schematic capture and printed circuit board (PCB) software
- Understanding the process for selecting components (understanding data sheets)
- Understanding PCB material considerations
- Understand the basics of soldering and rework techniques
- Understand the basics of project planning and management
- Understand the basics of safety engineering
- Use of lab notebooks for documentation

ABET Criterion 3

- Section h The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- Section k: The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Text Book

All lectures & materials are posted on Bison Academy

- www.BisonAcademy.com

Hy-Flex Model

This class is offered

- In-Person (We 3pm, ECE 125)
- Live-Stream (zoom)
- Online (YouTube videos & Bison Academy)

Students are welcome to attend however they like

ECE 401: Senior Design I

Syllabus

Lecture	Project (homework)
0. Syllabus Week #0 Slides - 1. Project List	Project List - HW1: Project Selection (10%) Which project you want to work on Pick your lab partner (2/group) Due Week #2
2. Project Management & OneNote Week #2 Slides Sample OneNote Document	HW2: Work Breakdown Structure (10%) Set up One-Note (one per group) Share with partners & instructors Outline Level 3 (sections) Outline Level 4 (pages) Due Week #3
3. CircuitLab, Diodes, & Transistors Week #3 Slides - LM7805 Datasheets	HW3: Paper Design (10%) Circuit Schematic Calculations for Rs Calculations for voltages and currents Due Week #5
4. Op-Amps & 555 Timers Week #4 Slides - LM555 Datasheets MCP602 Datasheets	
5. Designs Using a Microcontroller Week #5 Slides -	HW4: Simulation (10%) - CircuitLab Schematics - CircuitLab Results - Main IC Datasheets - Due Week #7
Career Fair (no class)	
6. Breadboards and Test Points Week #6 Slides -	HW5: Breadboard (10%) - Breadboard Photo - Schematics

Evaluation Procedures and Grading Criteria

Grades will be the average of the following:

Homework	Final Exam
100%	none

Grades are rounded to the nearest 1%, with your final grade being

F	D	C	B	A
59% or less	60% - 69%	70% - 79%	80% - 89%	90% or more

Overall Course Objective:

- Get familiar with the tools you'll use in Senior Design II & III
  - *CircuitLab*
  - *Fusion360*
  - *Soldering*
  - *Oscilloscopes & Multimeters*

- Design, build, test, and demonstrate a PCB
  - *Original design*
  - *2" x 2" PCB (no microcontroller)*
  - *2" x 3" PCB (with a microcontroller)*
  - *One per student (yours to keep)*

Syllabus

Stuff for Design II and III

- Project Management
- Fusion 360
- Breadboards
- Soldering

Short-Course on

- Electronics
- Embedded Systems
- (no guarantee students have had these)

Week	Topic
1	Syllabus & Project Selection
2	Project Management & OneNote
3	Breadboards, Pi-Pico, Python
4	CircuitLab & Op-Amps
5	Career Fair (no class)
6	Diodes & Transistors
7	Fusion 360 Schematics
8	Fusion 360 PCB Layout
9	Through-Hole Soldering
10	Test Equipment
11	*work on your project*
12	*work on your project*
13	*work on your project*
14	*work on your project*
15	*work on your project*
16	*final presentations*

HW1: Project Selection

Homework Sets are tasks you need to do to complete your PCB

Task #1: Pick a project

- Form groups of two
- Select one of twelve different projects

1. Freezer Alarm
2. Binary Counter
3. 0-9 Counter
4. LIght Sensor
5. H-Bridge Motor Driver
6. Stop Light (software)
7. Door Open with Delay
8. Mod-9 Up/Down Counter (software)
9. Freezer Alarm (software)
10. 0-9 Paper Clip Counter
11. Annoyatron
12. Electronic Doorbell

HW2: Work Breakdown Structure

Organize your project

- Level 1: Project Requirements
- Level 2: Project Breakdown
- Level 3: Major Activities
- Level 4: Tasks
  - *homework sets*

Set Up a OneNote Document

- Your diary for your work this semester
- Your final report
- How you submit your homework sets

OneNote Document		
Section	Page	Content
HW1 Project Selection	Contact Info	
	Project	
HW3 Paper Design	Schematic	
	Calculations	
HW4: Simulation	CircuitLab	
HW5: Breadboard	Schematic	
	Measurements	
	Parts List	
HW6: PCB	Schematic	
	PCB Layout	
	Gerber Files	
HW7: Practice PCB	Practice PCB	photo of PCB
HW8: Test Equip		
HW9: Final Report	Final PCB	
	Test Data	
	Poster	

HW3: Paper Design

Design a circuit to meet your requirements

- Schematics
- Calculations
- Transistors are off or saturated
- Diode current = 20mA +/- 5mA

Update your OneNote document

- How homework is submitted in this class

- Vin = 0V, 3V, 6V

Vin = 0V

- Ib = 0
- Ic = 0
- Vc = 5 - 20 Ib = 5V

Vin = 3V

$$I_b = \left(\frac{3-0.7}{2000}\right) = 1.15mA$$

$$I_c = 200I_b = 230mA$$

$$V_{ce} = 10 - 20I_c = 5.40V$$

Vin = 6V

$$I_b = \left(\frac{6-0.7}{2000}\right) = 2.65mA$$

$$I_c = 200I_b = 530mA \qquad \textit{if active}$$

$$V_{ce} = 10 - 20I_b = -0.60V \qquad \textit{if active}$$

That can't happen, so it's not active. Instead, it's saturated

$$V_{ce} = 0.2V$$

$$I_c = \left(\frac{10V-0.2V}{20}\right) = 490mA$$

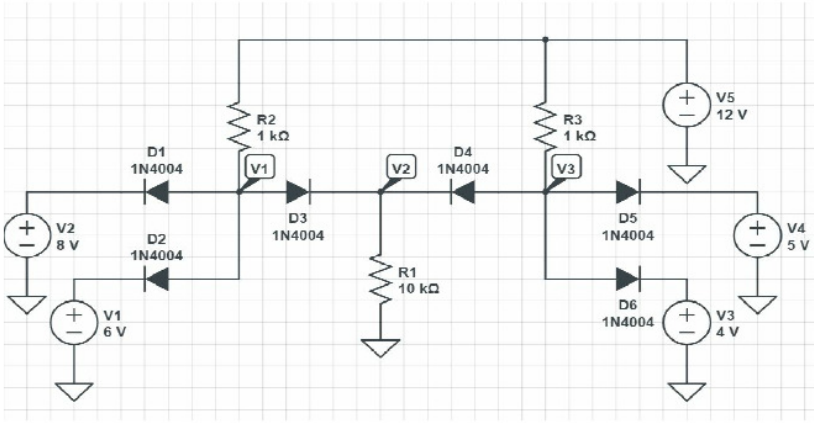
HW4: Simulation

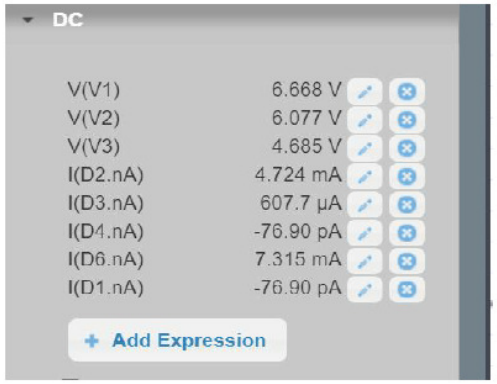
Transfer your schematic to CircuitLab

Check your design

- Is 9V converted to 5V?
- Are transistors off or saturated?
- Is the diode current 20mA?
- Is your design correct?

Update your OneNote document





HW5: Breadboard

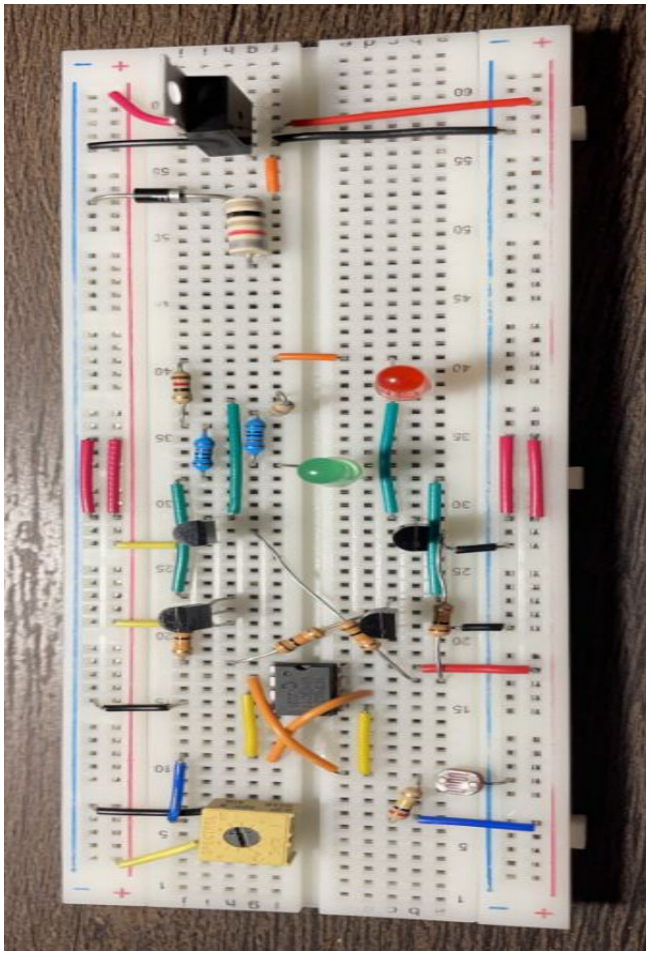
Transfer your design to a breadboard

Check that your circuit works in hardware

- Voltages are correct
- Currents are correct
- Logic is correct

Finalize your overall schematic

Update your OneNote document

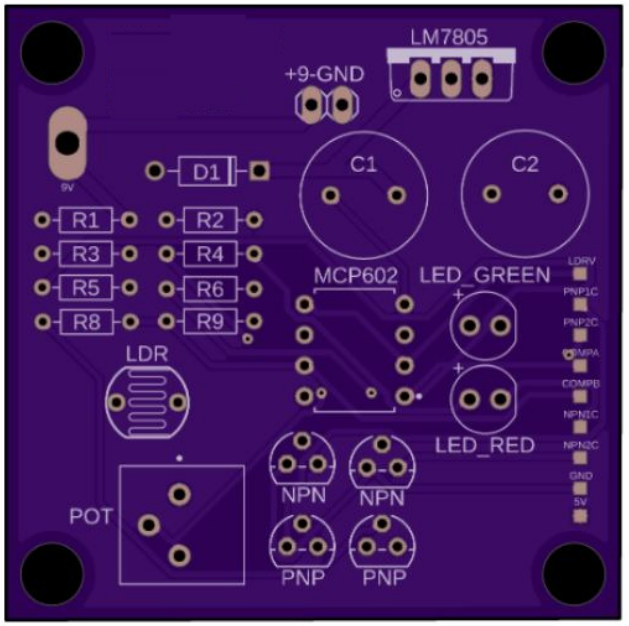


HW6: PCB Layout

Transfer your schematic to Fusion360

Create a PCB for your design

- 2" x 2" without a microcontroller
- 2" x 3" with a microcontroller
- Through hole components only
  - *surface mount parts allowed in Design 2 & 3*



Submit your Gerber files

- We then order five PCBs
- One for each person plus spares
- Takes 10 days to get back your PCBs

HW7: Practice PCBs

Practice soldering a PCB

- Through-Hole Components
- Lead vs. Lead-Free Solder

Activity while waiting for your PCBs to come in

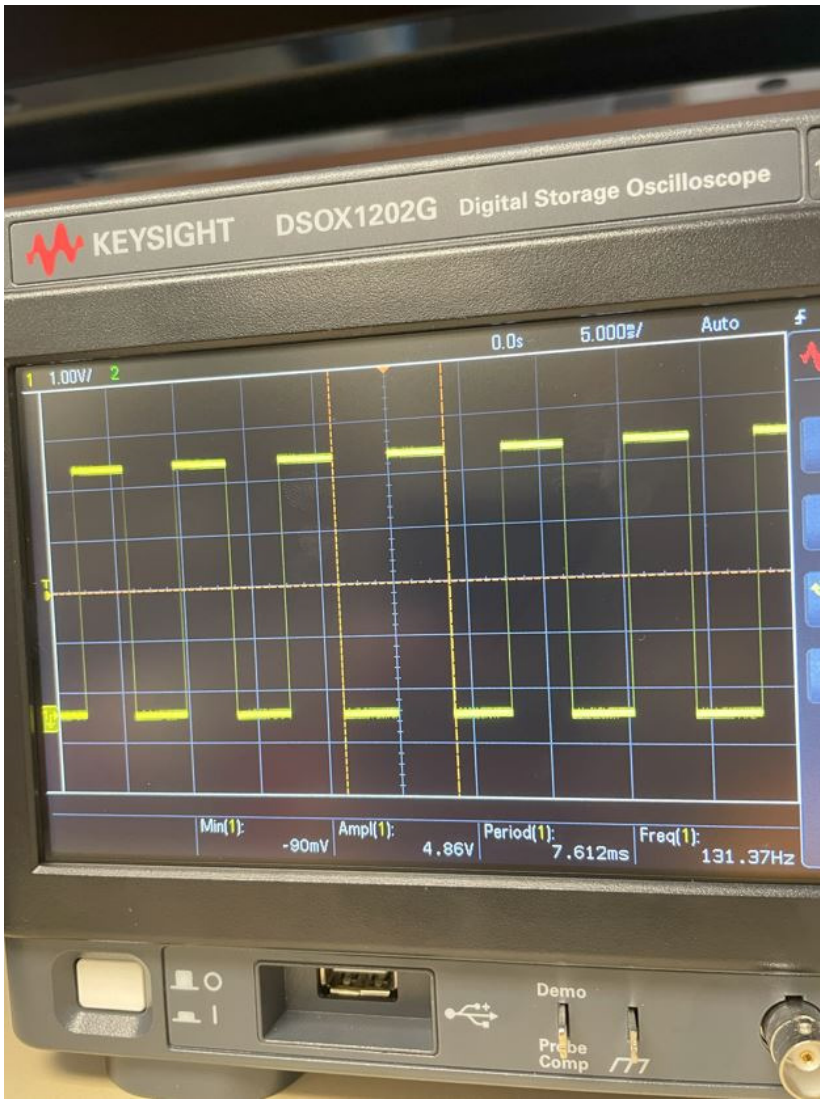
- Gives you practice soldering
- First time is always the hardest

HW8: Test Equipment

Verify you are able to use

- Multimeters
- Oscilloscopes

Activity while waiting for your PCBs to come in



HW9: Final Report

Populate your PCB

- Solder components onto your PCB
- One per student

Test your PCB

- Take measurements using
  - *Oscilloscopes*
  - *Multimeters*
- Verify transistors are off / saturated
- Verify diode current is 20mA +/- 5mA
- Verify overall operation

Demonstration

- 1/2 hour demonstration of your working PCB
- One PCB per student

Poster

- 11" x 17"

Legal Stuff:

Attendance: According to NDSU Policy 333, attendance in classes is expected. How you attend is up to you (in-person, live-stream (Zoom), or online (YouTube)). Students are responsible for the material covered in class and in assignments regardless of their attendance. Note that all lecture notes, homework sets, and solutions are available on-line at www.BisonAcademy.com

Students with Special Needs: Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Disability Services Office (www.ndsu.edu/disabilityservices) as soon as possible.

Academic Honesty: The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty.

Academic Honesty Defined: All written and oral presentations must "respect the intellectual rights of others. Statements lifted verbatim from publications must be cited as quotations. Ideas, summaries or paraphrased material, and other information taken from the literature must be properly referenced" (Guidelines for the Presentation of Disquisitions, NDSU Graduate School).

ECE Honor Code: On my honor I will not give nor receive unauthorized assistance in completing assignments and work submitted for review or assessment. Furthermore, I understand the requirements in the College of Engineering Honor System and accept the responsibility I have to complete all my work with complete integrity.

Veterans and Student Soldiers: Veterans and student soldiers with special circumstances or who are activated are encouraged to notify the instructor in advance.