Tasks & Applying Knowledge of ECE

ECE 403 Senior Design II

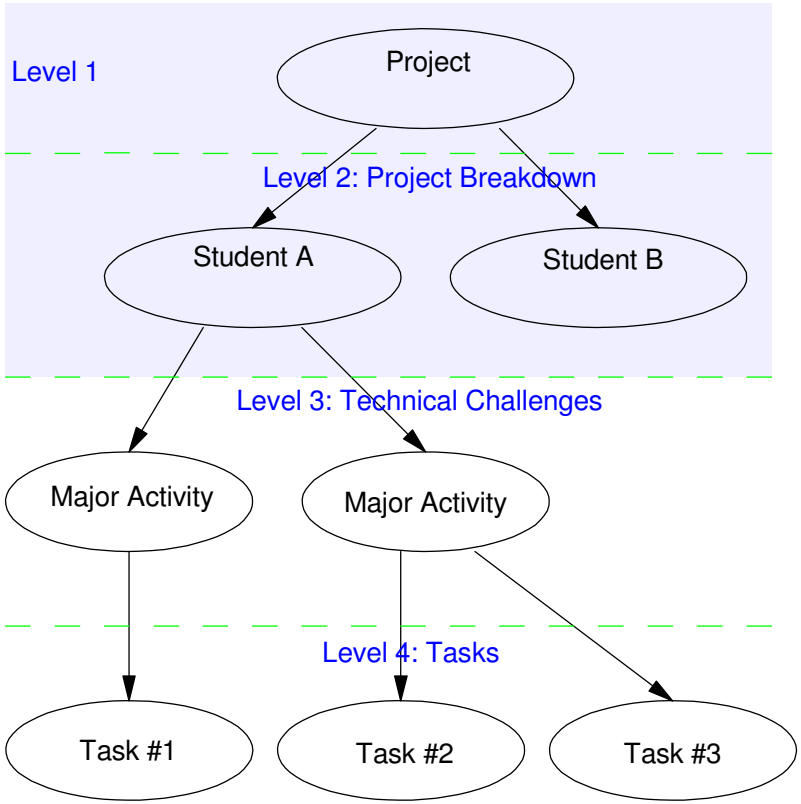
Week #3

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

Work Breakdown Structure

At this point, you should have

- Your Senior Design Project
  - Level 1 of the Work Breakdown Structure
- The role of each student in your project
  - Level 2 of the Work Breakdown Structure



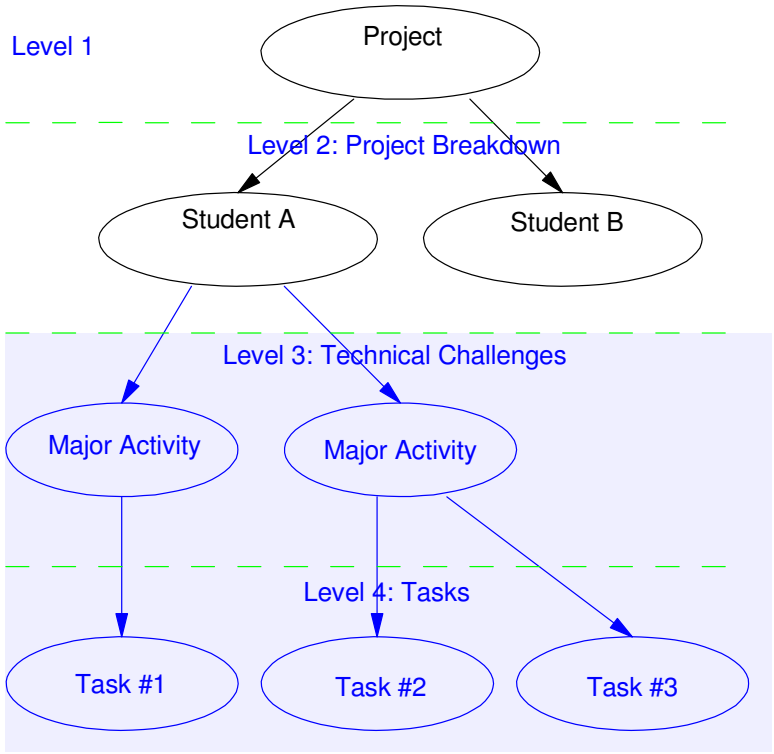
Work Breakdown Structure

This week, fill in the levels 3 & 4

- Technical challenges (Level 3)
  - Problems you need to solve
- Tasks (Level 4)
  - To-do list for ECE 403
- Specify how you are going to demonstrate knowledge of ECE while doing so.

The last bullet is kind of important.

- Your degree is from ECE
- You *do* need to demonstrate knowledge of ECE in some way.



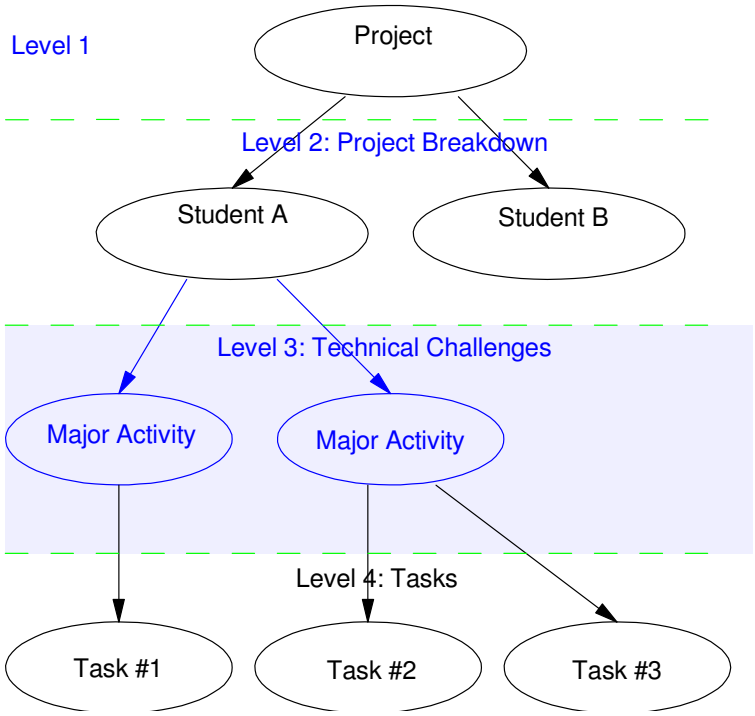
Level 3: Major Activities

- Technical Challenges (HW3)
- Breaks your project down into a list of major activities,
- Identifies what the technical challenges need to be solved
- So that you're ready when ECE 405 starts.

Think about

- What your project is and what your role is for this project, and
- What technical challenges you need to solve in ECE 403 for your project to work.

Add this list to your section of OneNote.



Level 3 Example

Build a better mouse trap (level 1).

- Some of the technical challenges could be:

Role = Hardware (Level 2)

- Detecting a mouse is in the trap
- Opening and closing the door

Role = Software (Level 2)

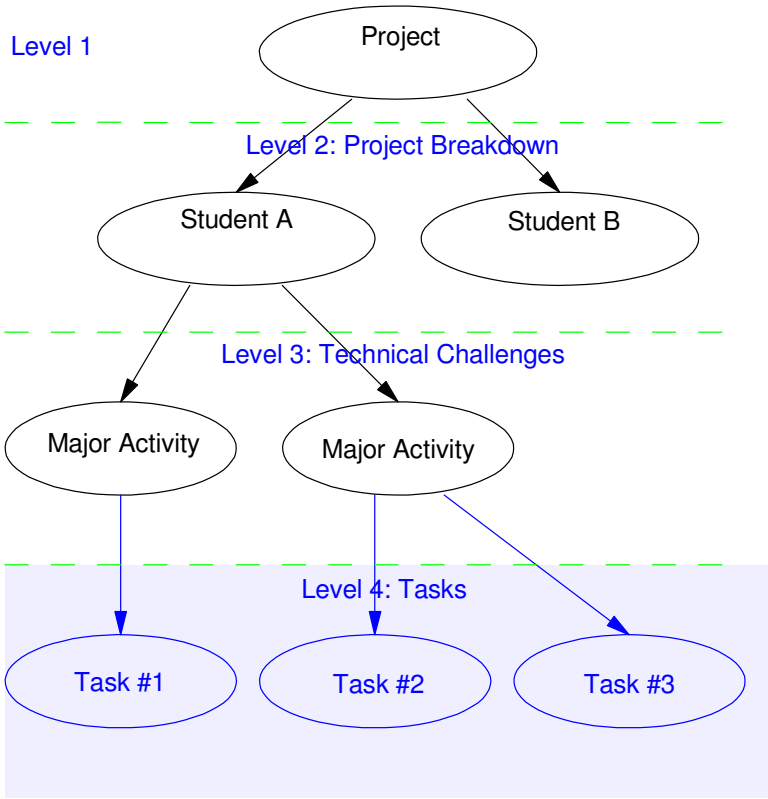
- Communicating with a cell phone to indicating the mouse trap is empty / full
- Communicating with the hardware to open/close the door
- Communicating with the hardware: mouse is present / not present

Level 4: Tasks

- To-Do list (HW3)
- *And apply knowledge of ECE*

Once you've identified what technical challenges you need to solve in ECE 403, come up with a list of tasks to complete this semester (i.e. a to-do list). Also indicate how you'll be applying knowledge of ECE in your design.

There are many ways to apply knowledge - as long as you've included four, you're good.



Example (Tasks)

- Project: build a better mousetrap.

Challenge: Detecting a mouse

- Task: Detect using an ultrasonic range sensor
  - ECE Knowledge: Timer1 Capture (ECE 376)
  - Statistics: 90% confidence interval (ECE 341)
  - Digital filtering: Reduce noise (ECE 343)
- Task: Detect using a vibration sensor
  - Instrumentation Amplifier: output -10V..+10V
  - Analog Filtering: Reduce noise (ECE 321)
  - Envelope Detectors: Convert AC to DC (ECE 321)
- Task: Detect using motion sensors
  - SPI Comm: Read a 16-bit A/D (ECE 376)
  - High-Pass Filters (differentiates) (ECE 311)
  - Amplifiers and Mixers (get 0-5V out) (ECE 321)

Adafruit VL53L0X Time of Flight Distance Sensor - ~30 to 1000mm

Product ID: 3317

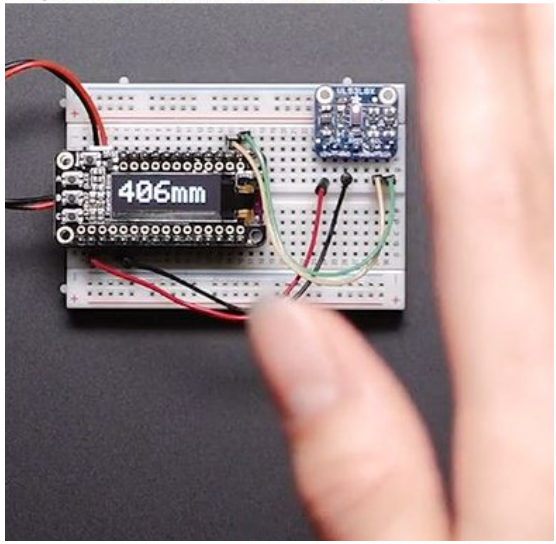
$14.95

In stock

1 Add to Cart

Also include 1 x STEMMA QT / Qwiic JST SH 4-pin Cable - 100mm Long ($0.95)

Also include 1 x STEMMA QT / Qwiic JST SH 4-pin to Premium Male Headers Cable ($0.95)



Example: Better Mousetrap

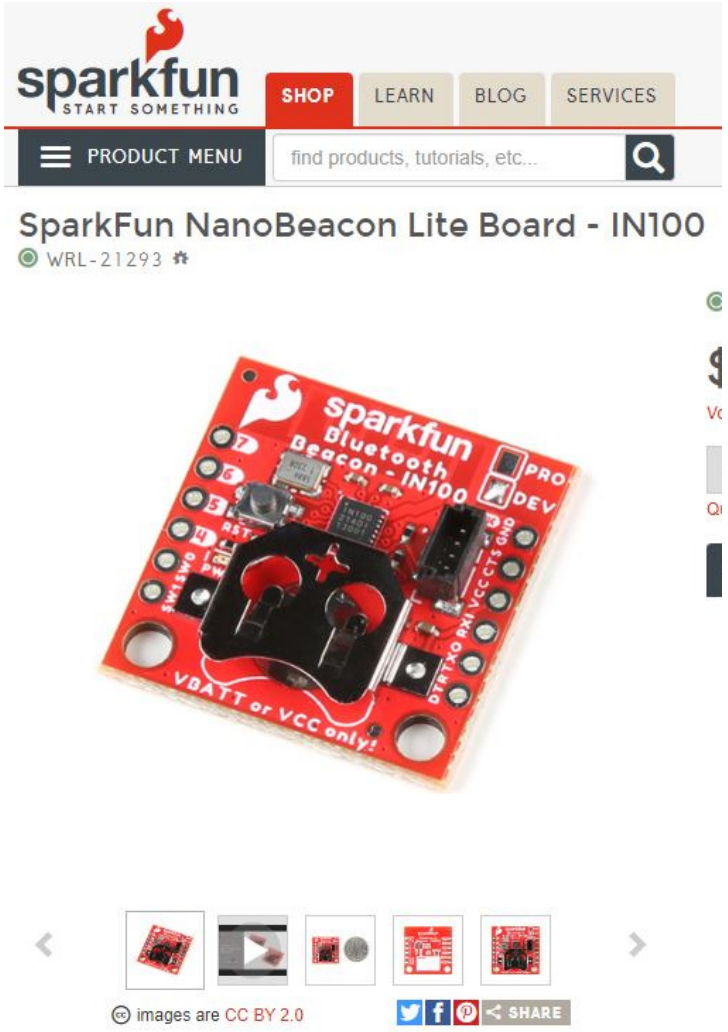
Challenge: Open and Close a Door

- Task: Use a stepper motor to open/close a door
  - Stepper Motor: Drive a stepper motor (ECE 376 - software)
  - H-Bridge: Build an H-bridge to drive the stepper motor (ECE 321 - hardware)
- Task: Use a solenoid to open/close a door
  - BJT Switch (ECE 320)
  - Mosfet Switch (ECE 320)

Example: Better Mousetrap

Challenge: Communicate with a Cell Phone

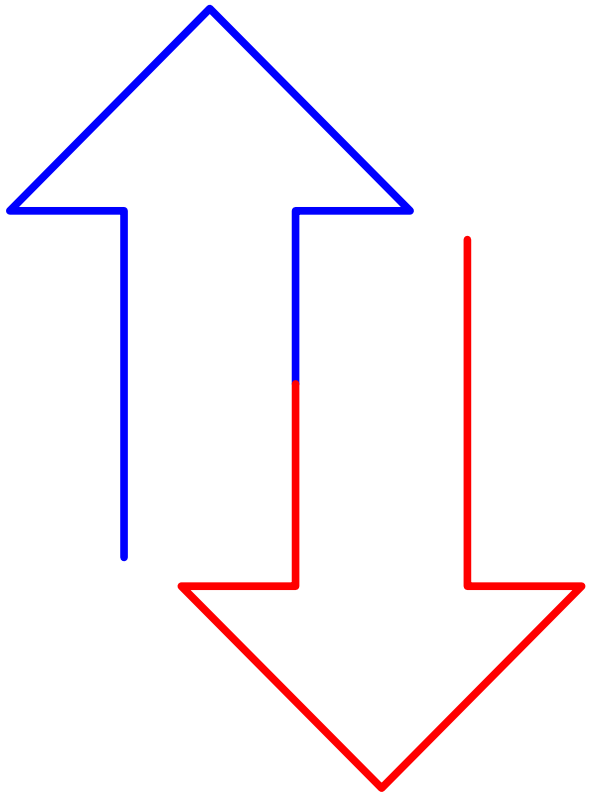
- Task: Send BlueTooth data with a uP (PIC, Arduino)
  - SCI Communications (ECE 376)
  - LCD Display (watch the SCI data communications - ECE 376)
  - Custom cell phone apps (CSxxxx)
  - Software UART using Timer0 (ECE 376 - if you need a second UART)



Example: Better Mousetrap

Challenge: Coordinate the hardware using software

- Task: Write a C program to read the sensors, drive the actuators, and provide user data on his/her cell phone
  - Top-Down Programming: Writing and testing a C program using top-down techniques (CSxxx)
  - Bottom-Up Programming: Writing and testing a C program using bottom-up techniques (CSxxx)
  - Use of Modules and Subroutines: Writing and testing a C program using CSxxx techniques
  - Use of tables and data bases (CSxxx)



ECE Tasks:

There's almost a limitless number of ways to tackle any given problem.

For ECE 403, as long as

- You have a working solution going into ECE 405 for each of your technical challenges, and
- You are able to demonstrate his/her ability to apply knowledge of ECE four different ways,

you've done enough to earn an A in ECE 403. You can do more, but that is enough to get an A.

Arduino & Raspberry Pi

In Design I, *only* PIC18F2620 was allowed

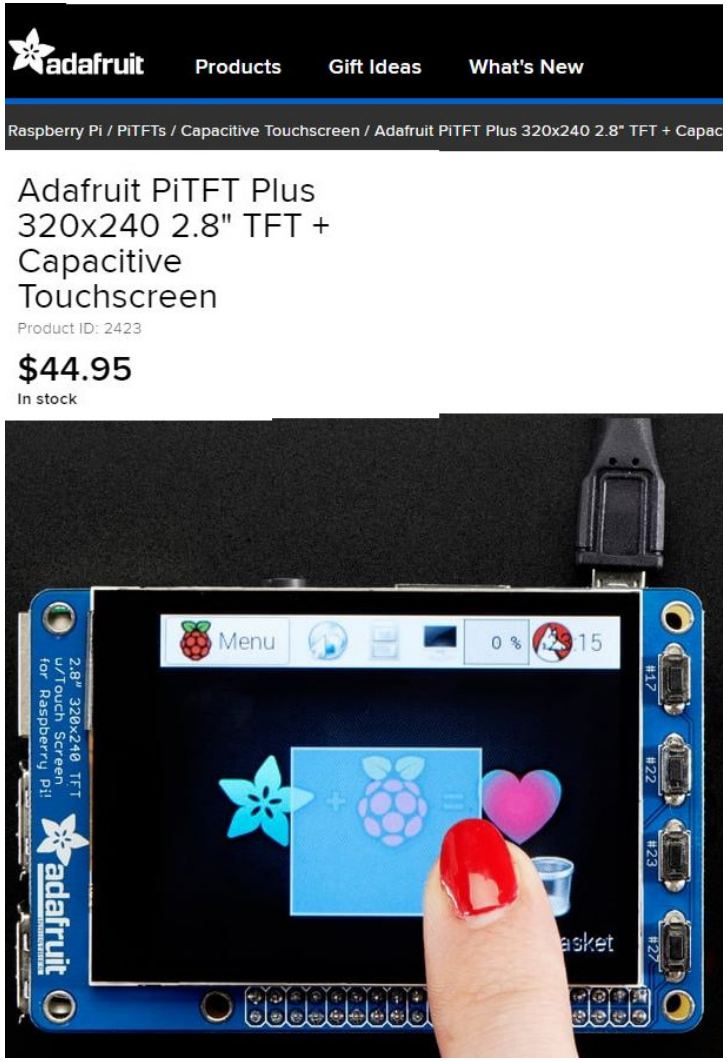
In Design II&III, *any* processor is allowed

But...

- Make sure you are able to apply knowledge of ECE
- Four different ways

Finding working code online doesn't count

- Writing your own I2C interface counts
- Using top-down programming counts
- You've learned a lot of the past 3 years
- All you need to do is demonstrate that you can apply four of them to your project...



Gantt Chart

Gantt Charts help you plan out the semester

- What activities do you need to complete,
- How much time do you allocate for each activity, and
- When these activities are to take place.

Essentially, a Gantt Chart is a tabular form of each person's Work Breakdown Structure.

The list of tasks kind of depends upon which project management structure you're using.

Gantt Chart with Waterfall

- Tasks = Technical Challenges
- Also demonstrate knowledge of ECE

Tasks	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Project Selection																
Project Breakdown																
Work Breakdown Schedule																
Acoustic Sensor Task 1: Inst Amp (ECE 321)																
Acoustic Sensor Task 2: Filtering (ECE 311)																
Door Task 3: Stepper Motors (ECE 376)																
Door Task 4: Solenoid (ECE 320)																
Sr Design Expo																

Gantt Chart for a Waterfall-Type Project

Gantt Chart with Agile

- Develop a prototype
- Keep improving it
  - Adding more features
  - Demonstrating knowledge of ECE

Tasks	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Project Selection																
Project Breakdown																
Work Breakdown Schedule																
1st Prototype Task 1: Detect Mouse, Open Close Door																
2nd Prototype Task 2: Improvement																
3rd Prototype Task 3: Improvement																
Sr Design Expo																

Gantt Chart for an Agile-Type Project

OneNote Sections

A little tricky

Trying to do two things at once:

- Document your work on each of your tasks, and
- Demonstrate your ability to apply knowledge of ECE four different ways.

How you organize your OneNote section is up to you.

- As long as you meet both objectives and
- The grader can find this information

any organization works.

Some suggestions based upon how your project is organized follows:

OneNote with WaterFall

- Section = Student A / B / C
- Pages Contain both your task as well as knowledge of ECE

Note: When completing each task, you'll probably apply advanced knowledge of ECE
Need to apply 4+ ECE topics and use 2+ ECE tools to get an A
Topics & tools can be scattered as you like in your sections - doesn't have to be 1-for-1

OneNote Section	Pages Within Section	Content
Student A	HW3: Work Breakdown	Role in Project Major Activities (technical challenges) Tasks to complete in ECE 403 Gantt Chart for ECE 403 List 4 advanced ECE topics you'll apply in your tasks List 2 ECE tools you'll use to validate your work
	Task #1 homework #4	Document work on task #1 *while applying knowledge of ECE (hw4)*
	Task #2 homework #5	Document work on task #2 *apply another advanced ECE topic (hw5)*
	Task #3 homework #6	Document work on task #3 *apply another advaned ECE topic (hw6)*
	HW8: ECE Tools	Demonstrate mastery of two ECE tools *usually done in previous sections*

OneNote with Agile

- Section = Student A / B / C
- Pages Contain iterations & knowledge of ECE

Note: When completing each iteration, you'll probably apply advanced knowledge of ECE
Need to apply 4+ ECE topics and use 2+ ECE tools to get an A
Topics & tools can be scattered as you like in your sections - doesn't have to be 1-for-1

OneNote Section	Pages Within Section	Content
Student B	HW3: Work Breakdown	Role in Project Major Activities (technical challenges) Tasks to complete in ECE 403 Gantt Chart for ECE 403
	Iteration #1 *homework #4*	Get something to work *while applying knowledge of ECE (hw4)*
	Iteration #2 *homework #5*	Improve your design *while applying more knowledge of ECE (hw5)*
	Iteration #3 *homework #6*	Improve your design *while applying even more knowledge of ECE (hw6)*
	ECE Tools *homework #8*	Demonstrate mastery of two ECE tools *usually done in previous sections*

Examples of OneNote Pages:

Assume you're using a waterfall-type of project organization with

- N tasks specified for ECE 403, and
- Each task highlights your ability to apply a different set of knowledge of ECE.

Task 1: Trap Empty / Full Indicator

Description: Turn on an LED when the mousetrap is full, off when empty.

ECE Knowledge: Using a BJT transistor as a switch (ECE 320)

Requirement:

- Input:
  - 12V power supply, capable of 1A
  - A: TTL input: 0V/5V capable of 10mA
- Output: 5W white LED. Vf = 5V @ 1A
- Relationship:
  - When A is 0V, the LED is off
  - When A is 5V the LED is on, drawing 500mA, +/- 10mA

Analysis:

Pick a 6144 NPN transistor

- Capable of 3A continuous, 10A peak
- 200 < gain < 500
- Vbe = 0.7V
- Vce(sat) = 0.36V

Calculations:

$$R_c = \left(\frac{12V - 5V - 0.36V}{500mA}\right) = 13.28\Omega$$

$$\beta I_b > I_c$$

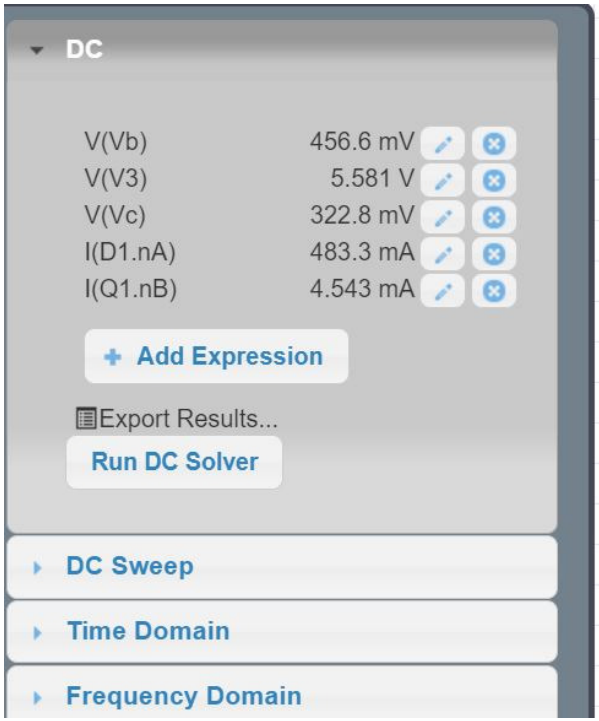
$$I_b > \frac{I_c}{\beta} = \frac{500mA}{200} = 2.5mA$$

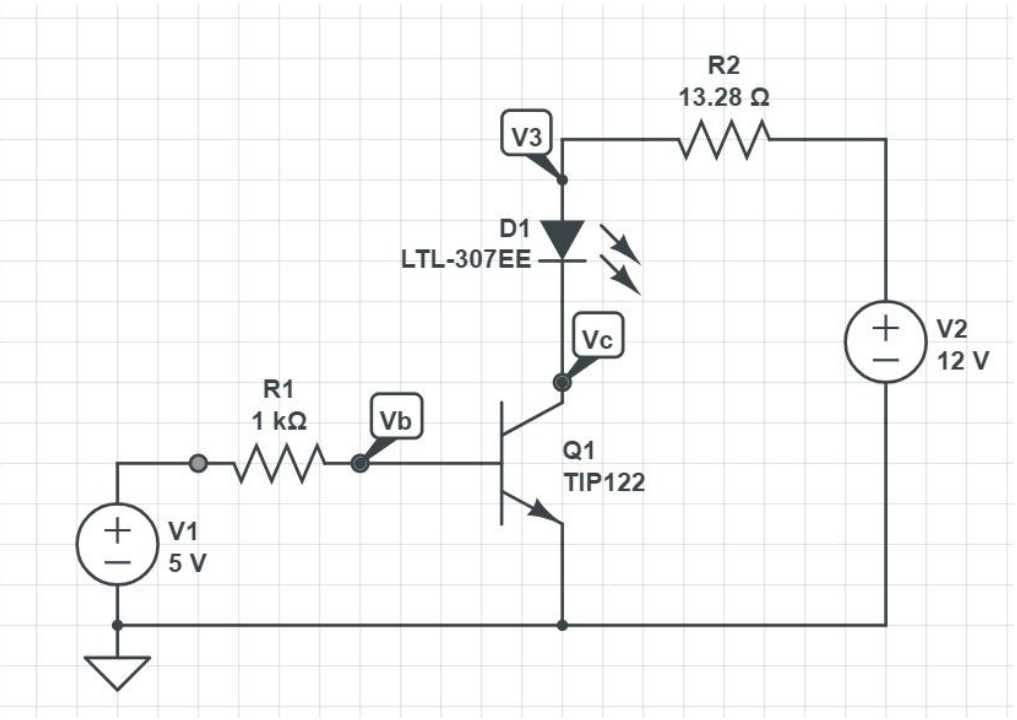
Let Ib = 4.3mA

$$R_c = \left(\frac{5V - 0.7V}{4.3mA}\right) = 1k\Omega$$

Simulation:

- Goal: verify your calculations were correct
- Ic = 500mA
- Ib = 4.3mA
- Transistor is saturated (Vce = 0.2V)

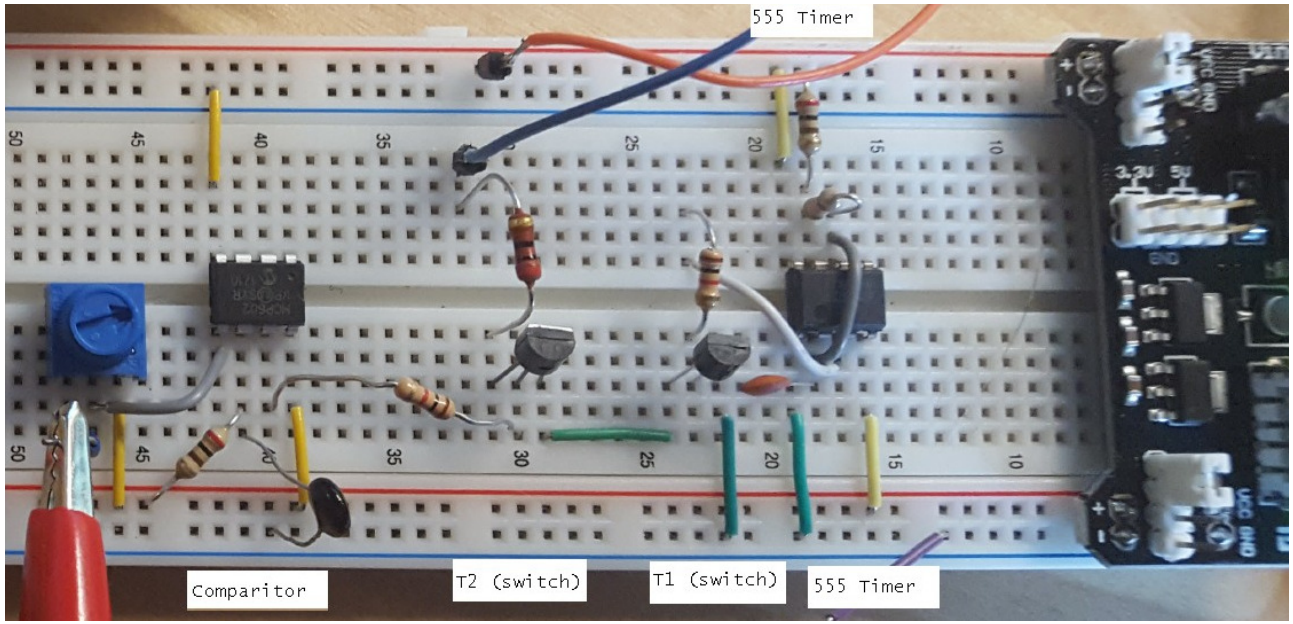




Breadboard:

Goal: Verify calculations and simulations are correct

- Include a photo of your breadboard
- Include measurements
- Demo: Include or link to a video



Optional: Summarize Your Work:

- Did calculations match simulation match breadboard result?

	Calculation	Simulation	Breadboard
12V source	12V	12V	12.13V
5V source	5V	5V	4.89V
Rc	13.28	13.28	12.04
Rb	1k	1k	986
Vb(on)	700mV	456mV	723mV
Vce(on)	360mV	322mV	68mV
Vd	5.0V	5.258V	5.25V
Ib	4.3mA	4.543mA	4.27mA
Ic	500mA	483.3mA	479mA

Homework #3: Work Breakdown Structure

For each student in your group, add pages to your section for HW3 to HW8

Add content to the page for Homework #3 including

- Your role in the project (Level 2 of work breakdown structure
- Technical challenges you need to solve in ECE 403 (Level 3)
- Tasks you need to complete in ECE 403 (Level 4)
- A Gantt chart for ECE 403
  - The order in which you'll do your tasks
  - When your plan on working on each task

Also list out

- Four advanced ECE concepts you'll apply to your part of the design
- Two ECE tools you'll use