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# **Syllabus**

## **ECE 320 Electronics I**

### **Digital Electronics**

#### **Lecture #0**

Please visit [Bison Academy](#) for corresponding lecture notes, homework sets, and solutions

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# What are Electronics?

Devices made out of semiconductors

- Silicon, Germanium

Nonlinear devices in general

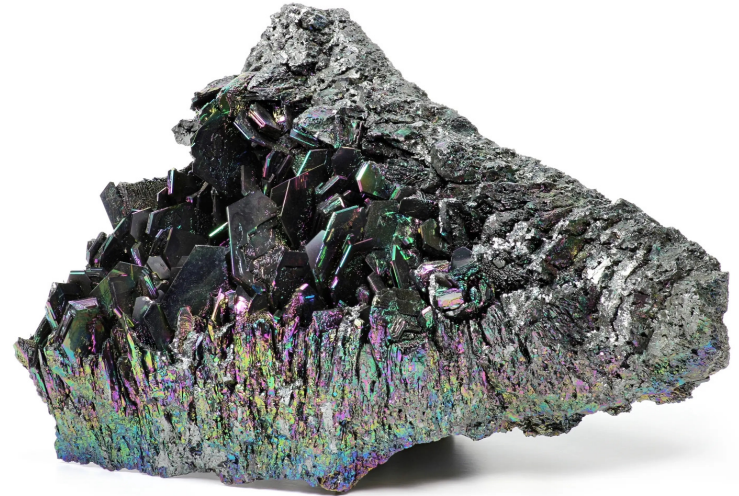
- Makes circuit analysis hard

Note: This is a junior-level course

- Students don't know what they don't know
- 24 lectures = 24 different things you can do with electronics

Electronics Courses:

- ECE 320: Digital Electronics
- ECE 321: Analog Electronics



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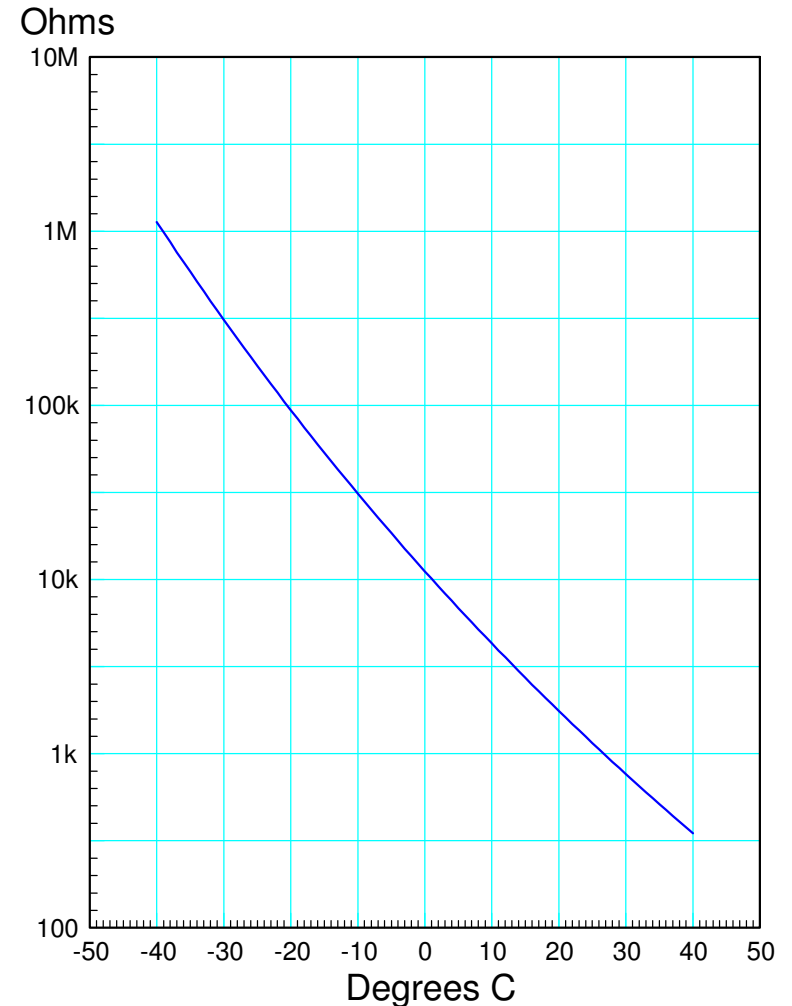
# Course Content

## Start with Silicon

- Insulator at 0K
- Conductor above 0K
- Can be used as a temperature sensor

## With doping

- Becomes a conductor
- Can be used as a resistor
- Can control if current is carrier by
  - Positive charges (p-type), or
  - Negative charges (n-type)



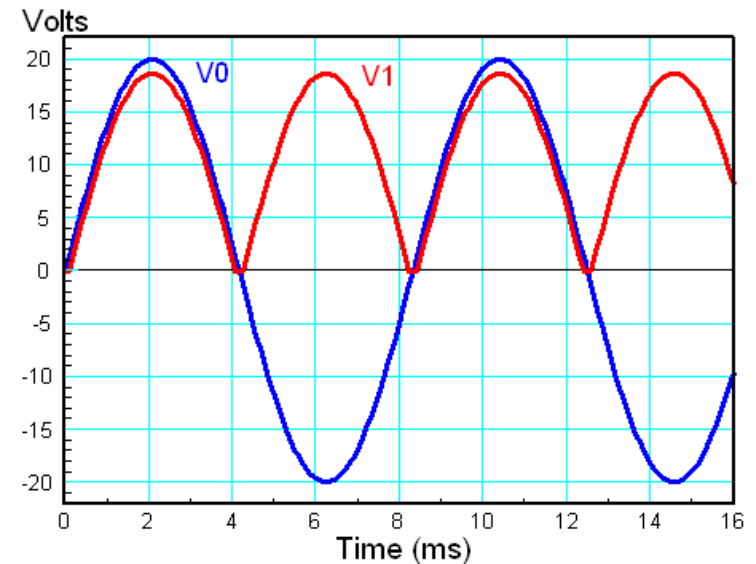
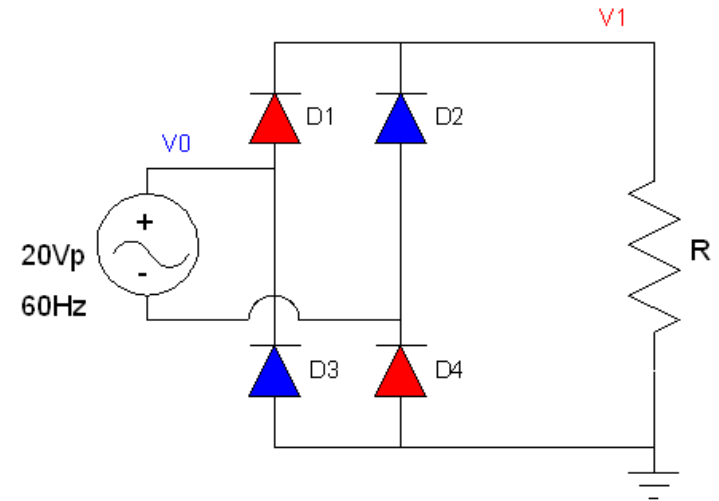
# Course Content: pn junction

Create a pn junction and you have a diode

- Valve that lets current flow in only one direction

With diodes, you can build

- Reverse polarity protection
- LEDs
- AC to DC converters
- Max/min circuits
- Clippers (implement  $y = \sqrt{x}$  in hardware)



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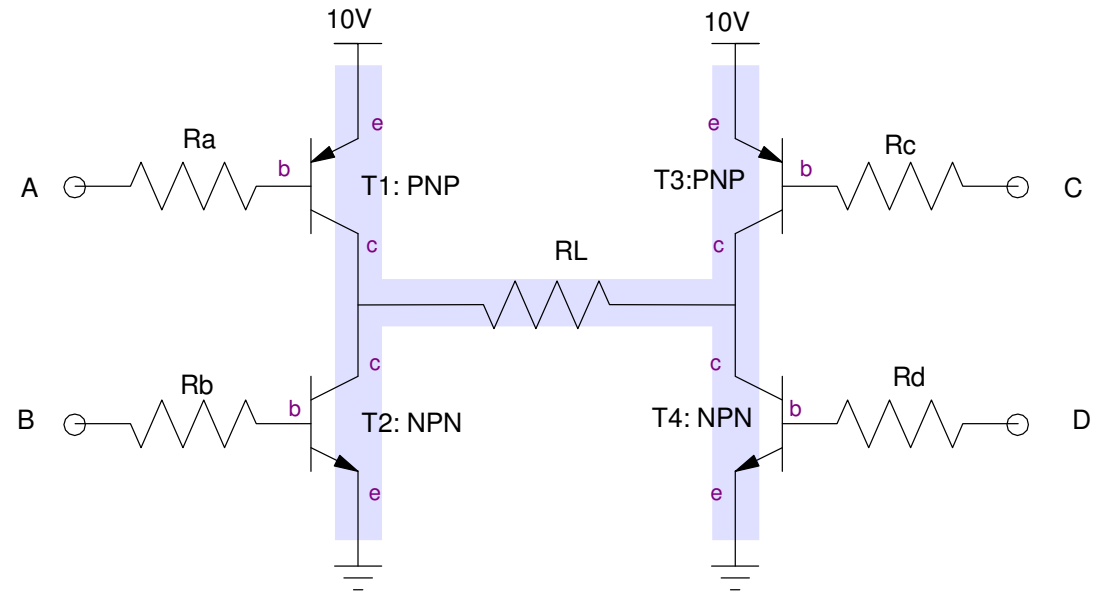
# Course Content: npn or pnp

Creates a BJT Transistor

- Current-controlled current device

Can be used to build a

- Electronic switch (on/off)
- H-bridge (forward / off / reverse)
- DC to DC converter
- NAND, NOR, NOT gates
- Amplifier (ECE 321)



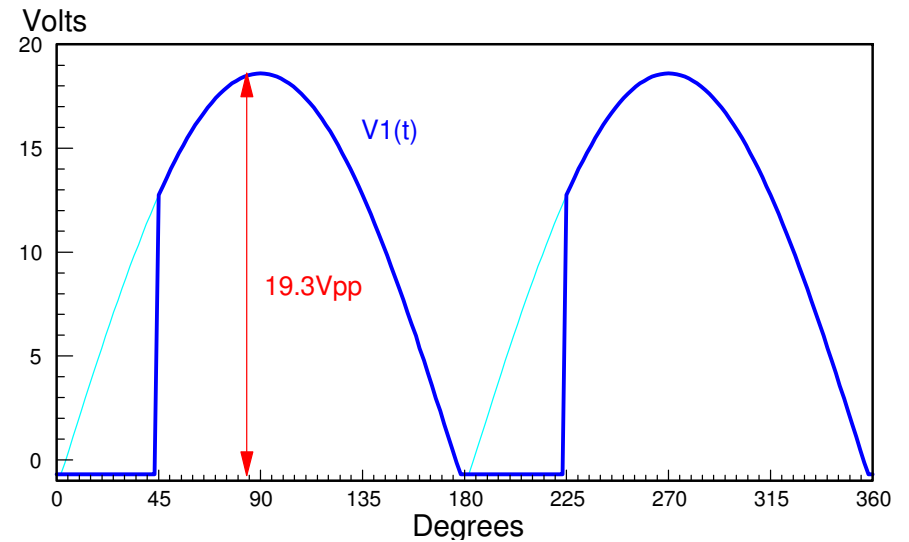
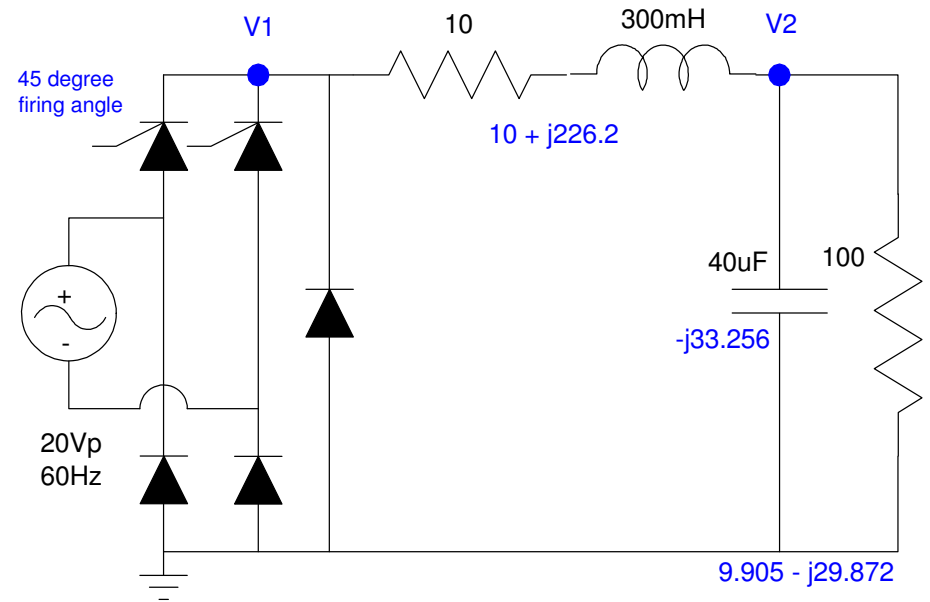
# Course Content: pnpn

Creates a Semiconductor Relay (SCR)

- Diode you can turn on and off

Allows you to build

- AC to DC converter
- Adjustable DC output



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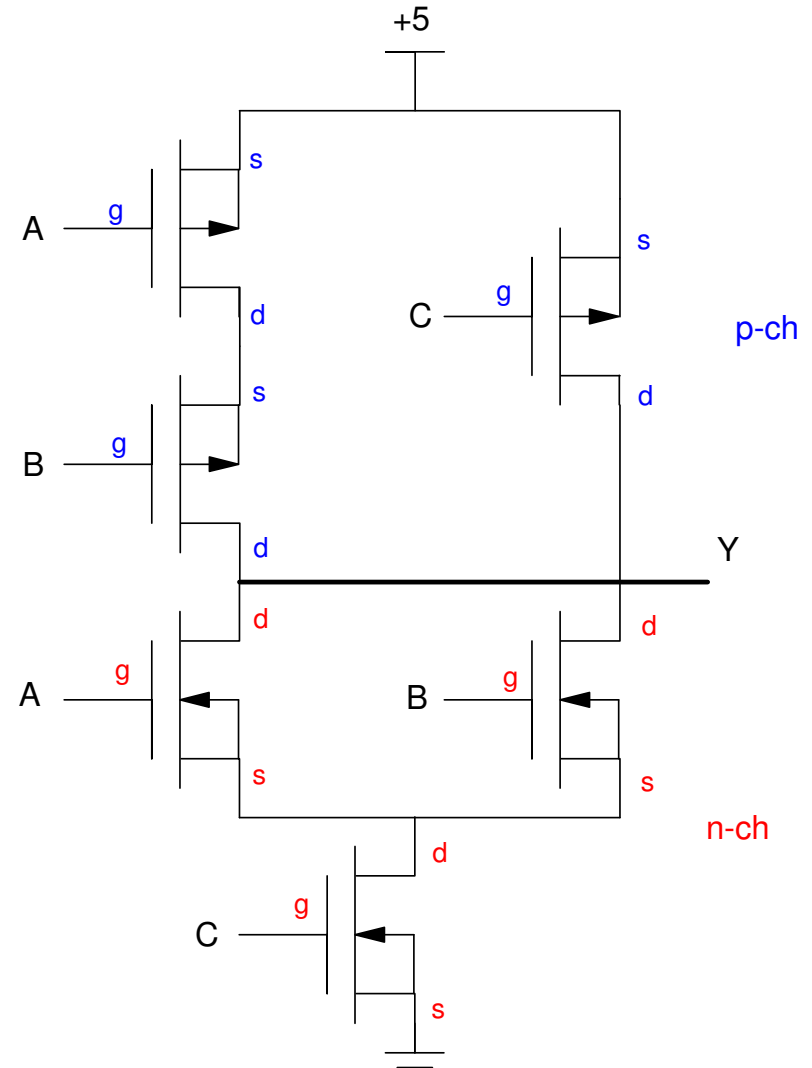
## Course Content: Mosfet

- pnp + gate = p-channel MOSFET
- npn + gate = n-channel MOSFET

Voltage-controlled resistor

With a Mosfet, you can build

- Electronic switch (on/off)
- H-bridge (forward / off / reverse)
- CMOS logic (computer logic)



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## Course Information:

Instructor:

- Ivan Lima

Class Times

- Tu / Th / Fr

Labs:

- Open Labs (no scheduled time)
- ECE room 211 & 237
- Labs are part of homework sets
  - No separate lab reports needed

Office Hours:

- t.b.d.
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## **Bulletin Description:**

**ECE 320:** Characterization, modeling, and analysis of digital circuits using diodes, BJTs, FETs, and Op Amps. 4 one-hour lectures, 1 two-hour laboratory each week for 10 weeks. Prereq: EE 206. F, S

- ECE 320 is required for all electrical and computer engineers. Everyone should sign up for ECE 320.

**ECE 321:** Characterization, modeling, and analysis of analog circuits using diodes, BJTs, FETs, and Op Amps. 4 one-hour lecture, 1 two-hour laboratory each week for 6 weeks. Prereq: EE 206. F, S

- ECE 321 is required for all electrical engineers and is optional for computer engineers. It counts as a 2cr technical elective for computer engineers.
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## **ECE 320 Course Objectives:**

By the end of the semester, students should:

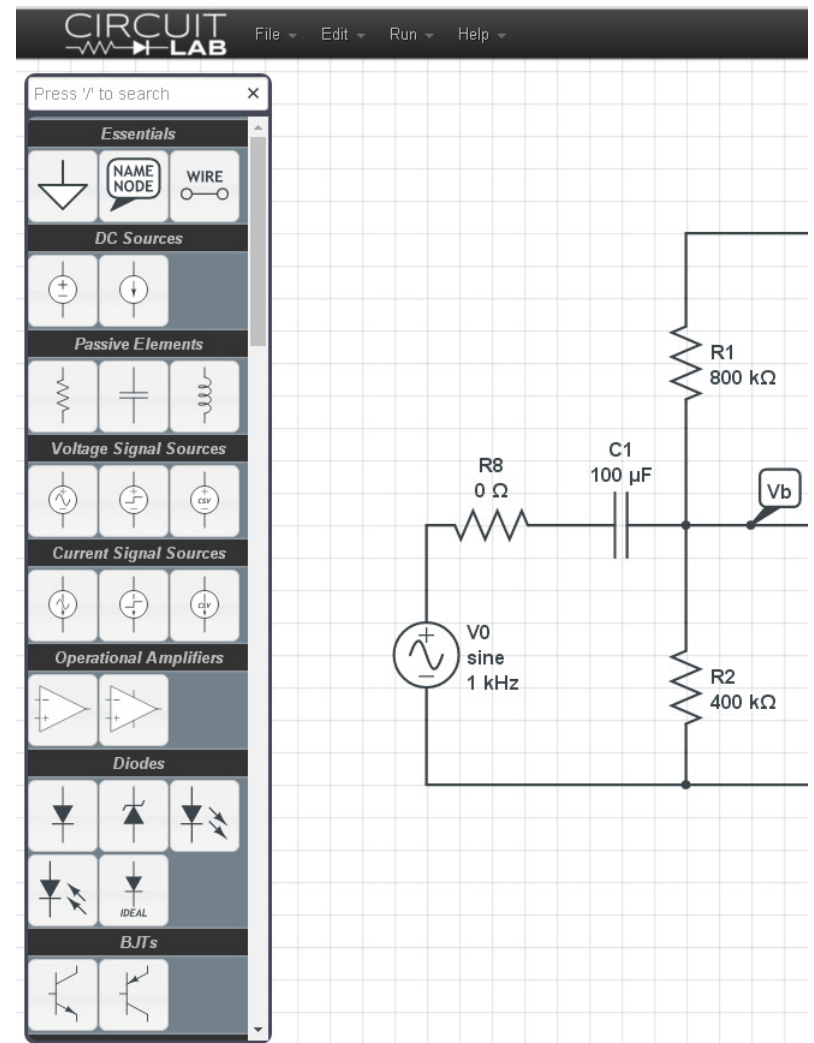
- Explain how current flows in a semiconductor via holes and electrons
  - Explain how diodes and transistors operate
  - Design and analyze diode circuits using nonlinear and ideal-diode models
  - Design and analyze transistor circuits with binary outputs, and
  - Design and analyze op-amp circuits with binary outputs
-

## Required Student Resources:

- Calculator capable of complex numbers
  - HP35S recommended
  - Most ECE students use TI84 Plus
- Ability to make videos
- CircuitLab account
  - free if you use your NDSU email account
  - Register at [www.CircuitLab.com](http://www.CircuitLab.com)

If you are doing the labs off-campus

- MultiMeter that can read 1VAC
  - \$29 from Amazon.
- Electronics Kits (\$18 from Amazon)
- Extra parts (pick up from ECE 201)
- 6-16V DC power supply (wall plug)
  - 9V battery also works



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# Evaluation Procedures and Grading Criteria

Grades will be the average of the following:

	Weekly Quizzes	Homework	Final Exam
ECE 320	33%	33%	33%
ECE 321	33%	33%	33%

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

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# Text Book

[www.BisonAcademy.com](http://www.BisonAcademy.com)

- Free
- What most students use

[www.electronics-tutorials.ws](http://www.electronics-tutorials.ws)

- Good web site with lots of ECE material

## Microelectronic Circuit Design

- Richard C. Jaeger
- Any edition works
- \$9.49 used
- optional if you want a hardcopy

**BISON  
ACADEMY**

ECE LABS

[Advising Info](#)  
[ECE Lab Supplies \(new\)](#)  
[ECE 111: Intro to ECE](#)  
[ECE 206: Circuits I](#)  
[ECE 311: Circuits II](#)  
[ECE 320: Digital Electronics](#)  
[ECE 321: Analog Electronics](#)  
[ECE 331: Energy Conversion](#)  
[ECE 341: Random Processes](#)  
[ECE 343: Signals and Systems](#)  
[ECE 376: Embedded Systems](#)  
[ECE 461: Controls Systems](#)  
[ECE 463: Modern Control](#)  
[ECE487 Cardiovascular Engineering](#)  
[ECE 494: Robotics](#)

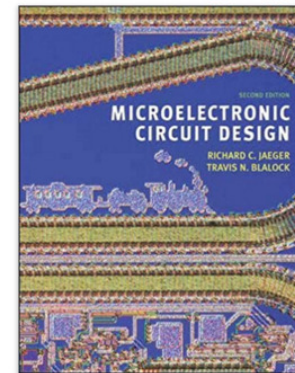


## Microelectronic Circuit Design with CD-ROM 2nd Edition

by Richard C. Jaeger (Author), Travis N. Blalock (Author)

★★★★☆ 6 ratings

[Look inside](#)



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# Lab Kits

Homeworks usually have three parts:

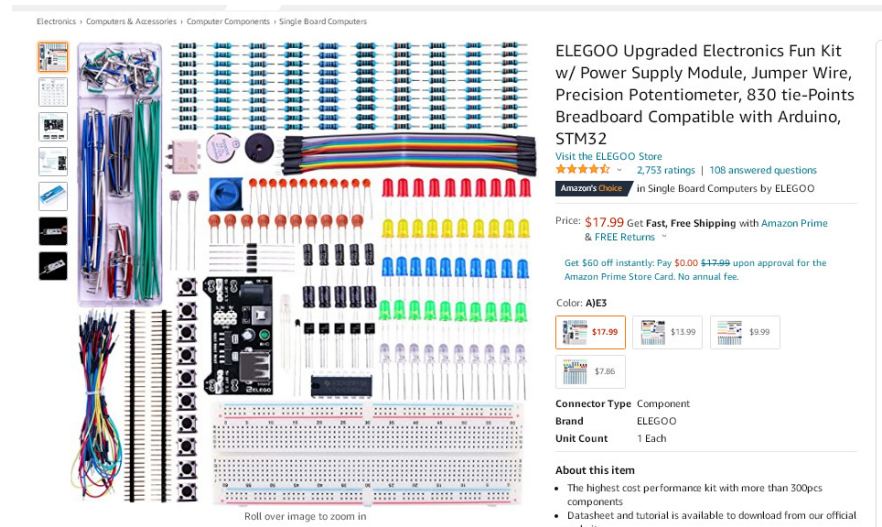
- Design on paper
- Simulate using CircuitLab
- Build in hardware

Hardware can be done on campus

- parts in room 211 & 237

Or at home.

- Parts kit from Amazon
- Extra parts (pick up in ECE 201 for free)
- Multimeter that can measure 2VAC
- 6V..16V DC power supply (wall plug)



Digital Multimeter, LOMVUM TRMS 6000 Counts Electrical Tester AC/DC Amp Ohm Voltage Tester Meter with Temperature Frequency Resistance Continuity Capacitance Diode and Transistor Test

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Pattern Name: T28C

# Bison Academy - Syllabus

- Topics covered each day
- Lecture notes in portrait and landscape format (pdf)
- Recorded lectures for online students (or anyone) - YouTube link
- Handouts and solutions that we go over in class
- Weekly homework and solutions to the homework (pdf)

	Date	Lecture	ECE 320 Videos YouTube Playlist	Handouts	Homework On-Line: Email solutions to Jacob_glower@yahoo.com Subject: ECE320 HWx
M	Jan 10	<b>Holiday</b>	0 Syllabus	Install Matlab	<b>HW #1</b>
W	Jan 12	<b>Intro to ECE 320 Circuits I Review</b> Slides #1	1 Circuits I Review	1 KCL KVN	
Th	Jan 13	<b>Complex Numbers and Phasors</b> Slides #2	2. Complex Numbers AC vs. DC (EB)	2 Phasors	
F	Jan 14	<b>Matlab &amp; CircuitLab</b> Slides #3	3 Matlab & CircuitLab		
M	Jan 17	<b>Holiday</b>			<b>HW #2</b>
W	Jan 19	<b>Semiconductors</b> Slides #4	4 Semiconductors	4 Thermistor	
Th	Jan 20	<b>The pn Junction</b> Slides #5	5 The pn Junction	5 Diode Ckt	
F	Jan 21	<b>Quiz #1 (EE 206 Review)</b>			

# Bison Academy - Homework Sets & Solutions

Homework sets and solutions from previous semesters

- Makes good sample problems to work on
- Solutions to these homework sets let you check your answers
- Solutions also useful if you get stuck on a homework problem

Quizzes and solutions from previous semesters

Fall 2021	Spring 2021	Fall 2020	Spring 2020	Fall 2020
<b>1: Circuits Review</b> Solution #1 (pdf) Solution #1 (YouTube) <b>Quiz #1</b> Quiz #1 Solution (pdf) Quiz #1 Solution (YouTube)	<b>1: Circuits Review</b> Solution #1 <b>Quiz #1</b> Quiz #1 Solution	<b>1: Circuits Review</b> Solution #1 (pdf) Solution #1 (YouTube) <b>Quiz #1</b> Quiz #1 Solution	<b>1: Circuits Review</b> Solution #1 <b>Quiz #1</b> Quiz #1 Solution	<b>1: Circuits Review</b> Solution #1 (pdf) Solution #1 (YouTube) <b>Quiz #1</b> Quiz #1 Solution
<b>2: pn Junction</b> Solution #2 (pdf) Solution #2 (YouTube) <b>Quiz #2</b> Quiz #2 Solution (pdf) Quiz #2 Solution (YouTube)	<b>2: pn junction</b> Solution #2 <b>Quiz 2</b> Quiz 2 Solution	<b>2: pn Junction</b> Solution #2 (pdf) Solution #2 (YouTube) <b>Quiz #2</b> Quiz #2 Solution Quiz #2 (YouTube)	<b>2: pn Junction</b> Solution #2 <b>Quiz #2</b> Quiz #2 Solution	<b>2: pn Junction</b> Solution #2 (pdf) Solution #2 (YouTube) <b>Quiz #2</b> Quiz #2 Solution Quiz #2 (YouTube)
<b>3: LED, AC-DC</b> Solution #3 (pdf) <b>Quiz #3</b> Quiz #3 Solution (pdf) Quiz #3 (YouTube)	<b>3: LEDs</b> Solution #3 <b>Quiz 3</b> Quiz 3 Solution	<b>3: AC to DC, LEDs</b> Solution #3 (pdf) <b>Quiz #3</b> Quiz #3 Solution	<b>3: AC to DC &amp; LEDs</b> Solution #3 <b>Quiz #3</b> Quiz #3 Solution	<b>3: AC to DC, LEDs</b> Solution #3 (pdf) <b>Quiz #3</b> Quiz #3 Solution



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# Bison Academy - Best of ECE 320

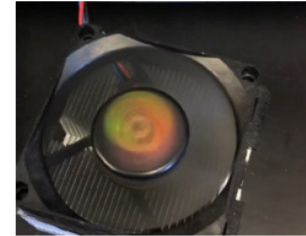
Homework sets usually contain three parts

- Design on paper
- Simulate in CircuitLab
- Build and demonstrate in hardware

Making a YouTube video works pretty well for demonstrating your hardware

- YouTube videos also work well for demonstrating your skills to employers
- Place YouTube link on your resume.

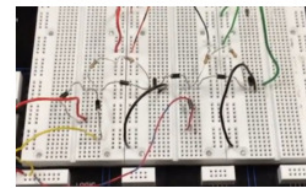
Better YouTube videos linked on Bison Academy (with student's permission)



## Electronically Turning On and Off a Fan

Spring 2018

A Schmitt Trigger along with a transistor switch replace the resistor with a light sensor or temperature sensor based upon light level or temperature.



## DTL NAND Gate

Fall 2014

A DTL logic gate is built using transistors and

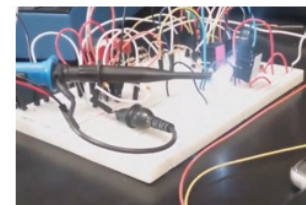
## ECE 321: Analog Electronics



## Bass Boost

Spring 2015

The audio signal from a computer (or cell phone) subwoofer. A 3rd-order Butterworth filter is used. An amplifier boosts the voltages. A push-pull amplifier



## Electronic Candle

Fall 2018

An electronic circuit is built to simulate a flicker generator (from a cell phone app) is mixed with a push-pull amplifier with a current

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# Weekly Quizzes

Typical week in ECE 320:

- Lecture on 3 topics (MWF)
- Class handouts each day (practice problems)
- Do homework solving similar problems (Mo)
- Go over the homework on Wednesday
- Quiz on that material

Quizzes are usually Thursdays

- Posted on Blackboard
- 2 hour time limit
- Can start any time from 6am to 10pm
- Each quiz is different
- Working together or using Chegg is not allowed

Date	Lecture
Jan 10	Holiday
Jan 12	Intro to ECE 320 Circuits I Review Slides #1
Jan 13	Complex Numbers and Phasors Slides #2
Jan 14	Matlab & CircuitLab Slides #3
Jan 17	Holiday
Jan 19	Semiconductors Slides #4
Jan 20	The pn Junction Slides #5
Jan 21	Quiz #1 (EE 206 Review)
Jan 24	Idea Diodes Slides #6
Jan 26	Light Emitting Diodes (LEDs) Slides #7
Jan 27	Quiz #2
Jan 28	AC to DC Converters Slides #8
Jan 31	Min, Max Circuits Slides #9
Feb 2	Clipper Circuits Slides #10
Feb 3	Quiz #3
Feb 4	Transistor Theory Slides #11
Feb 7	555 Timers Slides #25
Feb 9	Using a Transistor as a Switch Slides #12
Feb 10	Quiz #4
Feb 11	Comparitors, Schmitt Triggers Slides #14
Feb 14	H-Bridges Slides #13
Feb 16	DC to DC Converters Slides #15
Feb 17	Quiz #5

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## Hy-Flex Model

Electronics I is offered three ways this semester:

- In-Person: All students are welcome to attend class in person.
- Live-Stream: Zoom link will be posted on BlackBoard and emailed to each student
- On-Line: YouTube videos of each lecture are posted on Bison Academy

Students are welcome to attend however they like each day. Whatever fits your schedule.

You can also attend lectures & take quizzes any way you like.

- Quizzes and final exam can be taken in class
    - Work problems in any order
    - 50 minute time limit
  - They can be taken on BlackBoard as well
    - 8am-10pm on quiz day
    - Random order for questions
    - No back-tracking
    - 100 minute time limit (to compensate for no back-tracking & scanning answers)
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## Legal Stuff:

**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](http://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](http://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.

**Attendance:** According to NDSU Policy 333 ([www.ndsu.edu/fileadmin/policy/333.pdf](http://www.ndsu.edu/fileadmin/policy/333.pdf)), attendance in classes is expected. Students are responsible for the material covered in class and in assignments regardless of their attendance.

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