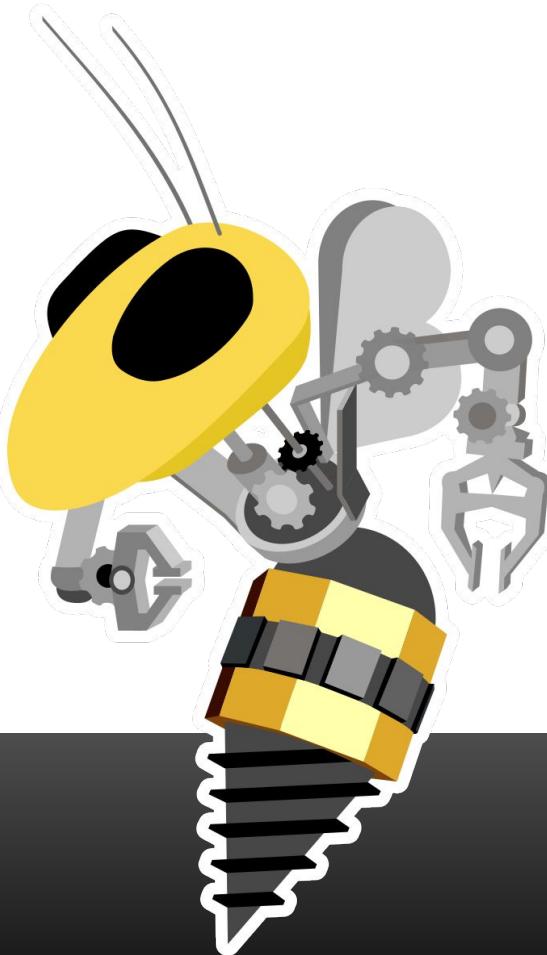


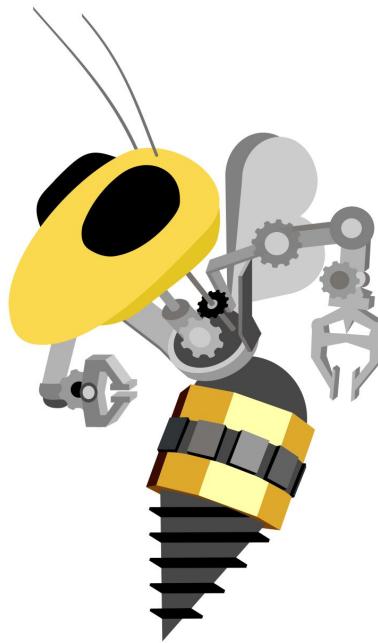
Welcome!

Electrical/Firmware
Training Week 0

ROBOJACKETS
COMPETITIVE ROBOTICS AT GEORGIA TECH

www.robojackets.org





Instructor Introductions

Who are we?

Electrical Trainers

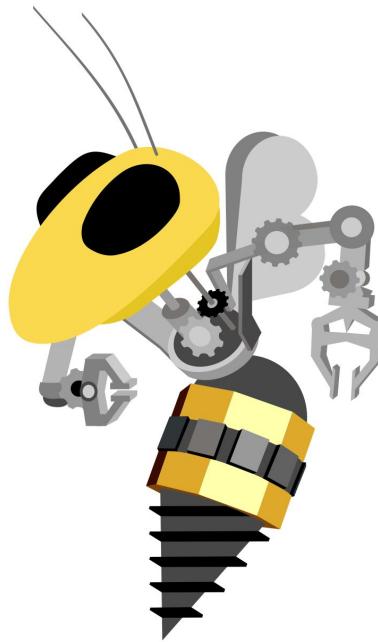
- Alex Peng (RoboWrestling, CmpE)
- Bernardo Perez (RoboCup, EE)



Firmware Trainers

- Andrew Roach (RoboNav, Math / CS)





Disciplines

What's the difference?

Electrical

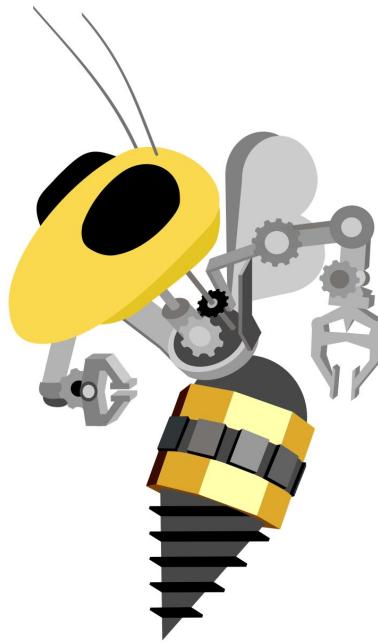
- What we do?
 - Develop PCBs to integrate components (sensors, motors, etc), assemble and test them
 - System design (power, wiring, safety systems)
- What you learn in Electrical Training?
 - Electrical components and common circuits
 - Prototyping
 - Printed Circuit Board (PCB) design using EAGLE
 - Debugging circuits and soldering

Firmware

- What we do
 - Writes the code to run on PCBs that electrical designs
 - Implements the low-level functionality for software
- What you learn in Firmware Training
 - Electrical components and common circuits
 - Prototyping
 - Microcontroller programming
 - Communication Protocols
 - Debugging circuits and soldering

Software

- What we do
 - Write code that runs (mostly) on “regular” computers
 - “Autonomy”: Vision, motion planning, decision making, etc.
 - A little bit of motion control (split between SW/FW teams)
- What you learn in Software Training
 - Basics of C++ and ROS
 - Robotics concepts for autonomy



Logistics

How will this work?

Electrical/Firmware Training

- Two sessions a week
 - Monday and Wednesday 6:30pm - 8:00pm
 - Only need to come to one a week

Weekly Plan

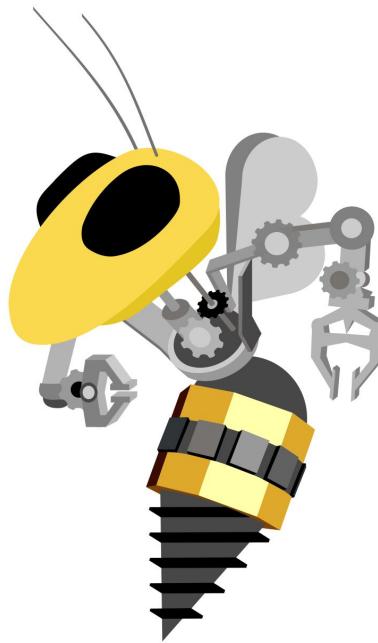
Week	Electrical Training	Firmware Training
0	Introductions, Electrical Basics	
1	Introduction to Prototyping and Arduino	
2	EAGLE Parts and Libraries	More C and Interrupts
3	EAGLE Schematics	PWM and Bitwise Operations
4	EAGLE Board Layout	Communication Protocols
5	Debugging and Soldering	

Online Platforms

- Email - Announcements
- GitHub - Slides and Labs
 - github.com/robojackets/electrical-training
- Slack - RoboJackets Team Communication

Important Slack Channels

- Join:
 - #<team> (i.e. #robocup)
 - #<team>-electrical (i.e. #robocup-electrical)
 - #electrical-core (electrical/firmware collaboration)
 - #electrical-ama (electrical/firmware questions)
 - #pixie-wranglers (memes/off-topic)
- Set profile picture / “What I do” (<team> Electrical)
- Other channels: #rj-girl-gang #pets #research
#lets-meet-up

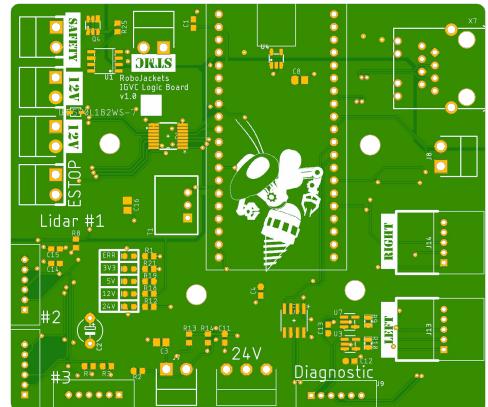
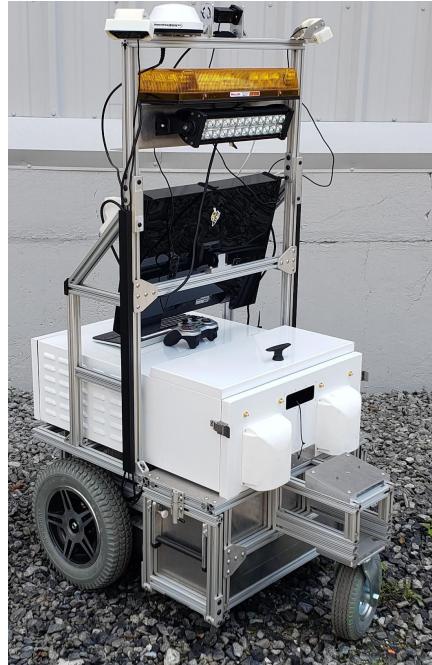


Team Introductions

We build robots!

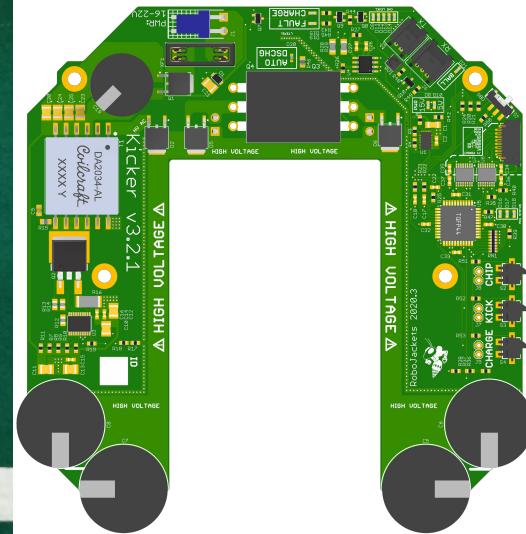
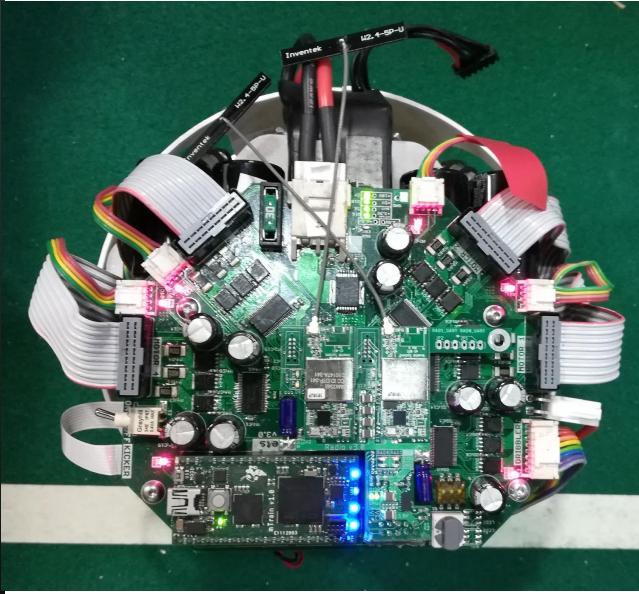
RoboNav

- *Weatherproof Electronics*
- *Multi-threaded Firmware*



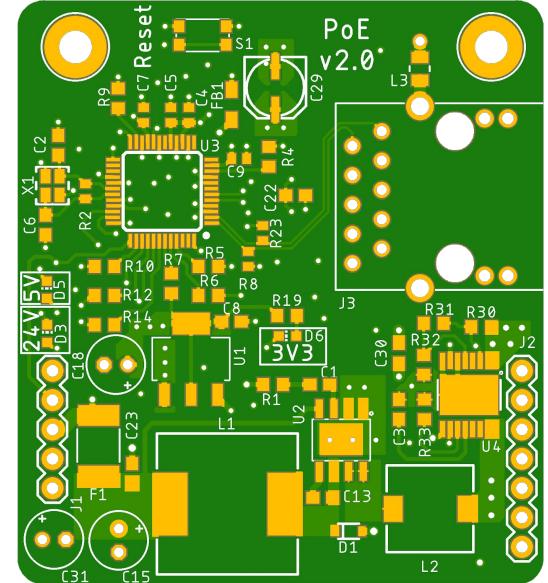
RoboCup

- *Power Electronics*
- *FPGA-based Motor Control*



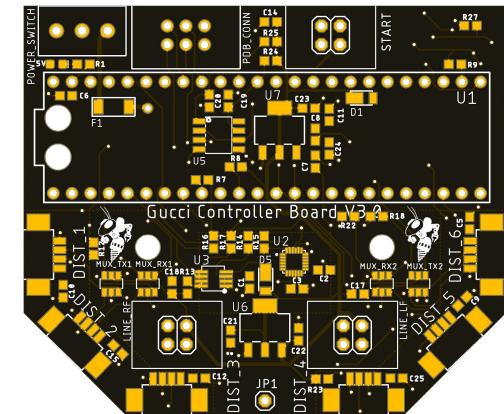
RoboRacing

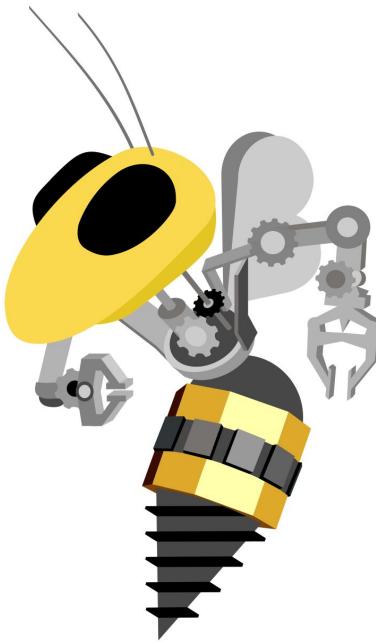
- Distributed Network Systems*
- High Speed and Power*



RoboWrestling

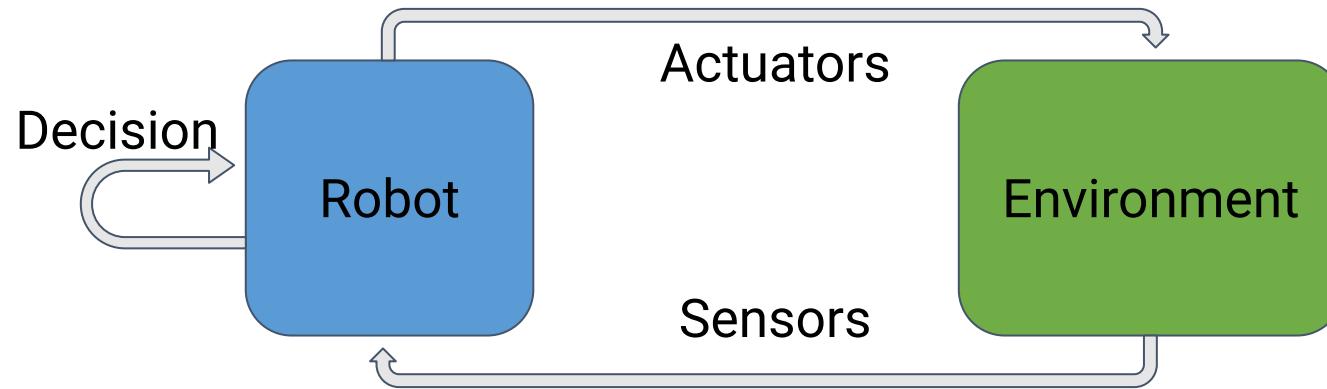
- *Real-Time Strategy*
- *Small Packaging*

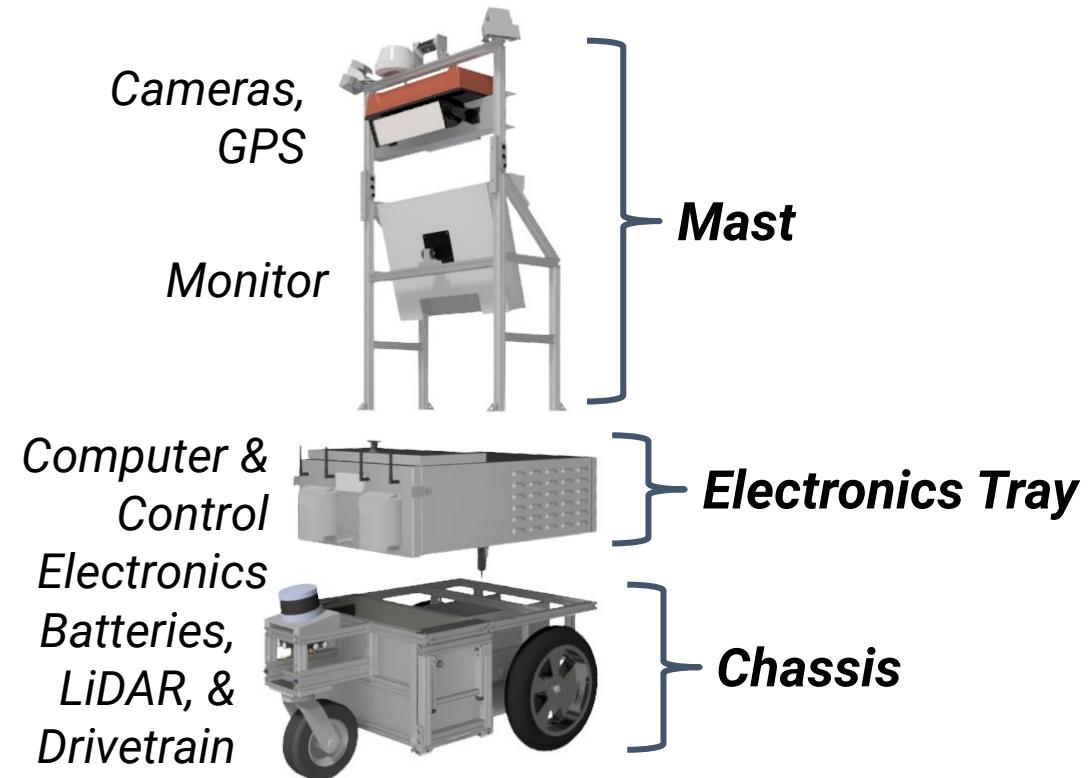




Robotics

What is a Robot?



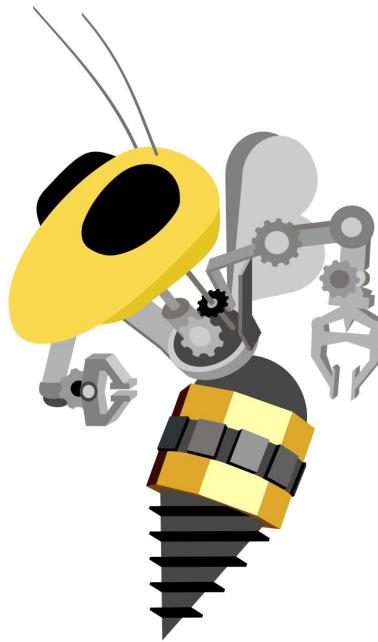




- LiDAR
- Inertial Measurement Unit
- Cameras
- Wheel Encoders

- Custom-built Computer
- Mbed Microcontroller

- 2x Brushed DC Motors



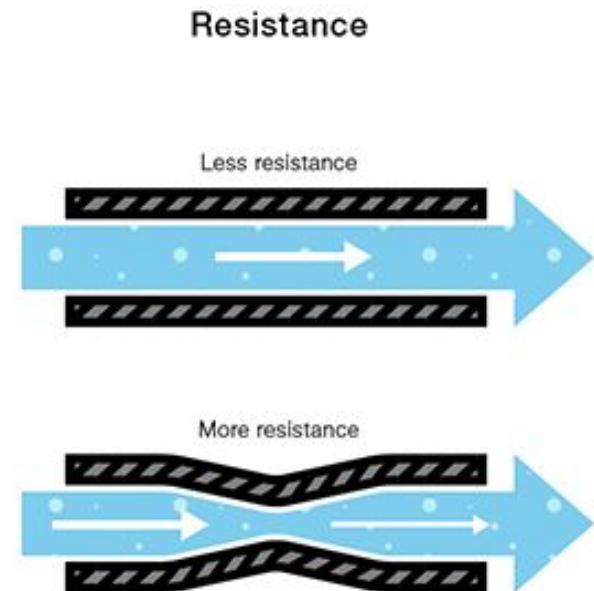
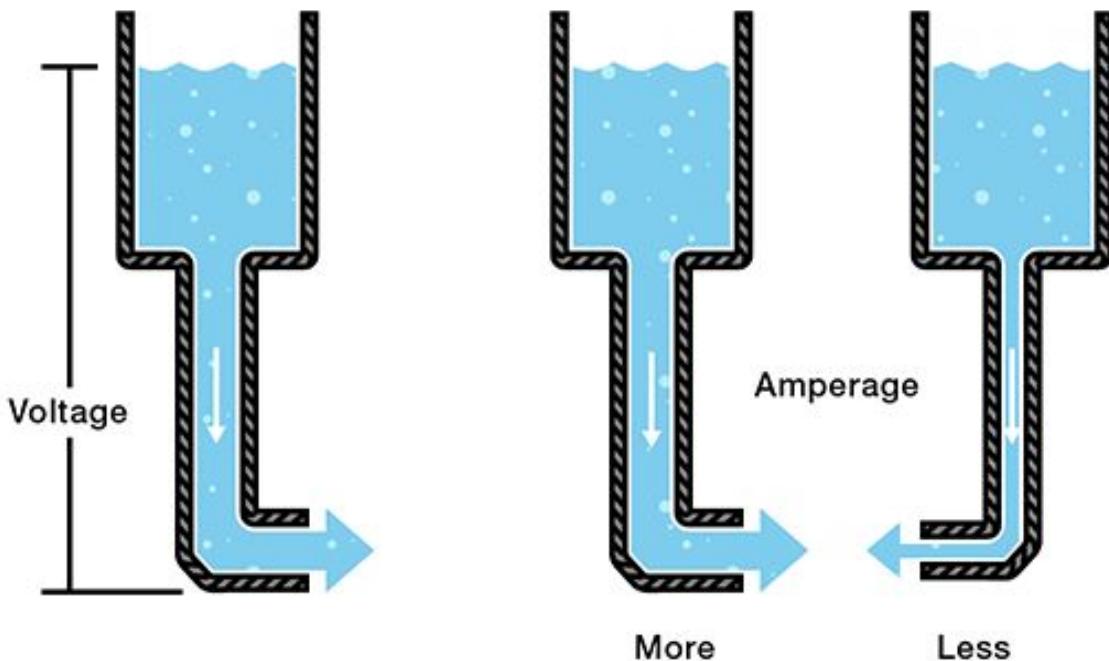
Electricity Basics

Electrons go brrrr

What is electricity?

- Movement of charged particles (electrons)
- Voltage: Amount of potential energy in electrons (J/C)
- Current: Rate at which electrons flow (C/s)
- Current flows from high potential to low potential, releasing energy

Water Analogy



V_{CC}/V_{DD} and GND

V_{CC}/V_{DD} is often used to represent a power voltage

GND is used to represent ground
Reference voltage for 0 Volts

Measuring

Multimeter Basics



Ohm's Law

- $I = V/R$
 - Current (I): net flow of charged particles, Amperes(A)
 - Voltage (V): electric field potential difference, Volts(V)
 - Resistance (R): difficulty for current to pass through, Ohms(Ω)

Example circuit

Connect either end of a battery to light bulb

Have a switch to control the flow of current

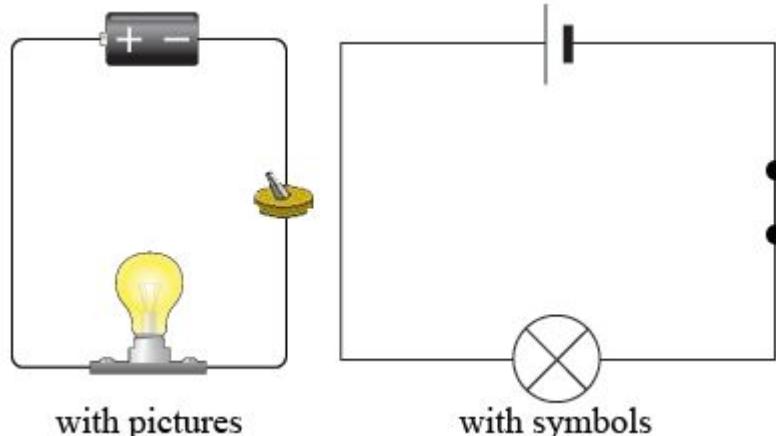


Image Source: k8schoollessons.com

Electron Flow Notation

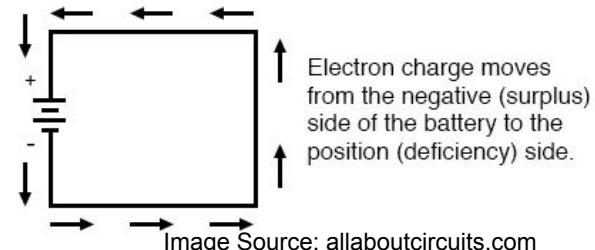
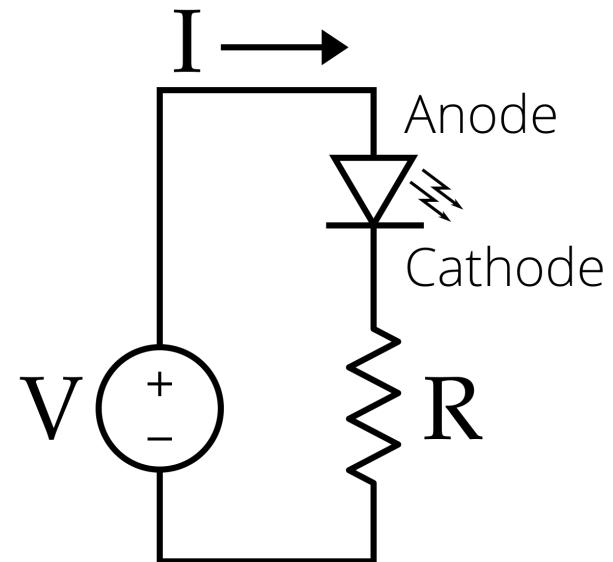


Image Source: allaboutcircuits.com

Example circuit

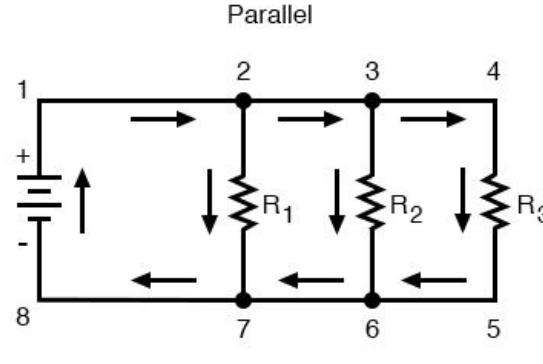
Current flows through the circuit allowing the LED to turn on



Parallel and Series Circuits

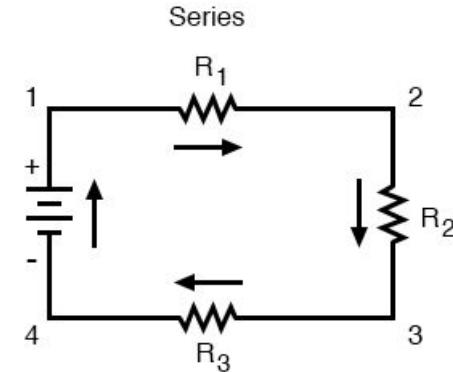
Parallel

- Constant voltage drop for each path



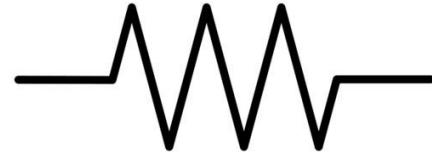
Series

- Current is the same everywhere in the circuit



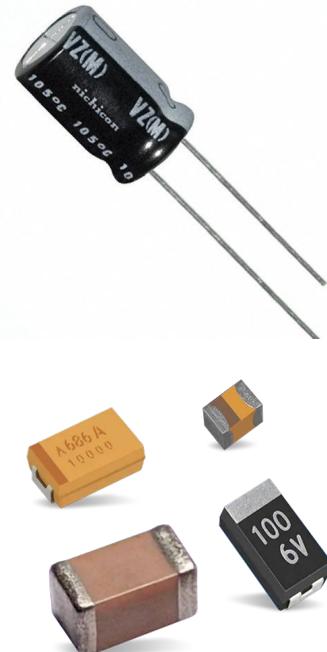
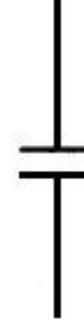
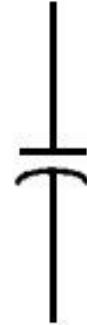
Resistor

- Resistance measured in Ohms (Ω)
- Reduces current flow
- Converts electrical energy to heat



Capacitor

- Measured in Farads (F)
- Stores energy as an electric field between two charged plates
- Uses:
 - Power Source
 - Smoothing voltage signals



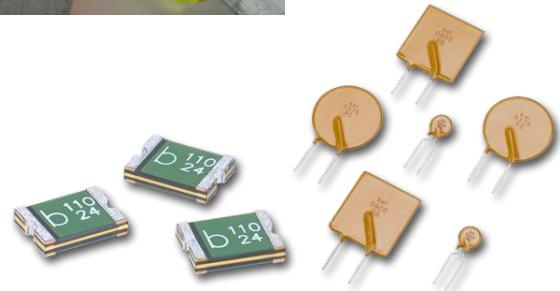
Inductor

- Measured in Henry (H)
- Stores energy as a magnetic field in a coil
- Uses:
 - Smoothing current
 - Electromechanical parts



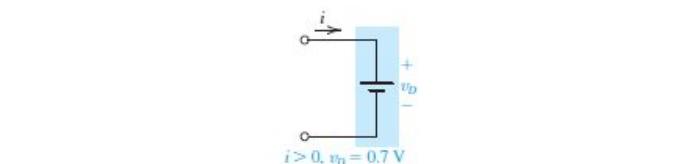
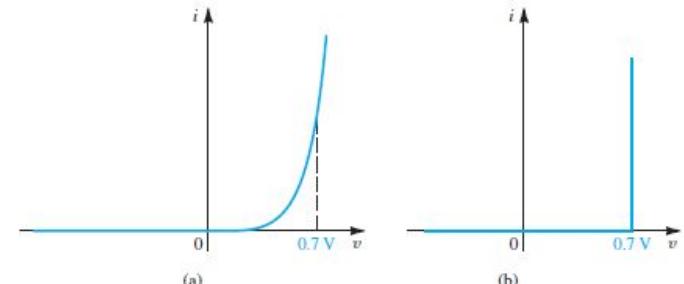
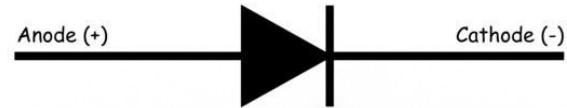
Fuse

- Safety device which blows when too much current flows through it



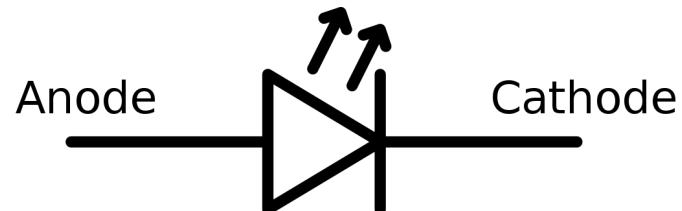
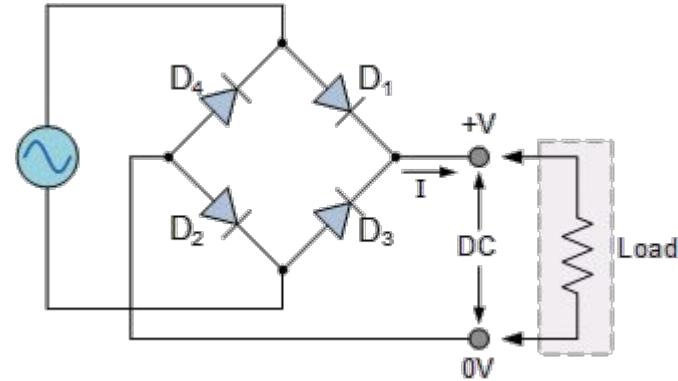
Diode

- Conducts current in one direction
- CVD Model: Assume diode conducts infinite current at constant voltage



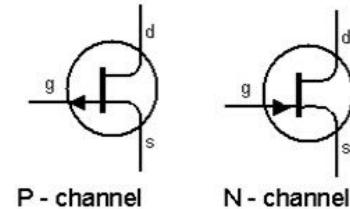
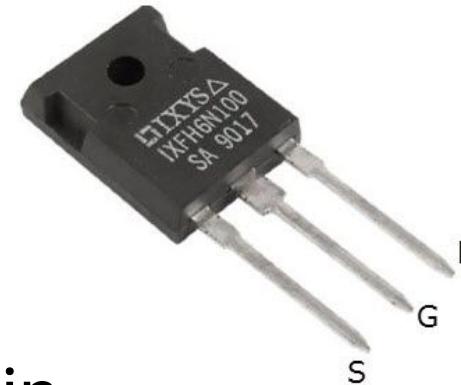
Diode

- Uses:
 - Rectification
 - Reverse Polarity Protection
 - Light Emitting Diode



Transistor (MOSFET)

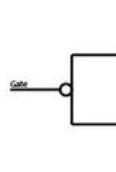
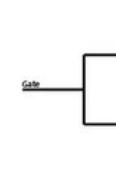
- 3 Terminal Component
 - Gate, Drain, Source
- Voltage signal at gate controls current flow between Source and Drain
- Acts as an electronic switch



D=Drain
S=Source
G=Gate

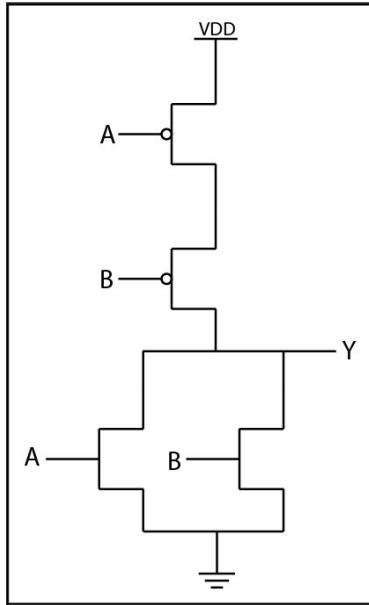
Transistor

- Transistors “activate” when the gate-source voltage reaches the threshold
- Two types: N- and P-Type
 - N-Type: source kept at GND
 - P-Type: source kept at VCC

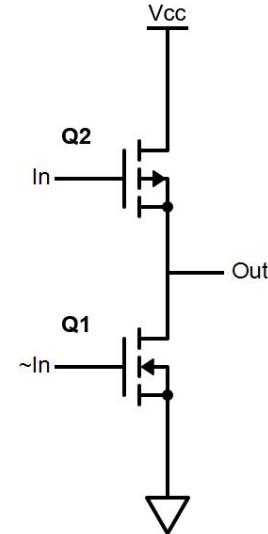
Signal on the Gate	PFET	NFET
		
0 (Logic Low, VDD)		
1 (Logic High, GND)		

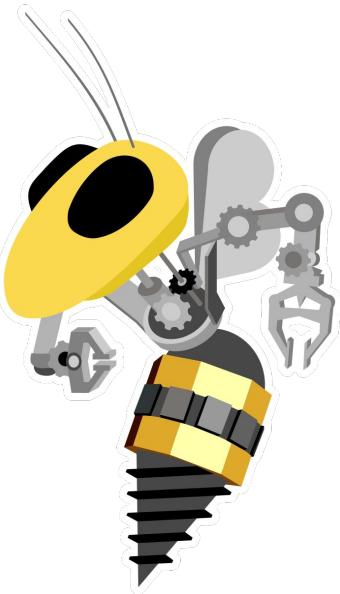
Transistor Uses

Digital Logic



Power Amplification





Kahoot

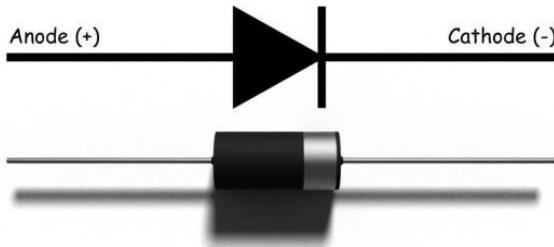
Test your knowledge

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Electrical Components

Diodes

- Conducts current primarily in one direction



Fuses

