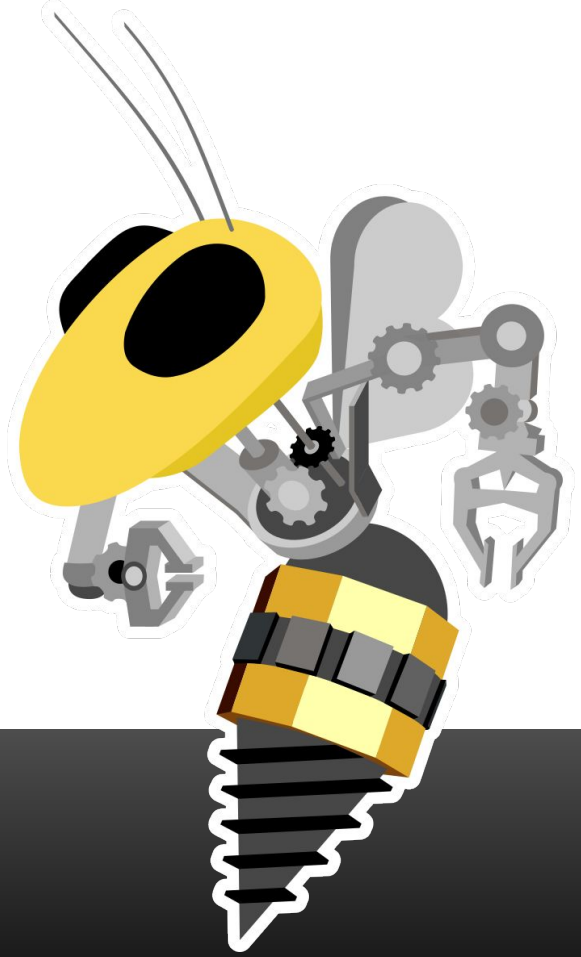
Welcome!

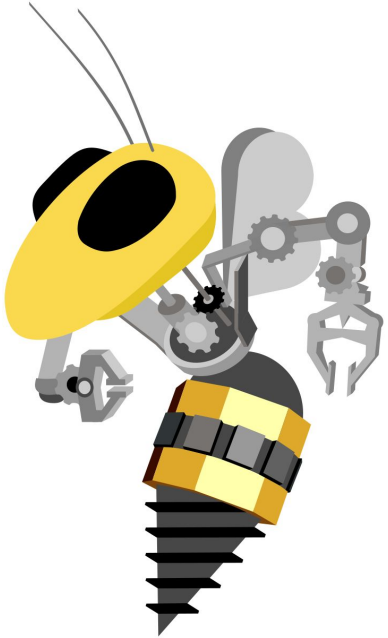
Electrical/Firmware Training Week 0



RoboJackets

Competitive Robotics at Georgia Tech

www.robojackets.org

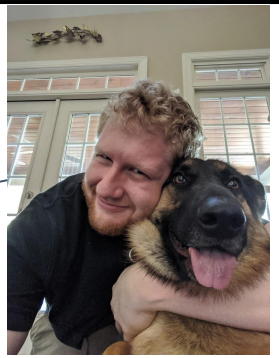


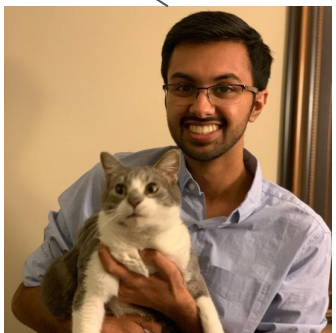
Instructor Introductions

Who are we?

4+ Years

- Collin (RoboCup, CS)
- Joe (RoboRacing, EE)
- Juan (RoboWrestling, EE)
- Logan (RoboWrestling, CS)
- Varun (BattleBots, EE)



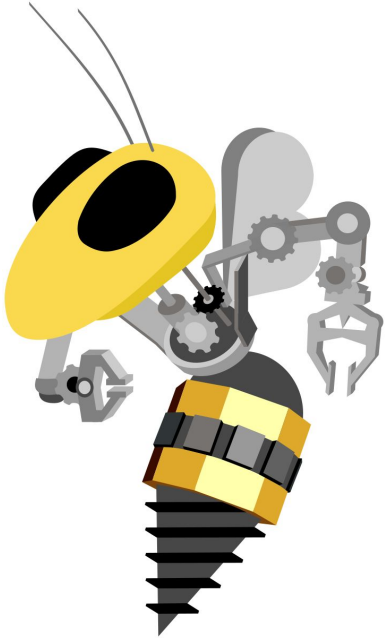


3rd Years

- Arvind (RoboCup, CompE)
- Arthur (RoboCup, CompE)
- Asha (RoboCup, CompE)
- Marine (RoboCup, EE)

2nd Years

- Andrew (RoboRacing, CompE)
- Eugene (RoboNav, CompE)
- Maanas (RoboWrestling, CompE)
- Stella (RoboCup, EE)
- Devaughn (RoboCup, EE)



Disciplines

What's the difference?

Electrical

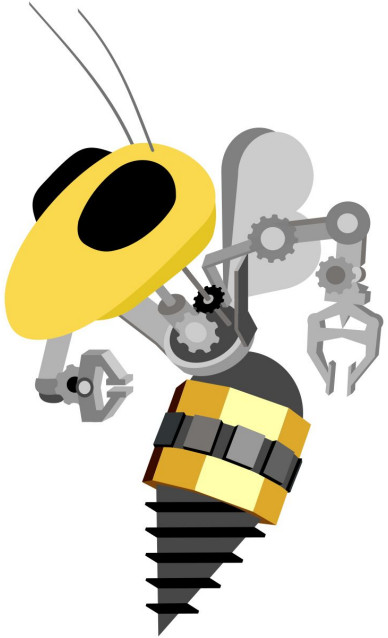
- What we do?
  - Develop PCBs to integrate components (sensors, motors, etc), assemble and test them
  - System design (power, wiring, safety systems)
- What you learn in Electrical Training?
  - Electrical components and common circuits
  - Prototyping
  - Printed Circuit Board (PCB) design using EAGLE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

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
  - Design choices for electrical systems

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 Thursday 6:30-8:30
  - Only need to come to one a week
  - All meetings will be virtual on MS Teams

Weekly Plan

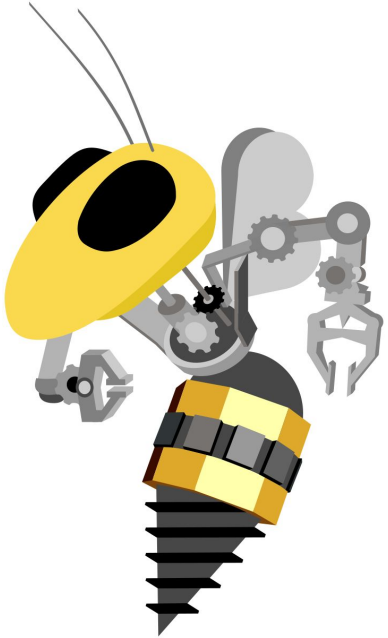
Week	Electrical Training	Firmware Training
0	Introductions, Electrical Basics	
1	Introduction to Prototyping and Arduino	
2	EAGLE Parts and Libraries	More C and Interrupts
3	EAGLE Schematics	PWM and Bitwise Operations
4	EAGLE Board Layout	Communication Protocols
5	Debugging	
6	Design Choices	

Online Platforms

- MS Teams - Training Calls
  - YouTube - Recorded Lectures
- Piazza - Q&A for Training
- Email - Announcements
- GitHub - Slides and Labs
- 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 #meet-n-greet



Team Introductions

We build robots!

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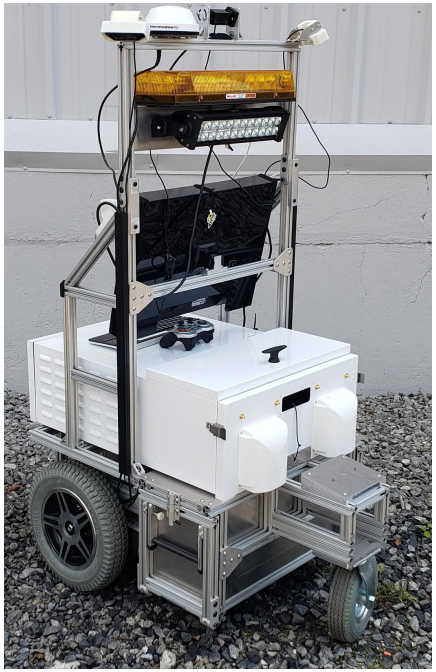
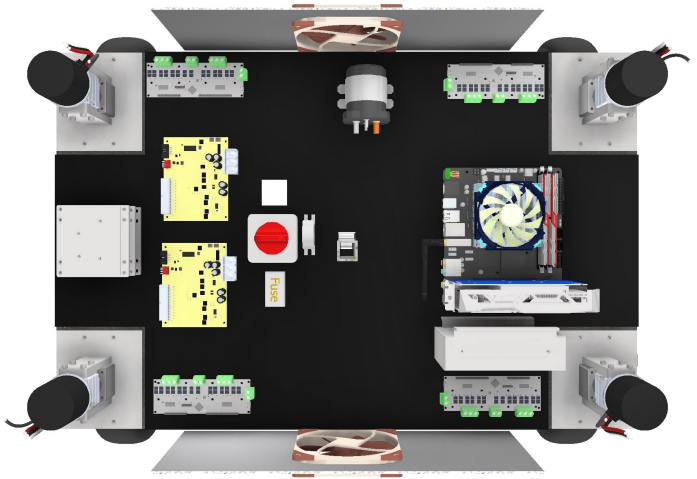
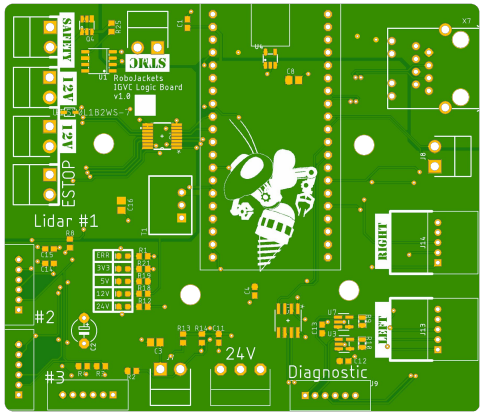
RoboNav

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

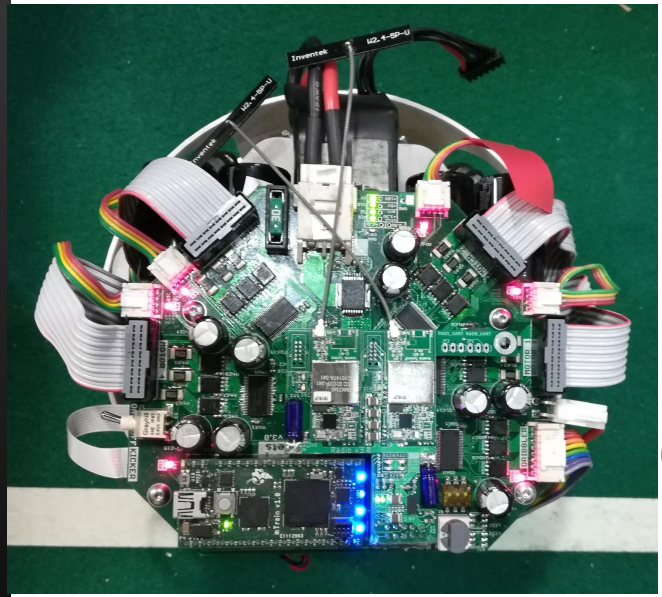


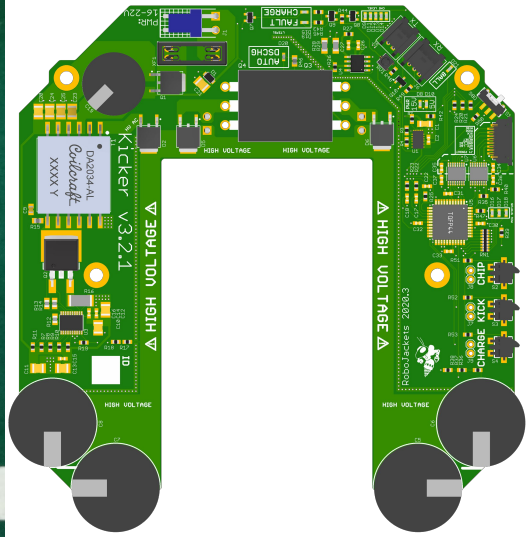




RoboCup

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





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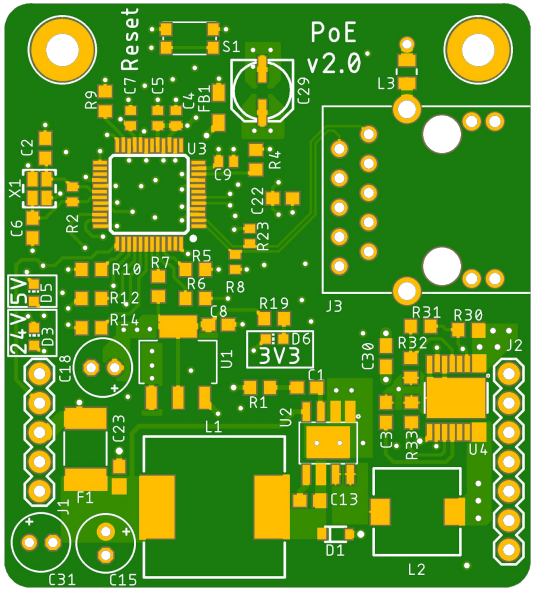
RoboRacing

- *Distributed Network Systems*
- *High Speed and Power*



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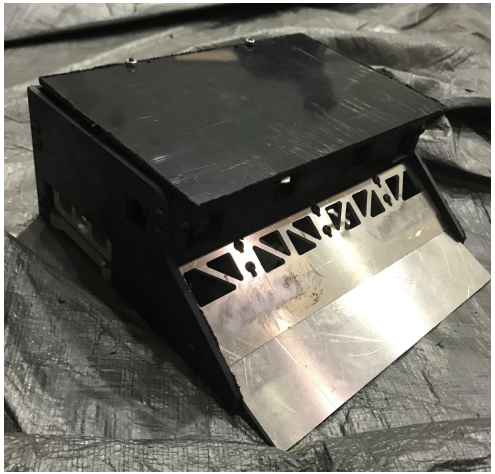
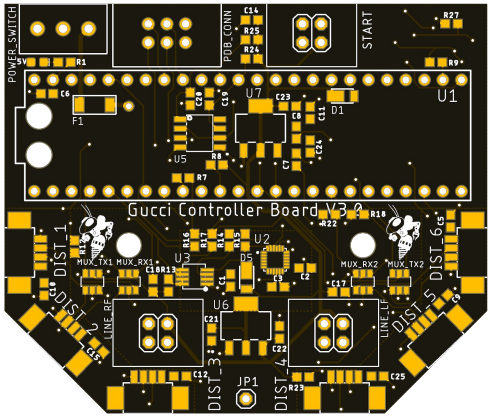
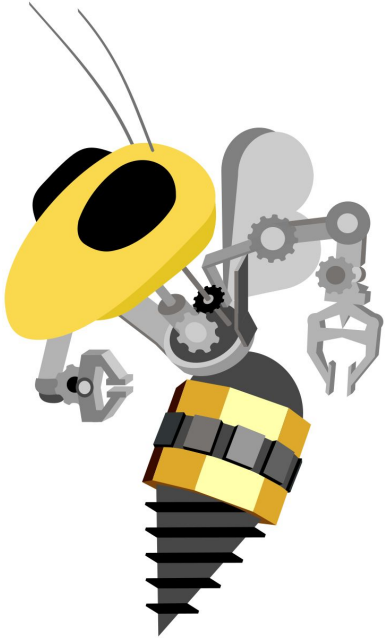
RoboWrestling

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

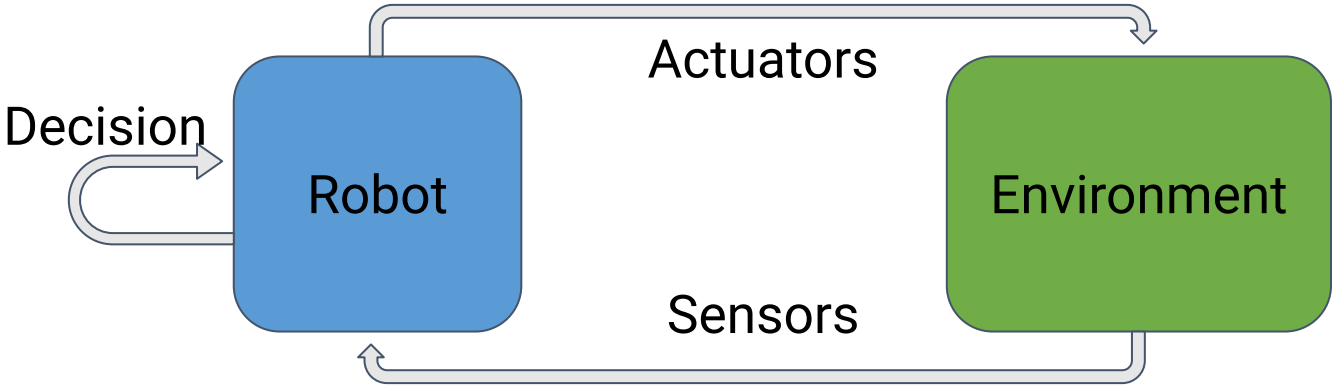






Robotics

What is a Robot?



Cameras, GPS

Monitor

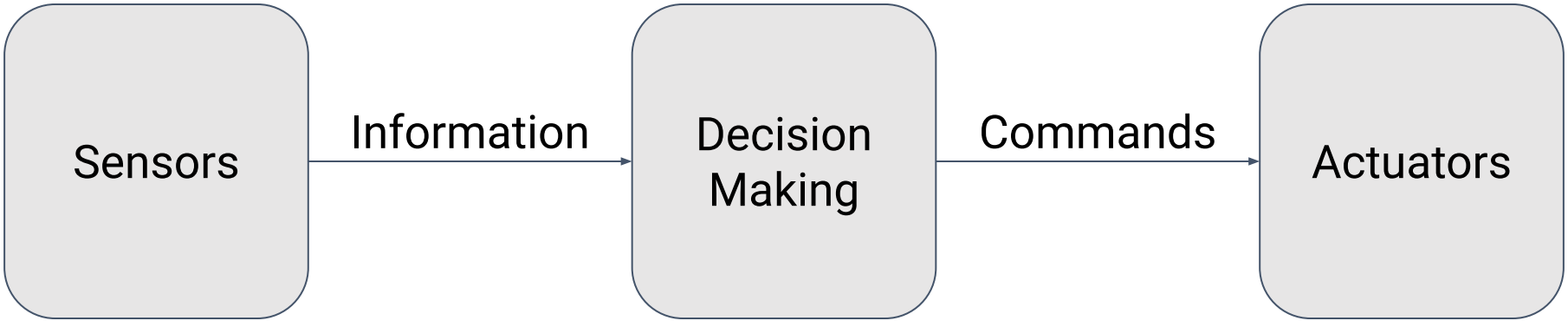
Mast

Computer & Control Electronics

Electronics Tray

Batteries, LiDAR, & Drivetrain

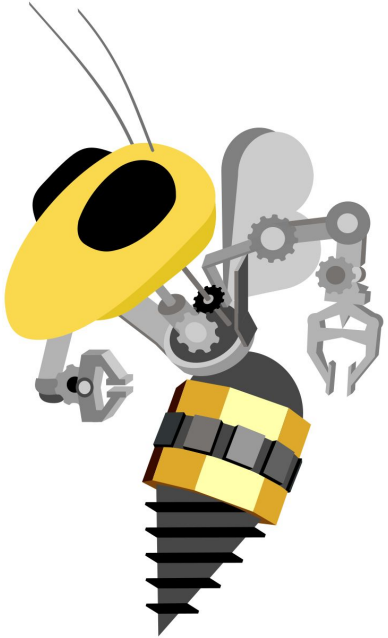
Chassis



- LiDAR
- Inertial Measurement Unit
- Cameras
- Wheel Encoders

- Custom-built Computer
- Mbed Microcontroller

- 2x Brushed DC Motors



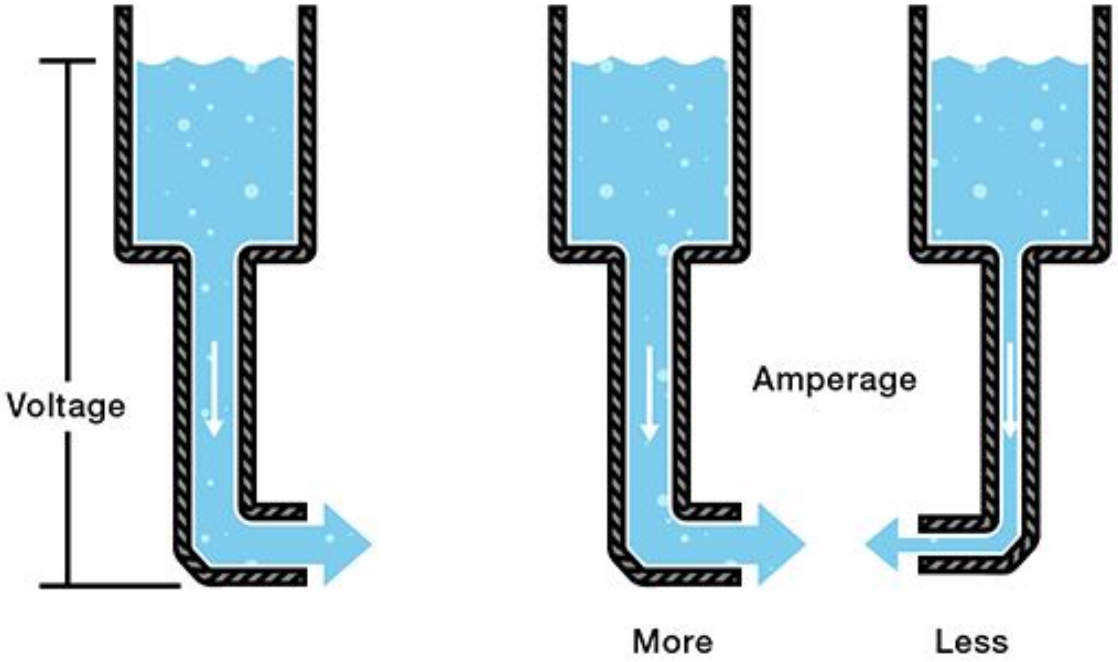
Electricity Basics

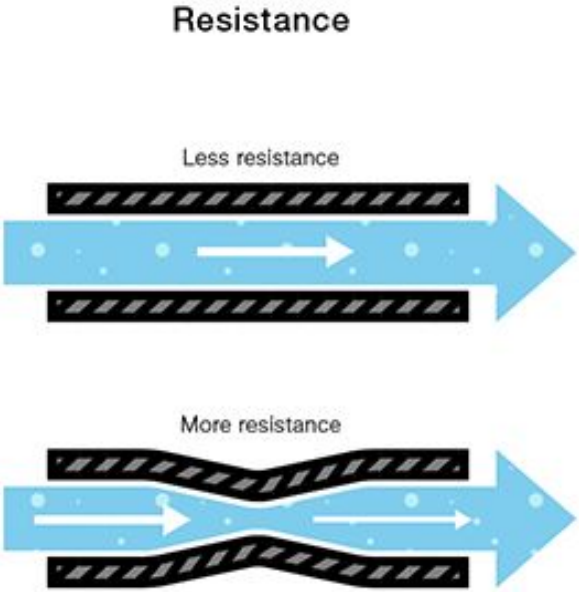
Electrons go brrrr

What is electricity?

- Movement of charged particles
- Charged particles in a potential difference (voltage) move from high potential to low potential

Water Analogy





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

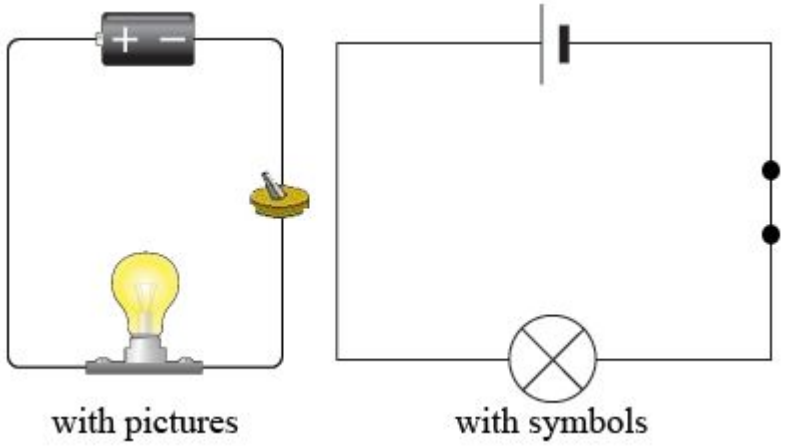


Image Source: k8schoollessons.com

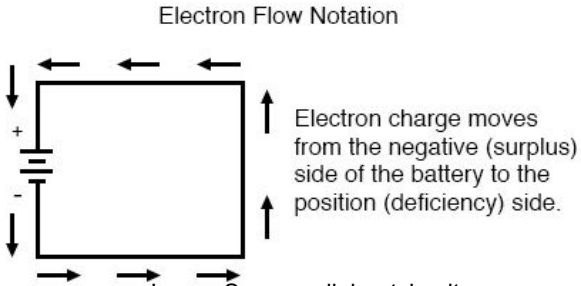


Image Source: allaboutcircuits.com

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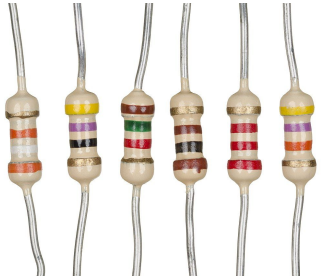
Measuring

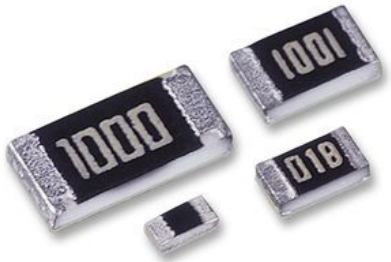
Multimeter Basics

Electrical Components

Resistors

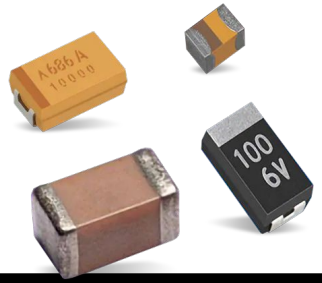
- Reduce current flow and divide voltage





Capacitors

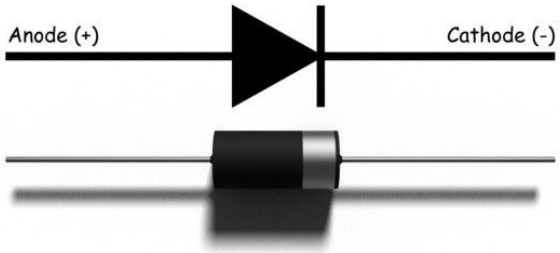
- Stores energy and smooths voltage levels



Electrical Components

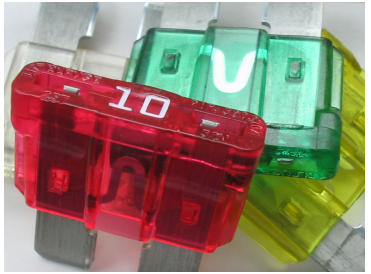
Diodes

- Conducts current primarily in one direction



Fuses

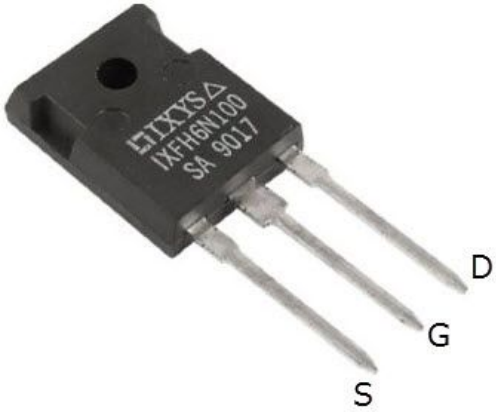
- Prevents over current

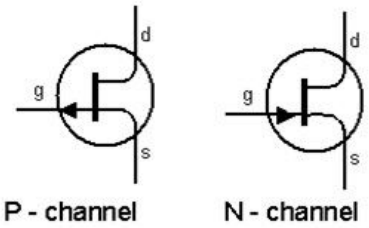


Electrical Components

Transistors

- Can act as electronic switches
- Can amplify electrical signals



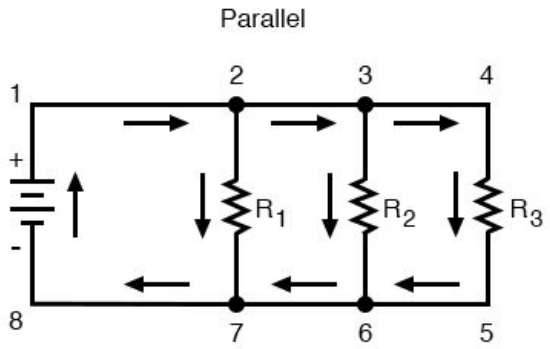


D=Drain
S=Source
G=Gate

Parallel and Series Circuits

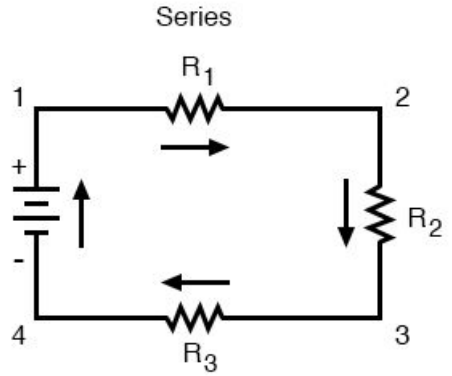
Parallel

- Constant voltage drop for each path



Series

- Current is the same everywhere in the circuit

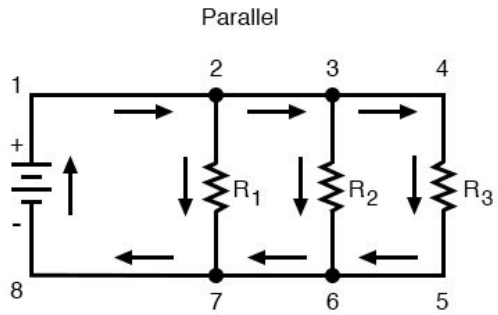


Parallel and Series Circuits

Parallel

$$V_{total} = V_1 = V_2 = V_3$$

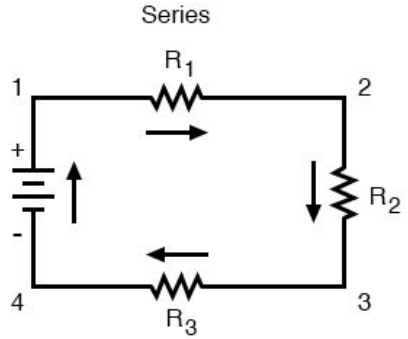
$$1/R_{total} = 1/R_1 + 1/R_2 + 1/R_3$$



Series

$$V_{total} = V_1 + V_2 + V_3$$

$$R_{total} = R_1 + R_2 + R_3$$



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