

STEM Sprouts Electrical Engineering Camp

#1 WiFi Websocket Controlled Vehicles (WCV)

2 Week Course, 12 Days

Overall Course Learning Objectives

By the end of the course, students will be able to:

- Design and build functional remote-controlled vehicles
- Apply basic electronic principles to real circuits
- Write and modify code (C, C++, HTML, JavaScript) to control hardware
- Use wireless communications to control a physical device
- Follow an engineering design process (Plan > Build > Test > Improve)
- Debug hardware and software issues systematically

Week 1 Establishing Foundation (Electrical Engineering and Programming)

By the end of week 1, students will be able to...

Core Electronics Understanding

Explain and apply the relationship between voltage, current, and resistance in simple circuits

Build and troubleshoot closed circuits using breadboards, LEDs, resistors, and buttons

Interpret and construct circuits from basic circuit diagrams

Input & Output Control

Program a microcontroller (ESP32) to control digital outputs (LEDs, motors)

Read and respond to digital inputs (buttons, switches)

Implement simple logic such as toggling, conditionals, and input-based behavior

Analog & Signal Control

Differentiate between analog and digital signals

Read analog inputs (e.g., potentiometers) and map values to outputs

Use PWM (Pulse Width Modulation) to control brightness and motor speed

Mechatronics Basics

Safely control a DC motor using a motor driver

Explain why motors require separate power considerations

Modify motor behavior (direction and speed) through code

Intro to Connected Systems

Describe how a microcontroller can act as a WiFi access point

Build a simple web interface using HTML/JavaScript to control hardware

Use WebSockets to enable real-time communication between a device and a controller

Problem-Solving Foundations

Identify and fix simple hardware and coding issues

Use iterative testing to improve circuit behavior

Day 1 Intro to Basic Electrical Engineering

Concepts:

What is voltage, current, resistances, ohms

Circuits, closed vs open

Breadboards

Microcontroller (ESP32s)

LEDs and semiconductors

Labwork:

Light an LED

Manipulate LED via buttons and switches

Day 2 LEDs and Inputs

Concept:

Digital inputs/outputs

Pull-up/pull-down

Debouncing

Labwork:

Button toggles LED on/off

Build a simple reaction game

Read a circuit diagram

Day 3 Analog Control (Potentiometers)

Concept:

Analog vs digital signals

Reading values (0–1023 or similar)

PWM (for dimming)

Labwork:

Using potentiometer to control LED brightness

Day 4 Motors and Power

Concepts:

Why motor needs more power

Motor drivers and their functions

Safety (capacitors)

Labwork:

Spin a DC motor, left and right
Control the spin of a motor using PWM

Day 5 Intro to Wireless Control**Concepts:**

WiFi, access points and websockets

Labwork:

Connect to microcontroller Wifi
Control LED from a webpage

Day 6 Real Time Control**Concepts:**

Differences clicks vs continuous
control Real-time communication

Labwork:

Slider on a webpage to control motor speed

Week 2 Application (Electrical Engineering and Programming)

By the end of Week 2, students will be able to...

Engineering Design & Planning

Apply the engineering design process (Plan → Build → Test → Improve) to a real project
Create and interpret a basic circuit diagram for a multi-component system
Make design decisions based on constraints (materials, power, stability)

Mechanical & Structural Design

Build a functional vehicle chassis with attention to stability and weight distribution
Explain how gear ratios and motor placement affect performance
Assemble mechanical and electronic components into a unified system

Systems Integration

Wire and organize a complete system including:
Microcontroller (ESP32)
Motor driver
Power supply
Implement clean wiring practices for reliability and safety

Control Systems Implementation

Map user inputs (web interface) to physical outputs (motor movement)
Implement differential steering (or equivalent control logic)
Operate a vehicle through wireless real-time control (WebSockets)

Debugging & Iteration

Systematically debug issues across:
Hardware (wiring, power)
Software (logic, communication)
Test and refine designs to improve performance and reliability

Communication & Reflection

Demonstrate a working WiFi-controlled vehicle
Explain design choices and challenges encountered
Reflect on improvements and future iterations

Day 7 Engineering Design and Planning

Concepts:

Design process (plan > build > test > improve)
Show available materials for project and ask what students are looking for

Labwork:

Sketch the WCV
Choose 2-wheeler or 4-wheeler
Choose additional components
Plan the circuit diagram

Day 8 Chassis and Mechanical Build

Concepts:

Stability and weight distributions
Gear ratios

Labwork:

Build chassis
Mount motor and wheels

Day 9 Wiring and Power Systems

Concepts:

Clean wiring
Power distribution

Labwork:

Battery
Motor driver
Microcontroller

Day 10 Control System Integration

Concepts:

Mapping inputs

Labwork:

Connecting WCV to websocket
First controllable WCV

Day 11 Debugging and Testing

Concepts:

Debugging mindsets
Iterations

Labwork:

Debugging hardware and software
Continue work on WCV

Day 12 Showcase with Competition

Labwork:

Obstacle courses and races
Awards given out to the students
Reflection

Course Success Criteria

By the end of the course every student should have...

- Working WCV they built themselves
 - Web-based controller they can understand and modify -
- At least one successful debugging experience