

# Embedded Devices Roadmap with Timeline

## Phase 1: Foundations (Month 1-2)

- Learn C/C++ programming (focus on memory management, pointers, structs).
- Understand basic electronics (Ohm's Law, resistors, capacitors, transistors).
- Get familiar with digital logic and binary number systems.
- Practice using basic microcontrollers like Arduino or STM32.

## Phase 2: Embedded Systems Core (Month 3-4)

- Study microcontroller architecture (ARM Cortex-M, AVR, etc.).
- Learn to read datasheets and use peripheral interfaces (GPIO, UART, SPI, I2C).
- Develop embedded C projects on platforms like STM32, ESP32, or AVR.
- Learn to use IDEs and toolchains (Keil, STM32CubeIDE, MPLAB X).

## Phase 3: RTOS and Advanced Concepts (Month 5-6)

- Learn RTOS concepts (FreeRTOS, ThreadX).
- Understand task scheduling, semaphores, mutexes, and queues.
- Implement multitasking systems with FreeRTOS on STM32 or ESP32.
- Explore interrupt handling and low power modes.

## Phase 4: Embedded Linux and Connectivity (Month 7-8)

- Get started with Embedded Linux (Yocto, Buildroot, Raspberry Pi).
- Work with device trees, kernel modules, and drivers.
- Learn networking protocols (MQTT, HTTP, TCP/IP) for IoT.
- Explore tools like Wireshark for debugging.

## Phase 5: Projects and Specialization (Month 9-12)

- Build end-to-end projects (IoT, robotics, wearable devices).

- Learn OTA updates, bootloaders, and secure firmware practices.
- Specialize in a domain (automotive, medical devices, consumer electronics).
- Contribute to open-source or freelance in embedded systems.