



LAUNCH OFFER: Get 15% OFF on early enrolment · Limited seats per cohort

EMBEDDED SYSTEM COMMUNICATION PROTOCOLS INTERNSHIP

ESP32 — Basic to Advanced

🔗 Industry-Level Communication Protocol Mastery — design, build and debug real-world embedded systems from the ground up.

START DATE	DURATION	MODE	FEE
15 June 2026	6 Weeks 8 Live Sessions · 2 hrs each	Online — Live Theory + Live Coding	Rs. 2,499/- (MRP Rs. 4999/-)

RESERVE YOUR SEAT

BOOK FREE CAREER CALL

In collaboration with NSDC & DPIIT | MSME Registered | Recognised under Startup India & Skill India

Meet Your Instructor

Industry-grade trainer who has shipped real embedded products.



Radha Vishwakarma

Embedded Systems Expert · Technical Trainer

Industry practitioner with deep expertise in ESP32, embedded communication protocols and IoT product development. Brings a "build-first" classroom approach — every topic is taught with live coding and real hardware so learners walk out with shippable skills, not just slides.

Has trained 2,000+ students and engineers across UART, I2C, SPI, MQTT, CAN Bus and Modbus, with a focus on industry-grade debugging, signal-level understanding and protocol troubleshooting.

About the Program

A 4-week deep-dive into the protocols that power modern embedded products.

This 6-week intensive live training is designed for engineering students, electronics hobbyists and working professionals who want to master embedded communication protocols on industry-grade hardware. Built around the ESP32 platform and the Arduino IDE, the program takes you from "blink an LED" all the way to multi-protocol IoT systems — the same protocols that power real consumer, industrial and automotive products today.

You will go deep into wired protocols (UART, I2C, SPI), signal control (ADC, DAC, PWM), wireless stacks (Wi-Fi Web Server, Bluetooth Classic, BLE), cloud IoT messaging (MQTT, HTTP REST API), and industrial buses (CAN, Modbus RTU over RS485). Every concept is reinforced with live coding, real sensors, real displays and real cloud dashboards — not simulations. You will also learn the engineering fundamentals that make all of this work: pull-ups, baud rates, addressing, master/slave architectures, interrupts and data logging.

By the end of the course, you will be able to design, build and debug complete embedded communication systems from scratch, ship a portfolio of 5 industry-grade final projects, and confidently walk into interviews for embedded, IoT and firmware roles.

Learning Outcomes

By the end of this program, you will be able to:

- ✓ Set up the ESP32 toolchain and confidently program GPIOs, serial debugging and basic peripherals.
- ✓ Implement and troubleshoot wired communication using UART, I2C and SPI with real sensors and displays.
- ✓ Read, condition and process analog signals using ADC, generate analog output with DAC, and control motors / servos using PWM.
- ✓ Build Wi-Fi Web Servers (Station + Access Point modes) and exchange data using HTTP and JSON.
- ✓ Communicate over Bluetooth Classic and BLE — including controlling devices from a mobile app.
- ✓ Connect ESP32 to the cloud using MQTT (publish/subscribe model) and HTTP REST APIs with a live dashboard.
- ✓ Implement industrial protocols — CAN Bus and Modbus RTU over RS485 — at the message-frame level.
- ✓ Log sensor data to SD Card and store configuration in EEPROM in real time.
- ✓ Use external and timer interrupts efficiently with proper ISR design.
- ✓ Architect and ship complete multi-protocol embedded products combining UART + I2C + SPI + Wi-Fi + MQTT in one system.

Course Curriculum

11 modules across 4 weeks · Live sessions + hands-on labs + instructor-led doubt clearing.

WEEK 1 — BASIC FOUNDATION

MODULE 1

ESP32 Fundamentals

Topics Covered

- What is an Embedded System
- Difference between Microcontroller and Microprocessor
- Introduction to ESP32 — CPU cores, GPIO, Memory (Flash, SRAM)
- Installing Arduino IDE and setting up ESP32
- Working with GPIO — LED Output and Button Input
- First Program: LED Blink and Button-Controlled LED
- Using Serial Monitor for output and debugging
- What is a Pull-up and Pull-down resistor
- Debugging techniques using Serial Monitor

MODULE 2

UART Communication

Topics Covered

- What is UART Communication
- TX and RX pins — how data flows
- What is Baud Rate and why it matters
- UART in ESP32 — multiple UARTs and configurable pins
- Sending (TX) and Receiving (RX) data
- Basic idea of UART Interrupt
- Who can ESP32 talk to: Computer, Arduino, GSM Module
- Troubleshooting common UART problems

WEEK 2 — WIRED COMMUNICATION PROTOCOLS

MODULE 3

I2C Communication

Topics Covered

- What is I2C — SDA and SCL pins

- Master and Slave architecture
- Device addressing in I2C — how multiple devices share one bus
- I2C speed modes and configuring pins on ESP32
- I2C Scanner — finding all connected devices
- Connecting and running multiple I2C devices simultaneously
- Why Pull-up resistors are needed on I2C lines
- Troubleshooting common I2C problems

Devices Used

- ▶ OLED Display
- ▶ RTC Module (Time & Date)
- ▶ Temperature Sensor
- ▶ EEPROM

MODULE 4

SPI Communication

Topics Covered

- What is SPI — MOSI, MISO, SCK, CS pins and their roles
- Master and Slave in SPI
- SPI modes (CPOL and CPHA) and SPI speed
- Using SPI on ESP32
- Connecting and managing multiple SPI devices
- Difference between Hardware SPI and Software SPI

Devices Used

- ▶ SPI Display
- ▶ SD Card Module
- ▶ Flash Memory

WEEK 3 — SIGNAL CONTROL + WIRELESS COMMUNICATION

MODULE 5

ADC / DAC (Analog to Digital & Digital to Analog)

Topics Covered

- What is ADC — Analog to Digital Converter
- How many ADC channels are available in ESP32
- Reading accuracy and resolution
- Reading values from analog sensors
- What is DAC — Digital to Analog Converter
- Difference between PWM and true DAC output
- Signal conditioning basics

Devices Used

- ▶ Potentiometer
- ▶ LDR — Light Dependent Resistor
- ▶ Analog Sensors

MODULE 6

PWM (Pulse Width Modulation)

Topics Covered

- What is PWM — Pulse Width Modulation
- What is Duty Cycle and how it controls power/speed
- PWM Frequency and Resolution
- ESP32 LEDC PWM — using multiple PWM channels simultaneously
- Controlling a Servo Motor using PWM
- Controlling DC Motor speed using PWM

Devices Used

- ▶ Servo Motor
- ▶ DC Motor
- ▶ LED (brightness control)

MODULE 7

Wireless Communication — Wi-Fi & Bluetooth

Topics Covered

- Wi-Fi: Station Mode — connecting ESP32 to existing Wi-Fi
- Wi-Fi: Access Point Mode — ESP32 creates its own Wi-Fi hotspot
- Wi-Fi: Building a Web Server with ESP32
- Wi-Fi: What is HTTP and how requests work
- Wi-Fi: Sending sensor data to a web page
- Wi-Fi: Working with JSON data format
- Bluetooth: What is Bluetooth Classic vs BLE (Bluetooth Low Energy)
- Bluetooth: Bluetooth communication using ESP32
- Bluetooth: Controlling a device from a mobile app over Bluetooth

WEEK 4 — IoT + INDUSTRIAL PROTOCOLS + FINAL PROJECTS

MODULE 8

IoT Protocols — MQTT & HTTP

Topics Covered

- MQTT: What is MQTT and why it is used in IoT
- MQTT: What is a Broker — Publish and Subscribe model
- MQTT: Setting up MQTT on ESP32

- MQTT: Sending sensor data to cloud and receiving commands
- HTTP: What is HTTP GET and HTTP POST
- HTTP: Basic idea of REST API
- HTTP: Uploading data to a server using HTTP

Platforms Used

- ▶ MQTT Broker
- ▶ Cloud Dashboard

MODULE 9

Industrial Protocols — CAN Bus & Modbus

Topics Covered

- CAN: What is CAN Bus and where it is used in industry
- CAN: CAN Message Frame structure
- CAN: What is Arbitration in CAN
- CAN: Using CAN protocol on ESP32
- Modbus: What is Modbus RTU
- Modbus: Master and Slave communication in Modbus
- Modbus: Reading data from Registers
- Modbus: What is RS485 and how it differs from UART

MODULE 10

Data Logging

Topics Covered

- What is Data Logging and when is it needed
- Saving sensor data on an SD Card in real time
- Storing small data in EEPROM — read and write

MODULE 11

Interrupts

Topics Covered

- What is an Interrupt and why it is used
- External Interrupt — triggering action on button press
- Timer Interrupt — triggering action after a set time interval
- Interrupt Service Routine (ISR) — writing efficient interrupt handlers

WEEK 5 & 6 — Hands-on Final Projects

Hands-on Final Projects

Graduate with 5 working, demonstrable projects — built end-to-end, the way real products are.

#	PROJECT	WHAT YOU WILL BUILD
#1	IoT Weather Monitoring System	<i>I2C sensor + Wi-Fi + MQTT cloud upload + Web Dashboard. Build a live weather station that publishes temperature, humidity and pressure data to a cloud broker and visualises it on a custom web dashboard.</i>
#2	Smart Home Automation	<i>UART + Firebase + Flutter App + Relay control over Wi-Fi. Build an end-to-end smart home system controlled from a mobile app, with real-time state sync via Firebase.</i>
#3	Industrial Sensor Monitoring	<i>Modbus RTU + RS485 + MQTT + Cloud Dashboard. Industry-grade Modbus slave reader that bridges plant-floor data to the cloud over MQTT — the same architecture used in real Industry 4.0 deployments.</i>
#4	Data Logger with Cloud Upload	<i>ADC sensor reading + SD Card logging + HTTP POST to server. Capture, log and upload analog sensor data with offline buffering and automatic cloud sync once Wi-Fi is back.</i>
#5	Multi-Protocol Communication Gateway	<i>UART + I2C + SPI + Wi-Fi + MQTT in one system. Capstone project — a single ESP32 acting as a multi-protocol gateway, integrating every protocol learnt across the course into one shippable product.</i>

Get Certified








Yes! You will be certified for this course on completion of the program.

✓ Official & Verified	✓ Easy to Share	✓ Career Edge
Signed by the instructor — recognised certificate	Add directly to your resume and LinkedIn profile	Use it to stand out and get ahead in your career shift

[!\[\]\(3d8c13c92b853674f749aac6fa869926_img.jpg\) RESERVE YOUR SEAT](#)

Live Training Highlights

Everything you get when you enrol in a Nation Innovation live training program.

 Certificate Certificate course in collaboration with NSDC, DPIIT	 Internship Opportunity to intern overseas	 24×7 Support Training with 24×7 mentor support
 1:1 Mentoring Personalised 1:1 mentoring & doubt sessions	 Flexible Schedule Designed to fit students and working professionals	 6-Digit Salary Assured 6-digit salary association with industry partners
 LMS & Recordings Free access to Learning Resource Portal and session recordings	 Live Projects Engage in 3+ live projects and live case studies	 100% Placement Support Career assistance by industry experts

Bonus Learning Perks

Career-ready add-ons included with your enrolment, at no extra cost.

★ GitHub Profile	★ LinkedIn Profile	★ Resume Writing	★ Soft Skills	★ Mock Interview
Build a recruiter-ready GitHub portfolio	Optimise your LinkedIn for visibility,	Craft an ATS-friendly, role-targeted resume	Communication, teamwork and workplace etiquette for interviews.	Live mock interviews with feedback to

★ GitHub Profile	★ LinkedIn Profile	★ Resume Writing	★ Soft Skills	★ Mock Interview
with real project commits.	keywords and recruiter reach.	that gets shortlisted.		sharpen your performance.

Learning Roadmap

Your journey from learner to placed professional — broken down into three guided steps.

STEP 1	STEP 2	STEP 3
Building a Strong Foundation	Internship & Project Learning	Placement Support
Build strong fundamentals from scratch with industry experts.	Gain hands-on experience working on 3+ live projects.	Counselling, confidence building and resume support to land the right career opportunity.

Recognised & Trusted

Operating in collaboration with leading Government of India initiatives and industry bodies.

MSME Registered	Startup India	Skill India	DPIIT Approved	NSDC Partner
Yes	Yes	Yes	Yes	Yes

What Our Learners Say

Trusted Reviews: 24+ | Average rating: 5 / 5 ★

<p>★★★★★</p> <p><i>"Nice and well-organized course."</i></p> <p>Ashwini Ranade</p>	<p>★★★★★</p> <p><i>"I recently completed my Python Programming Internship at Nation Innovation, and it was a highly enriching experience that</i></p>
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<p>Course: Data Science Placed at: National Institute of Hydrology (NIH)</p>	<p><i>strengthened my Python skills, coding confidence and industry readiness through practical learning and supportive mentorship.</i></p> <p>Manisha Kumari Course: Python Programming Internship Placed at: CISCO</p>
<p>★★★★★ “Overall good.”</p> <p>Deepak Chaudhary Course: Internet of Things Placed at: BlockDeep Labs</p>	<p>★★★★★</p> <p><i>“Thanks for understanding each topic very easily. I got to learn many new things from this training. Your teaching style and dedication always inspires me.”</i></p> <p>Sikandar Kumar Course: Python Programming Placed at: —</p>
<p>★★★★★</p> <p><i>“After this training, I can easily know where to do what I need to get done, from schematic capture to footprints to out-jobs.”</i></p> <p>Rishabh Keshavanand Joshi Course: PCB Design Placed at: —</p>	<p>★★★★★</p> <p><i>“A good platform for creative and curious minds interested in the field of electronics. Platform offers an extremely well-curated list of courses and modules — couldn’t be more satisfied!”</i></p> <p>Kartik Yadav Course: Electronic Devices and Circuits Placed at: —</p>

[View all testimonials →](#)

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Nation Innovation is a leading platform in the electronics and software domain, offering a comprehensive source of knowledge encompassing software and hardware.

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