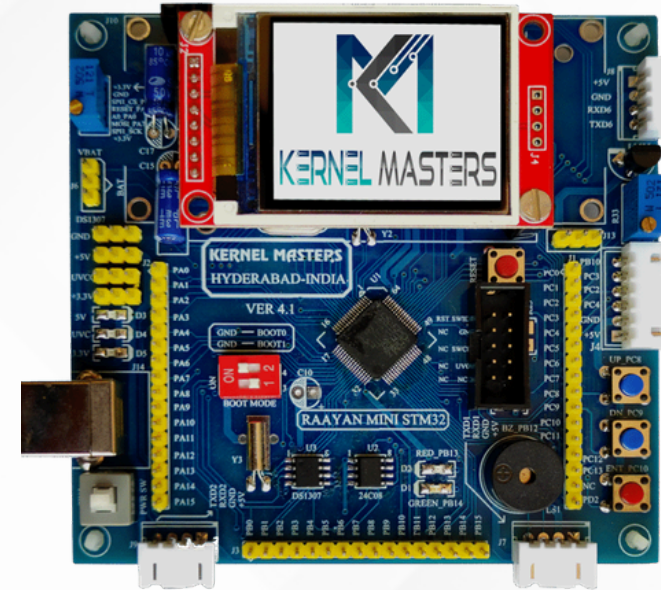


# Embedded Firmware Engineering with RTOS & AI

## Course Syllabus

"From Coding to Real-Time Systems & AI"



**Register Now:**  
[www.kernelmasters.com](http://www.kernelmasters.com)

**Presented By:**  
**Founder & Director of Kernel Masters**

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**Our Mission & Vision: To empower young Electronics Engineers with the right skills and training to build successful careers in Embedded Systems, while becoming a trusted bridge between talented engineers and the semiconductor industry by delivering quality, industry-ready professionals.**

”

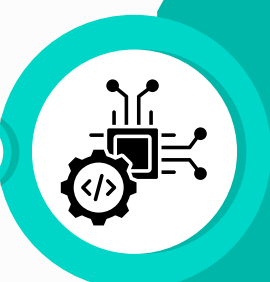
**Kishore Kumar Boddu**  
**Founder & Director of Kernel Masters**




# Course Roadmap

"From Coding to Real-Time Systems & AI"


**01** **Module 1:**  
Embedded Firmware Development



**02** **Module 2:**  
Real time System with FREE RTOS



**03** **Module 3:**  
Embedded AI & Edge Intelligence



# Module 1: Embedded Firmware Development

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**Build strong foundation in Embedded C and hardware control**

**Enable students to write firmware at register level**

**Transition from basic coding → embedded system thinking**



**Course  
Objectives**

## Module 2: Real time System with FREE RTOS

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**Teach real-time system design & multitasking**

**Enable students to build complex embedded applications**

**Introduce industry-level debugging**

**Course  
Objectives**

# Module 3: Embedded AI & Edge Intelligence

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**Introduce AI in embedded systems (future skill )**

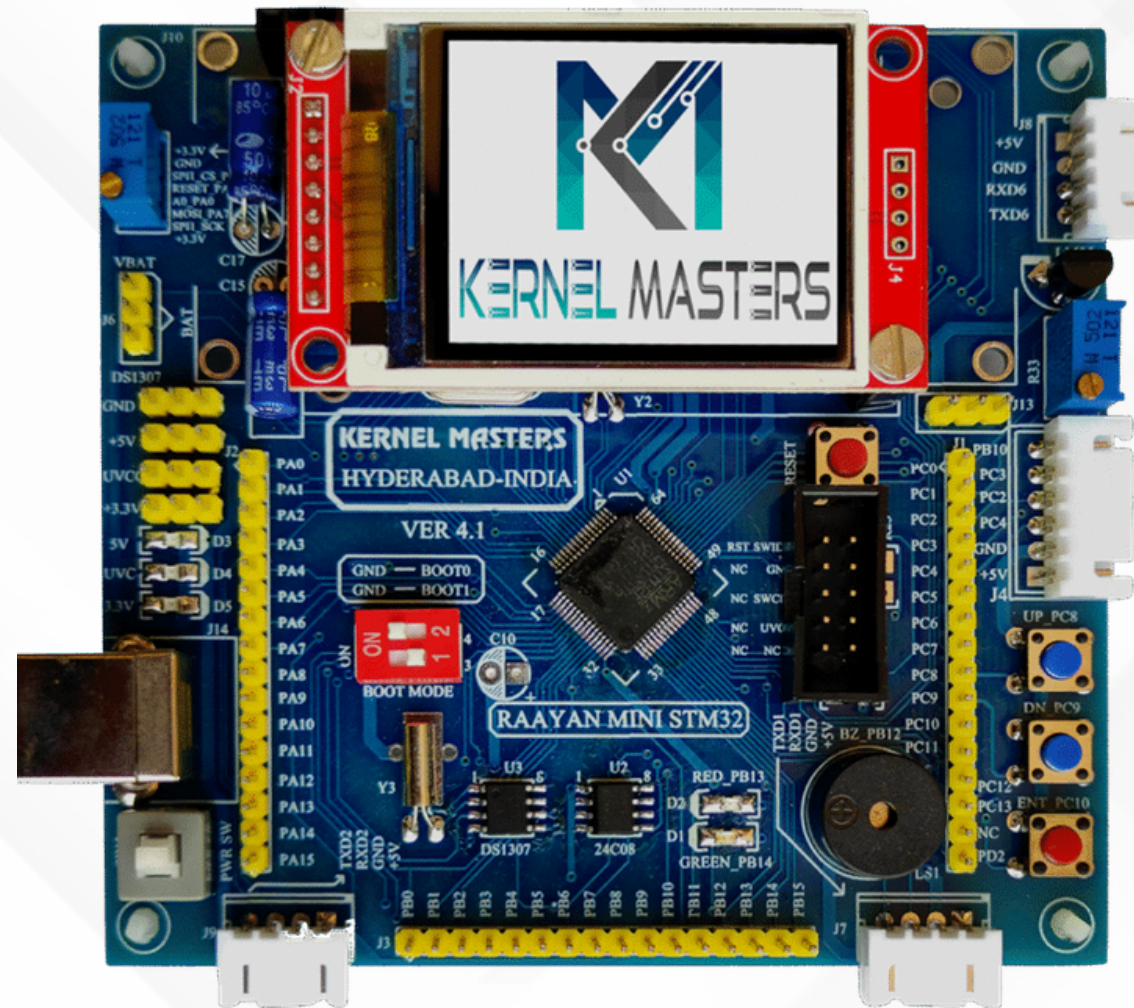
**Enable students to build smart embedded applications**

**Bridge Embedded + AI domain**



**Course  
Objectives**

# STM32 Based Raayan Mini Development Board



## Board Specifications

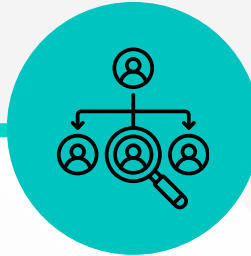
- ✓ ARM Cortex M0/M1/M2/M3/M4
- ✓ STM32 Controller
- ✓ Serial comm Protocols: UART, I2C, RS485, CAN, SPI & USB
- ✓ ADC Controller
- ✓ 16 X 2 monochrome LCD display
- ✓ 3G GSM Module
- ✓ Wireless Protocols: Zigbee, BT, Wi-Fi
- ✓ RTC, EEPROM
- ✓ 40 GPIO Pins

# Hardware Requirements

Essential tools and hardware to power practical embedded learning

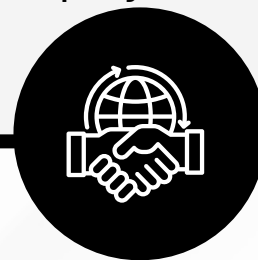
## Board Development

- Kernel Masters has designed and developed Industrial Hardware boards in collaboration with Embedded Core Companies.



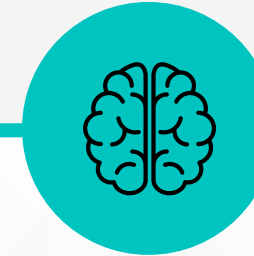
## Project Hardware

- These Hardware boards will be used as part of the course for real-time project. Students need to purchase the board at the time of project.



## Kit Cost

- Total estimated cost of hardware kit for Embedded C project will be approximately Rs. 10,000/-.

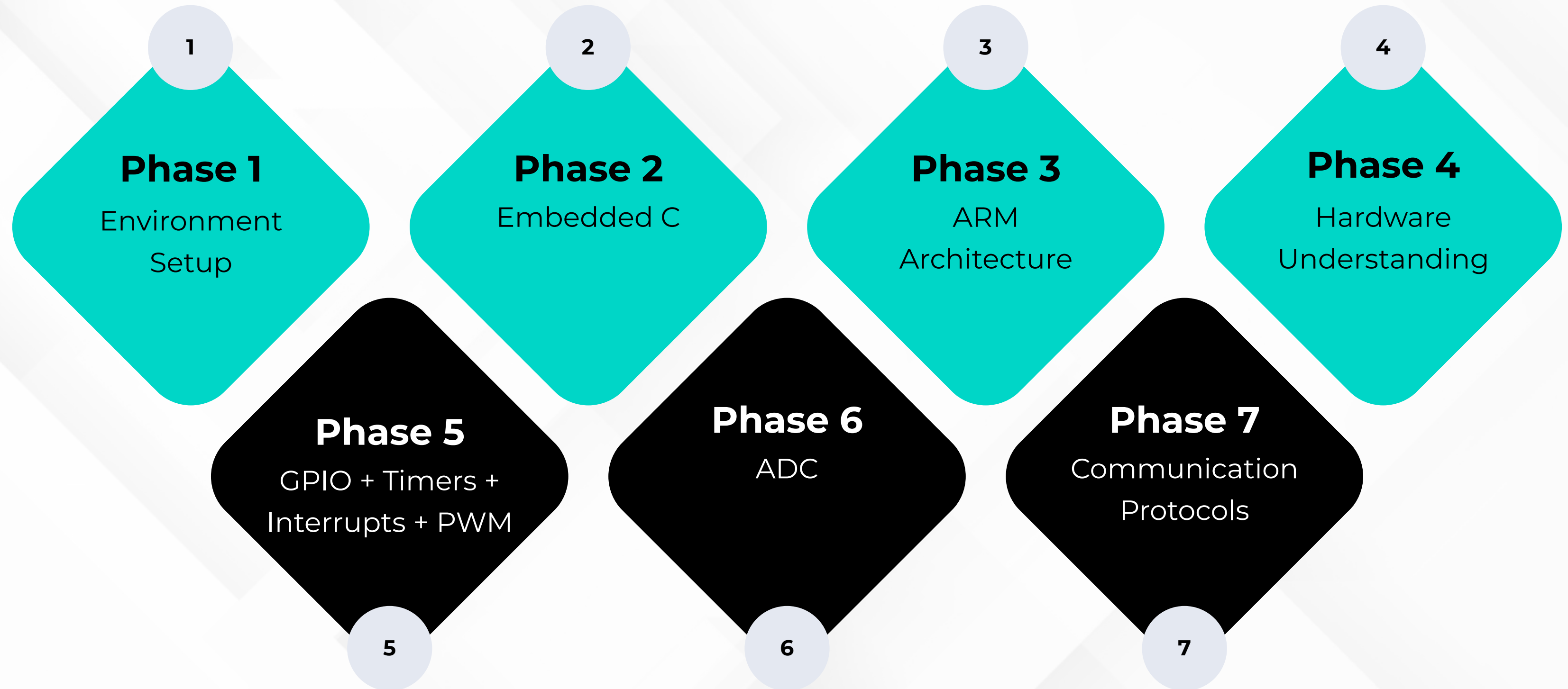


## The kit comes with below components:

- 01 STMicroelectronics based Raayan Mini Board (For Embedded C and RTOS)
- 02 ST Link V2 Debugger
- 03 ESP32 Wi-Fi Module
- 04 USB TO UART TTL 5V 3.3V CH340G module

# Module 1: Embedded Firmware Development

## Final Structured Flow (Quick View)



# Module 1: Embedded Firmware Development

1

## Phase 1 Environment Setup

- 01 Development Environment
- 02 Install Keil Software
- 03 Install STM32 Board Support Packages
- 04 ST-Link V2 Debugger Drivers
- 05 Introduction to HAL drivers (STM32Cube)

# Module 1: Embedded Firmware Development

2

## Phase 2 Embedded C

01 Embedded C Programming

02 Embedded C vs General C

03 Bitwise Operators

04 Memory Mapping Understanding

05 Register Programming

06 Startup Code (basic idea)

07 Embedded C Hello World Program

# Module 1: Embedded Firmware Development

3

## Phase 3 ARM Architecture

01 ARM Cortex M4

02 ARM Architecture (overview)

03 ARM CPU Registers

04 ARM Processor Modes (basic intro)

05 Cortex Core Peripherals

06 NVIC (Interrupt Controller intro)

07 System Tick Timer

# Module 1: Embedded Firmware Development

4

## Phase 4 Hardware Understanding

- 01 Embedded Hardware
- 02 RaayanMini Board Specifications
- 03 STM32F4 Controller Overview
- 04 STM32F4 Memory Mapping
- 05 Interrupt Vector Table

# Module 1: Embedded Firmware Development

5

## Phase 5 Basic Peripherals

(Core Peripherals)

01

### GPIO Zone:

LED interfacing  
Switch interfacing  
LCD basics

02

### Timers:

Timer basics  
Delay generation

03

### Interrupts:

External interrupts  
NVIC usage (practical)

04

### PWM:

PWM basics  
LED dimming

# Module 1: Embedded Firmware Development

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6

## Phase 6 Analog Interface

01

### ADC Zone:

ADC basics  
LM35 Temperature Sensor interfacing

# Module 1: Embedded Firmware Development

7

## Phase 7 Communication Protocols

01 **STM32 Communication Protocols**

02 **UART Zone:**  
UART basics  
Wi-Fi, Bluetooth, GPS interfacing

03 **I2C Zone:**  
RTC interfacing  
EEPROM  
ADXL345 Sensor

04 **SPI Zone:**  
TFT LCD  
SD Card

05 **CAN Zone:**  
CAN basics  
IoT Node communication

# Module 1: Embedded Firmware Development

## Final Outcome of Module 1

Students will be able to:

01

Write Embedded C code

02

Understand registers & memory

03

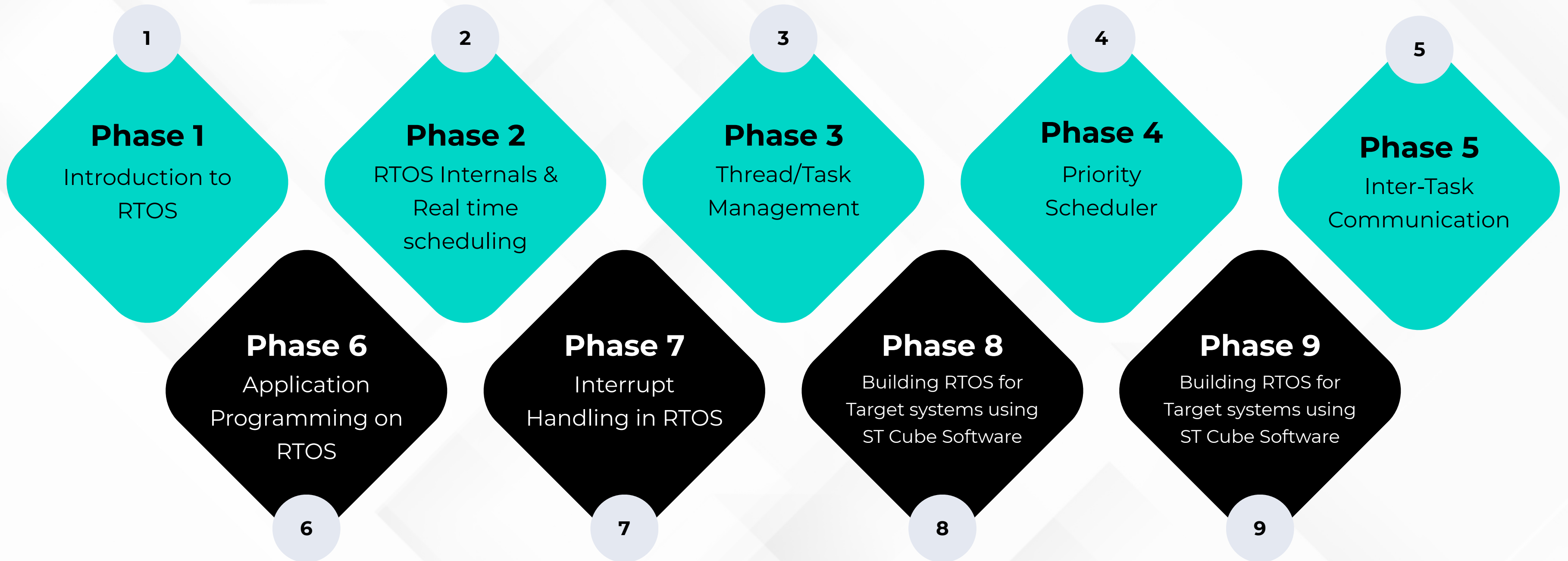
Interface peripherals

04

Build real embedded applications

# Module 2: Real time System with FREE RTOS

## Final Structured Flow (Quick View)



# Module 2: Real time System with FREE RTOS

1

## Phase 1 Introduction to RTOS

- 01 What is RTOS?
- 02 Need for RTOS vs Bare-metal systems
- 03 Types of RTOS (Hard, Soft, Firm)
- 04 Real-time constraints & deadlines
- 05 RTOS vs General Purpose OS

**Hands-on:**

**Bare-metal vs RTOS demo  
(delay vs task switching)**

# Module 2: Real time System with FREE RTOS

2

## Phase 2 RTOS Internals & Real time scheduling

01 RTOS architecture overview

02 Task Control Block (TCB)

03 Scheduler types:  
Cooperative scheduling  
Preemptive scheduling

04 Context switching concept

05 Tick interrupt & system tick

**Hands-on:**

**Understanding scheduler  
behavior using simple task**

# Module 2: Real time System with FREE RTOS

3

## Phase 3 Thread/Task Management

01 Task creation & deletion

**Task states:**

- Ready
- Blocked
- Running
- Suspended

03 Task stack management

04 Task delays & timing functions

### Hands-on:

Multiple task creation (LED  
blinking at different rates)

# Module 2: Real time System with FREE RTOS

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4

## Phase 4 Priority Scheduler

- 01 Task priorities
- 02 Priority-based preemption
- 03 Priority inversion problem
- 04 Priority inheritance concept

# Module 2: Real time System with FREE RTOS

5

## Phase 5 Inter-Task Communication

01 Need for synchronization

02 Queues

03 Semaphores:  
Binary semaphore  
Counting semaphore

04 Mutex (mutual exclusion)

05 Event groups (optional advanced)

### Hands-on:

- Producer–consumer using queue
- Task synchronization using semaphore
- Shared resource protection using mutex

# Module 2: Real time System with FREE RTOS

6

## Phase 6 Application Programming on RTOS

01 Designing RTOS-based applications

02 Task splitting strategy

03 Resource sharing

04 Real-time constraints handling

### Hands-on Projects:

- Sensor reading + display + communication (multi-task system)
- Button-controlled multi-task system

# Module 2: Real time System with FREE RTOS

7

## Phase 7 Interrupt Handling in RTOS

01 ISR vs Task context

02 Interrupt-safe APIs

03 Deferred interrupt processing

04 Synchronization between ISR & task

### Hands-on:

- External interrupt triggering a task
- ISR to queue communication

# Module 2: Real time System with FREE RTOS

8

## Phase 8 FREE RTOS Porting on Raayan mini

01

What is RTOS porting?

02

FREE RTOS architecture (portable layer)

03

Porting steps overview

04

Memory configuration

05

Stack & heap management

### Hands-on:

- Running FreeRTOS on RaayanMini
- Configuring FreeRTOS for STM32

# Module 2: Real time System with FREE RTOS

9

**Phase 9**  
Building RTOS for  
Target systems  
using ST Cube  
Software

**01** FreeRTOS integration in  
STM32CubeIDE

**02** Configuration using CubeMX

**03** Task creation using GUI

**04** Middleware integration

## Hands-on:

- Create RTOS project using Cube
- Configure tasks, queues, timers

# Module 2: Real time System with FREE RTOS

## Final Outcome of Module 2

Students will be able to:

01

Design real-time embedded systems

02

Implement multitasking using FreeRTOS

03

Handle inter-task communication

04

Debug RTOS-based applications

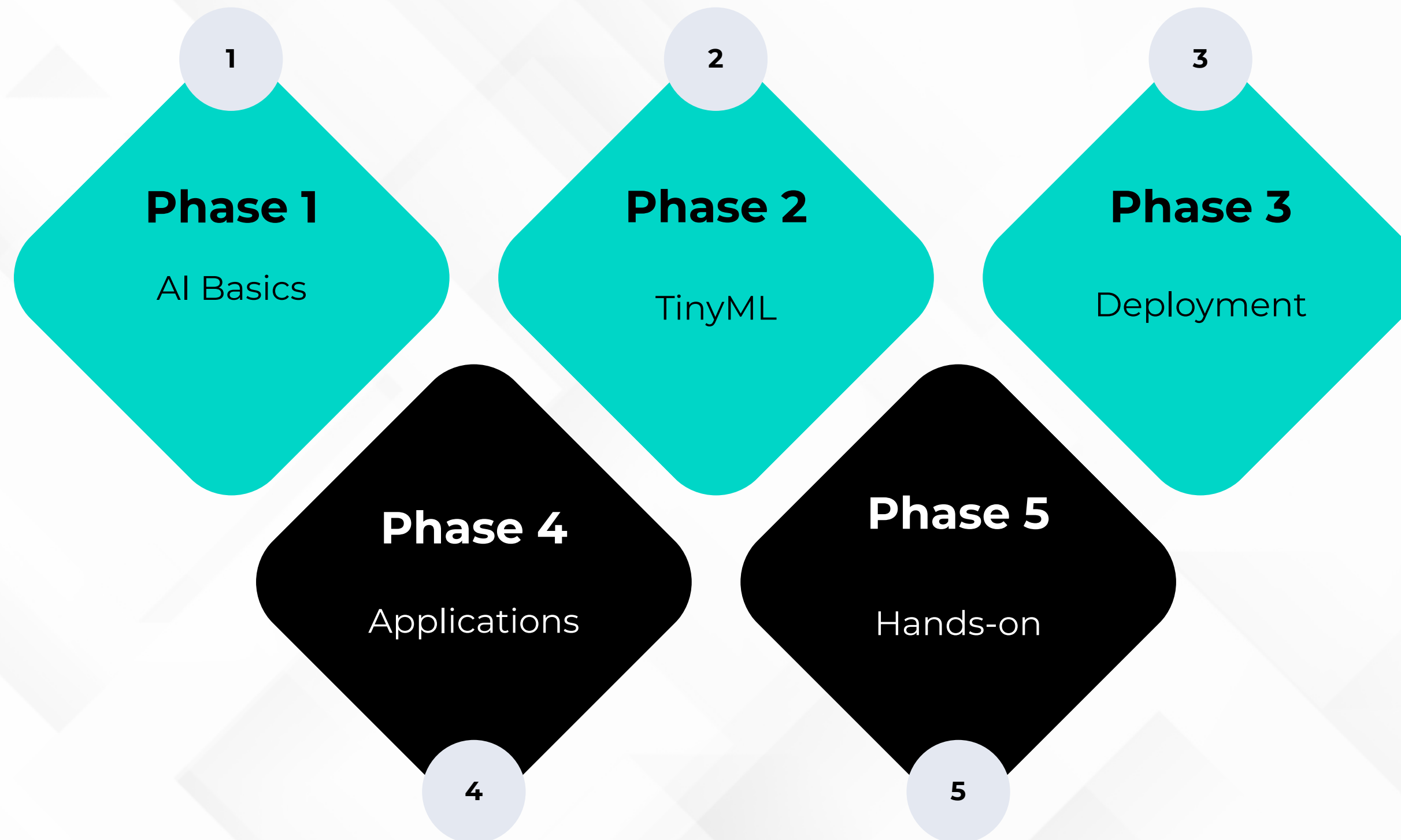
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Build industry-level projects

# Module 3: Embedded AI & Edge Intelligence

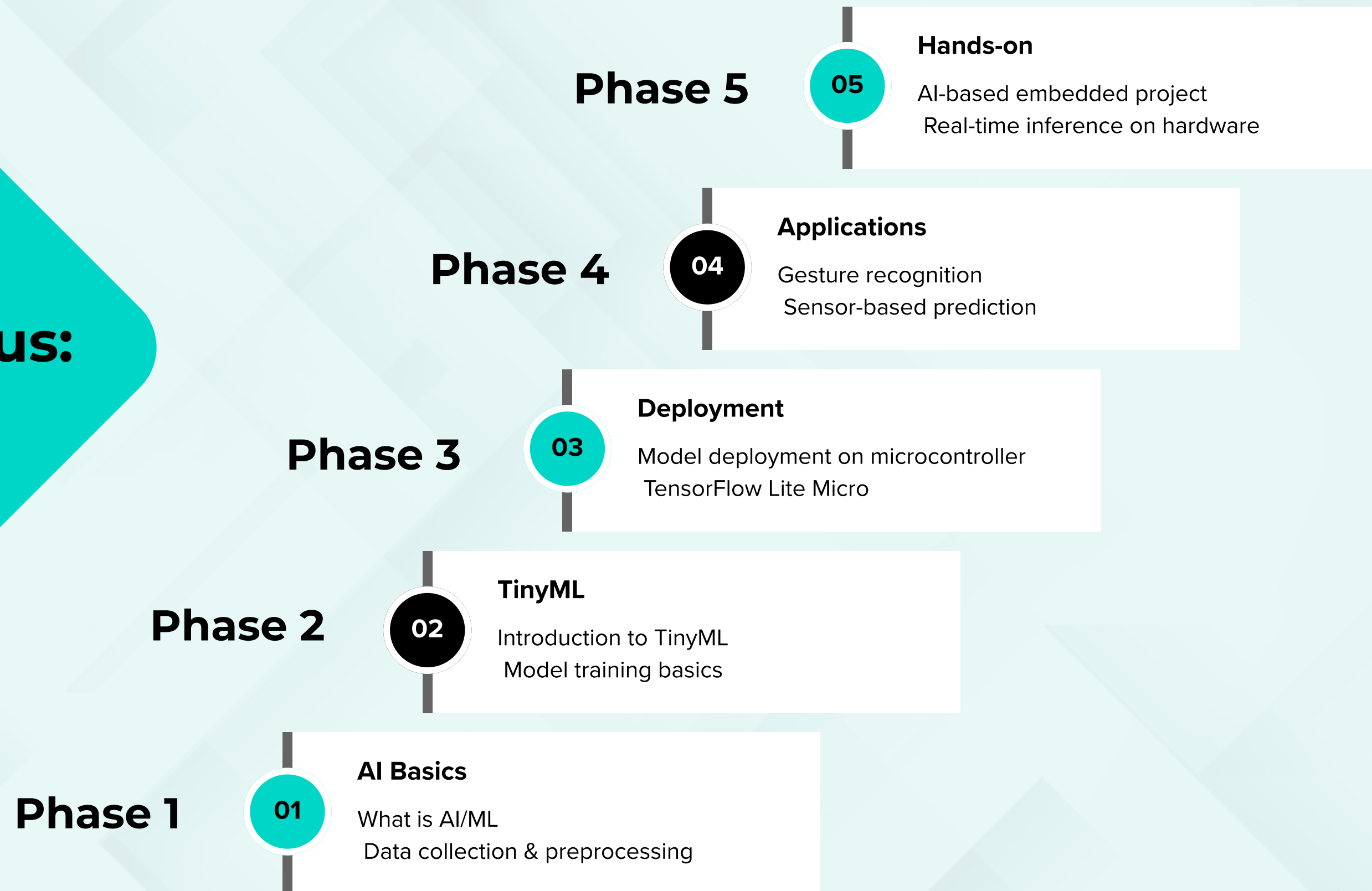
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## Final Structured Flow (Quick View)



# Module 3: Embedded AI & Edge Intelligence

## Syllabus:



# Module 3: Embedded AI & Edge Intelligence

## Embedded Firmware Projects:

01

Smart Weather Monitoring System

02

Smart Tracking system

03

Smart Attendance System

04

Smart Data Logger

05

Smart Gateway

06

Smart Grid

07

Smart Health Monition System

08

Smart Hand Held Terminal

09

Smart Home Automation

# About Us

**Kernel Masters**, established in November 2012, has **completed 14 years** of dedicated service in embedded systems training. We have **trained 15,000+** students across **55 batches** and supported **16,000+ learners** in building careers in the embedded industry.

Our programs are designed for both **freshers** and experienced **professionals**, with nearly 30% of our learners coming from **Embedded Systems** or related domains to **upskill and advance their careers**. Our students are now working in reputed companies such as **Qualcomm, Sasken, Collabera, GlobalEdge, Mirafra, SmartPlay, American Megatrends, Visiontek, Qolsys, and Elear Solutions**, reflecting the strong industry relevance of our training in Device Drivers and Embedded Linux.



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# Recognition of Excellence

Kernel Masters is proud to have been recognized as **“Embedded Training Institute of the Year”** for both **2022–2023** and **2023–2024** under the Global Education Award category. Receiving this recognition in consecutive years reflects **our consistent commitment to excellence** in embedded training, **practical learning**, and **industry-oriented skill** development.

These awards stand as a testament to our dedication in **shaping skilled embedded professionals** and delivering **quality technical education** that aligns with industry needs. Such achievements inspire us to continue **empowering students** and **professionals** with strong fundamentals, **hands-on experience**, and **career-focused training**.



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# Thank You

For your attention

**VISIT US**



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