



CERTIFICATE PROGRAM IN

# Future Wireless Communications

Gain Knowledge of Future Wireless Communication (5G/6G) Both  
HARDWARE & SOFTWARE with 5G/6G R&D at IIT-BANGLORE  
and IITB COMET Foundation's Testbed

 [comet.iitb.ac.in](http://comet.iitb.ac.in)

## What you get

- Opportunities to work as intern/full time on cutting edge wireless system design at IIT-Bangalore and IITB COMET Foundation Testbed.
- Understanding of 3GPP standards for 5G-NR wireless system design.
- Expertise in embedded system design and programming for 5G wireless system design, a very demanding field.

## Stipend

Meritorious Students who qualify through the test are entitled to avail a scholarship of 15,000/- per month after successful enrollment into the program.

## Qualification

- Diploma/BSc/B.Tech or equivalent in any branch of Science/ Engineering.
- Final year project students are eligible upon producing an NOC from their institute.

**Module**

# 1

## Digital Design and Programming

This course covers the basics of digital design and programming, including installation, documentation, digital design, applied logic, assembly programming, embedded C programming, internet of things, ARM programming, and Verilog programming.

Module Name	Content
Digital Design	Combinational and Sequential Logic using the Arduino Framework
Applied Logic	Porting digital logic to the arduino using Platformio
Assembly Programming	Introduction to AVR-Assembly, ATMEGA328P peripheral programming, Timers, Memory Management
Embedded C Programming	Introduction to AVR- GCC, Functions, BIT- FIELDS Pointers, Threads, Socket programming.
Internet of Things	Establishing a wireless sensor network using the Vaman-ESP
ARM Programming	Simple hardware interfacing using the Vaman-Cortex-M4
Verilog Programming	Digital Design using the Vaman-EOS-S3 FPGA

**Module**

# 2

## Advanced Digital Design and Programming

This course covers advanced topics in digital design and programming, including advanced digital logic, micro- controllers, and embedded systems.

Module Name	Content
Python Programming	Numpy for vector/matrix operations
C Programming	Using pointer arrays for vector/matrix operations
Data Structures	Pointers and lists for vector/matrix operations
Math Computing on hardware	78 Inter chip communication on the Vaman board for vector/matrix operations

**Module**

# 3

## Introduction to 5G: Comprehensive Course Details

### 1. EVOLUTION OF MOBILE TECHNOLOGIES

- ✓ Introduction to Mobile Technologies
- ✓ Early Mobile Telephony
- ✓ 1G: First Generation (Analog)
- ✓ 2G: Second Generation (Digital)
- ✓ 3G: Third Generation (Mobile Broadband)
- ✓ 4G: Fourth Generation (Fast Data and IP Networks)
- ✓ 5G: Fifth Generation (Ultra-Fast, Low Latency)
- ✓ Towards 6G: Sixth Generation (The Future)
- ✓ Comparison of Generations
- ✓ Impact on Society

## 2. INTRODUCTION TO 5G, KEY TECHNOLOGIES, USE CASES

- ✓ 1. Role of ITU and 3GPP in 5G Evolution
- ✓ 2. 5G Adoption, Global Proliferation, and Deployment
- ✓ 3. 5G Usage Scenarios and Key Capabilities
- ✓ 4. ITU-Defined 5G Usage Scenarios
- ✓ 5. Key 5G Use Cases
  - Enhanced Mobile Broadband (eMBB)
  - Ultra-Reliable Low Latency Communications (uRLLC)
  - Massive Machine Type Communications (mMTC)
- ✓ 6. 5G Network Architectures
- ✓ 7. Standalone (SA) vs Non-Standalone (NSA)
- ✓ 8. 5G Releases by 3GPP and Impact on Key Sectors
  - Agriculture
  - Education
  - Healthcare
  - Industry Applications

## 3. 5G CORE

- ✓ 1. Introduction to 5G Core Network
- ✓ 2. Key Functions of the 5G Core
- ✓ 3. Service-Based Architecture (SBA)
  - Core Network Elements
  - AMF (Access and Mobility Management Function)
  - SMF (Session Management Function)
  - UPF (User Plane Function)
  - AUSF (Authentication server function)
  - UDM (Unified Data Management)
  - Control and User Plane Separation (CUPS)
- ✓ 4. Network Slicing in 5G Core
- ✓ 5. 5G Core Interfaces: N1, N2, N3, N4, N5, N6, N7, N8
- ✓ 6. 5G Core and 5G NR (New Radio) Integration
- ✓ 7. Role of 5G Core in eMBB, uRLLC, and Mmtc, Security features in 5G Core

## 4. 5G RAN/L2/L3

- ✓ 1. 5G RAN Split Architecture
  - Centralized Unit (CU)
  - Distributed Unit (DU)
  - Radio Unit (RU)
  - Overview of ORAN architecture
- ✓ 2. 5G Interfaces
  - NGAP (Next Generation Application Protocol)
  - F1AP (F1 Application Protocol)
  - Xn (Interface between gNBs)
  - E1 (Interface between CU-Control Plane and CU-User Plane)
  - NG (Interface between gNB and 5GC)
- ✓ 3. Layer 2 (L2) Protocols
  - SDAP (Service Data Adaptation Protocol):
  - QoS handling.
  - PDCP (Packet Data Convergence Protocol): Header compression, encryption, and integrity protection.
  - RLC (Radio Link Control): Segmentation, Reassembly, and Retransmissions.
  - MAC (Medium Access Control): HARQ, and multiplexing/demultiplexing, Grant, TB
- ✓ 4. Layer 3 (L3) Protocols
  - NAS (Non-Access Stratum): UE mobility and session signaling with the Core.
  - RRC (Radio Resource Control): How to Controls radio bearers, mobility, and UE context management

## 5. PHYSICAL LAYER L1

- ✓ 1. Key physical layer technologies for 5G-NR
  - Hybrid ARQ
  - Orthogonal Frequency Division Multiplexing (OFDM),
  - Adaptive Modulation and coding (AMC)
  - MIMO, Massive MIMO
- ✓ 2. 5G-NR radio interface introduction
  - Frequency Bands supported by 5G NR
  - Channel Bandwidth Supported in 5G New Radio
  - Waveform and Modulation used in 5G NR
  - 5G NR Numerologies
  - Sub Carrier Spacing and Resource Block
  - Relation between 5G NR Numerologies, Supported Bandwidth, Frequency bands, cell size and its Usages.
  - Frame structure for numerologies 0 to 4
  - Visualization of Frame, Subframe, Slot and Symbols for each of the Numerologies.
  - Carrier Aggregation (CA), Bandwidth Part (BWP)

- ✓ 3. Uplink/downlink data and control channel design for 5G NR
  - PDCCH, PDSCH, PUCCH, PUSCH design,
  - Time Domain and frequency domain Resources allocation
  - Reference Signal Design
- ✓ 4. Initial Access and Synchronization
  - Physical broadcast channel (PBCH): MIB and SIB
  - SS Block
  - PSS and SSS
  - 5G-NR Cell: Physical Cell ID
  - Location of SSB in Time Domain
  - SSB Burst Set
  - SS Block
  - PSS and SSS
  - Synchronization procedure

## 6. 5G SA / NSA CALL FLOWS

- ✓ 5G NSA Call Flow
- ✓ 5G SA Call Flow
- ✓ 5G Registration
- ✓ PDU Session Establishment

## Selection Process

- Selection for the course is based on an offline written test at “IIIT-B Campus”.
- Students who clear a minimum threshold but below the qualification marks can still join the program by paying the fee but will not be entitled to avail any scholarship, those students who clear Module 1&2 are entitled to avail a scholarship during module 3.

Module	Course	Duration	Fees
Module1	Digital Design Through Embedded Programming	2 Months	30,000/-
Module2	Advanced Digital Design and Programming	2 Months	45,000/-
Module3	Design of 5G Networks with hands-on	4 Months	75,000/-

Fees in INR

- Each Module have a separate fee & Fee will be separately collected before the start of each module.
- Students can exit after each module
- Fee will be charged per module.
- Candidate has the option to drop out any time.
- Fee won't be refunded after payment.

**COMET Foundation**  
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### Questions?

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