IIITB COMET FOUNDATION

CERTIFICATE PROGRAM IN

Future Wireless Communications

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

comet.iiitb.ac.in

What you get

- Opportunities to work as intern/full time on cutting edge wireless system design at IIIT-Bangalore and IIITB 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/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

Advanced Digital Design and Embedded 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 and Wired Protocols.

Module Name	Content
Digital Design Arduino, Raspberry Pi and Pico W	Introduction to PlatformIO, Porting Digital Logic to the Arduino Pico W Using PlatformIO, GATE Exercises
Embedded C Programming	Introduction to AVR-GCC, Functions, BIT-FIELDS, Pointers, Threads, Socket programming
Introduction to AVR-GCC, Functions, BIT-FIELDS, Pointers, Threads, Socket programming	Establishing a wireless sensor network using the Vaman-ESP
Python using AI Programming	AI Tools with NumPy and Pandas simulations
Wired Protocols	UART/SPI/I2C/RS-485 configuration/programming in embedded systems/sensor networks
Data Structures	Pointers and lists for vector/matrix operations with OAI Simulations only
Unmanned Ground Vehicles	Toy car assembly, control, and communication
Inter-chip communication	ESP/FPGA/ARM co-processing

Module 2

Design of 5G Networks with hands-on

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

- **Role of ITU and 3GPP in 5G Evolution**
- **5G Adoption, Global Proliferation, and Deployment**
- **5G Usage Scenarios and Key Capabilities**
- **ITU-Defined 5G Usage Scenarios**
- **Key 5G Use Cases**
  - Enhanced Mobile Broadband (eMBB)
  - Ultra-Reliable Low Latency Communications (uRLLC)
  - Massive Machine Type Communications (mMTC)
- **5G Network Architectures**
- **Standalone (SA) vs Non-Standalone (NSA)**
- **5G Releases by 3GPP and Impact on Key Sectors**

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 DataManagement)
  - 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 RANL2/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. PHYSCIAL LAYER L1

- **1. Key physical layer technologies for 5G-NR**
  - Hybrid ARQ
  - Orthogonal Frequency Division Multiplexing (OFDM),
  - Adaptative 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
  - References Signal Design
- **4. Intial 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**

Module 3

AI/ML for 5G and 6G Wireless Communication

Introduction to Machine Learning:

- Overview of machine learning types: supervised, semi-supervised, unsupervised learning
- Detailed exploration of regression models

Introduction to Wireless Communication:

Python code examples on:

- Single Carrier Systems
- OFDM (Orthogonal Frequency-Division Multiplexing)
- MIMO (Multiple Input Multiple Output)
- OTFS (Orthogonal Time Frequency Space) systems

AI/ML in Wireless Communications:

- Massive MIMO receiver design
- Modulation classification techniques

Signal Estimation and Detection using AI/ML:

- Direction of arrival (DOA) and channel estimation in Massive MIMO systems
- STO (Sample Time Offset) and CFO (Carrier Frequency Offset) estimation techniques for OFDM/OTFS systems
- MIMO/OFDM/OTFS symbol detection strategies

FWC Program Instructors

G V V Sharma
Professor, IIT-Hydrabad

S Srikanth Reddy
Training Specialist

Prem Singh
Professor, IIIT-Bangalore

Vivek Yadav
Technology Officer &
Adjunct faculty, IIIT-Bangalore

Amrita Mishra
Professor, IIIT-Bangalore

Ajay Bakre
Professor, IIIT-Bangalore

Sridhar Pillalamarri
CEO, IIITB COMET Foundation

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 are entitled to avail a scholarship during module 2.

Module	Course	Duration	Fees
Module1	Advanced Digital Design and Embedded Programming	2 Months	45,000/-
Module2	Design of 5G Networks with hands-on	4 Months	75,000/-
Module3	AI/ML for 5G and 6G Wireless Communication	3 Months	75,000/-

Note: Module 3 is optional

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
R312 Ramanujan Building, IIIT Bangalore 26/c, Electronics City, Hosur Road, Bangalore - 560100

Questions?
Write to: fwc@iiitb.ac.in /
workshop.comet@iiitb.ac.in
Call: +91 8041407777 / 28527627 Ext : 240

Follow us @ /iiitb-comet-a33a83240 /IiitbF /comet_foundation

Scan to Apply