Indian Institute of Science
भारतीय विज्ञान संस्थान

Build Expertise to
Lead a Hyper-connected World

Join the PG Level Advanced Certification Programme in

5G Technologies with AI and Cloud

BATCH 2

Program Partner

NSE talent sprint

India makes its
FIRST 5G CALL

5G testbed, developed by IISc
and other institutions

iisc.talentsprint.com/5g

Is this programme for me?

The programme is ideal if you are

- ➤ A tech professional working in **industries implementing 5G technology and applications** or
- ➤ A tech professional in the **telecom ecosystem building 5G network solutions**

How will this programme help me build expertise?

Get the IISc advantage, World's #1 Research University*

Learn from top research faculty, trained in the world's best laboratories

Network with the early-adopters and thought leaders in the domain

Strengthen key fundamentals through live projects and case studies

*Based on metric of Citations per Faculty

Why build expertise in 5G technologies?

There is a surge in the global demand for 5G professionals across industries and the telecom ecosystem.

"

5G technology will add $1.3 Trillion to global GDP and $42 Billion to India by 2030[1]

pwc

"

India needs 22 million 5G-backed skilled professionals by 2025[2]

ET THE ECONOMIC TIMES

"

2022 is going to be the demonstrative year for 5G services[3]

EY

Why IISc?

QS WORLD UNIVERSITY RANKINGS	**nirf**
#1 World's Top research University(2023)*	**#1** University (2016, 2020 and 2022) Research University (2022)

THE WORLD UNIVERSITY RANKINGS		**RUR**
#1 Times Higher Education University in India (2020)	2 Bharat Ratna Awardees (1954, 2014)	RUR World #62 (2020)

*Based on metric of Citations per Faculty

IISc (Indian Institute of Science) is the oldest and the finest higher education institute of its kind in India. It pursues excellence in research and education in several fields of Science and Engineering and is one of the first three publicly funded institutes to be awarded the Institute of Eminence status. The alumni of IISc hold significant academic and industry positions around the globe. For more information visit https://www.iisc.ac.in

The Programme will be delivered by IISc's Centre for Continuing Education (CCE). CCE delivers courses suitably designed to meet the requirements of target groups: Research & Development (R&D) Laboratories and Industries, Research Scientists/Engineers, to enable them to grow into competent managers of technology intensive and data-driven organizations. For more information visit http://cce.iisc.ac.in

Who will I learn from?

The distinguished faculty group is involved in advanced research in Telecom through global projects like the National 5G Testbed (DoT), British Telecom India Research Centre (BTIRC), working on cutting-edge AI, mobility and software engineering technologies.

Programme Director

Prof. Chandra R Murthy

Ph.D., Electrical and Computer Engineering, UC San Diego, USA
Areas: 5G, Multiuser MIMO Systems, Wireless Communications
Professor in the Dept. of Electrical Communication Engineering at IISc.

He is the lead PI of the DoT-funded 5G testbed project at IISc. His research areas include 5G-and-beyond communications, intelligent reflecting surfaces, cell-free massive MIMO, random access protocols for massive machine-type communications, joint radar and communications, new waveform design for 6G, and sparse signal recovery techniques applied to communication systems. With 75+ journal papers and 100+ conference papers to his credit, his work has received best paper awards at NCC 2014, ICASSP 2018 and ISIT 2021. His team's demonstration of cell-free MIMO won the top-30 award in the 5G Hackathon recently conducted by DoT. He has participated in editorships of premier journals such as IEEE's Signal Processing Letters, Transactions on Signal Processing, Transactions on Information Theory, and Transactions on Communications. He was an elected member of the IEEE SPCOM Technical Committee and is a senior member of the IEEE.

Prof. K.V.S. Hari

Ph.D., UC San Diego, USA
Areas: Statistical Signal Processing, Array Signal Processing, Machine Learning (Applications to MIMO Wireless Communication Systems), Radar & Navigation Systems, Autonomous Systems

Professor at the Department of Electrical Communication Engineering, IISc. He has been with IISc since 1992. In addition to this, he also coordinates the activities of the institution's Statistical Signal Processing Laboratory. He is also a visiting faculty for Stanford University and KTH, Stockholm. Furthermore, he is the Editor-in-Chief (Electrical Sciences) of Sadhana and a Fellow of IEEE and INAE and INSA.

Sudhakar Balijepalli

Sr. Project Technologist, IISc
Areas: Electronics and Communication Engineering,
Wireless Computing, Network Management

He leads the 5G stack development in the FR1 band. His current interests include Wireless System Design, Protocol Implementation, Non-terrestrial Networks, Network Orchestration and Network Management, and Research toward 6G. He has worked in the wireless industry and contributed in 2G to 5G for three decades and held different technical and leadership positions. He was associated with premier organizations like Lucent Technologies (Bell Labs India), Motorola, Nokia Networks, Hewlett-Packard and IBM. Worked extensively in Mobile/Wireless communications technologies, contributing to all phases of the product life cycle, and served as Technical Editor for IEEE Communications Magazine between 2012 and 2015. He received his M.Tech (Digital Communications) from MANIT in 1993 and worked for the dissertation in the CSC Group, TIFR Mumbai.

Prof. Prabhakar T V

Ph.D, MSc (Engg), MSc(Phy)
Areas: Network Embedded Systems, Hardware System Design, Power Management Algorithms, Energy Harvesting Systems, IoT Security, Heterogeneous Networks for IoT, Tactile Internet Applications, Communication Systems, Sensor Networks

Principal Research Scientist at the Department of Electronic Systems Engineering, IISc. He leads the Zero Energy Networks (ZEN) Laboratory, dedicated to building embedded electronic systems for application areas such as airplane cabins, healthcare, smart homes, and other IoT applications such as indoor positioning systems. His lab mainly builds embedded electronic systems for application areas such as Space IoT, Urban Air Mobility, Industrial, and Tactile IoT. Under his leadership, ZEN focuses on RFID-based localization and building RF energy harvesting platforms. He is also engaged with about 100 MSMEs and facilitates funding and technical advice under the MSME Centre of Excellence.

Prof. Vaibhav Katewa

Ph.D., University of Notre Dame, Indiana, USA
Areas: Analysis & Design of Dynamical Systems and Networks using Control Theory Tools, Cyber-physical Systems, Sparse Feedback Control Design, Distributed Detection, Estimation & Control, Networked Control Systems

Assistant Professor at the Robert Bosch Center for Cyber-Physical Systems, IISc. He is also a faculty member of the institution's Electrical Communication Engineering Department. An IIT Kanpur alumnus, he also served as a Postdoctoral Scholar for two years at the Mechanical Department of the University of California, Riverside. The focus areas where his research works are applied include smart grids, transportation systems, and autonomous systems. Many of his research papers have won him accolades - recent ones include the IEEE Control Systems Letters Outstanding Paper Award in 2020 and the O. Hugo Schuck Best Paper Award in 2021.

Apart from these distinguished faculty, you will interact with industry experts and other faculty members at IISc and IITs through guest lectures.

What will I learn?

Module I - For 9 Months and 6 Months

I. 5G Foundation

1. Back to basics

> Digital communications, modulation, coding

> Channel effects, frequency and timing offset correction

> Demodulation and data decoding

> Signal processing: Fourier transforms, convolution, sampling

> Orthogonal frequency division multiplexing (OFDM)

> Matlab OnRamp course [exercise]

> Revisit Cellular communication systems

⌃ Basics of Cellular architecture, the need for cell structure

⌃ Ingredients of mobile communications and cellular fundamentals

> Mobile communications and evolution (2G to 5G)

> Spectrum for mobile communication, cell planning and concept of frequency reuse

2. Introduction to 5G NR

> 5G Terminology

> Principles of 5G NR architecture and operation

> Specific interfaces that support split architecture models

3. 5G Network elements and system overview

> Service based architecture and core network elements

> RAN elements and interfaces with the core network

> Deployment models – SA and NSA

> Dual connectivity models

II. 5G Standards and theory

1. Standards revisited

- > 3GPP standards and release numbers and significance
- > Overview of FR1 and FR2 operations
- > Physical and access layers

2. The 5G Technology – Theory

- > 5G NR PHY layer
  - ^ PHY layer fundamentals and design discussion
  - ^ Frame and slot structure and Resource blocks
  - ^ Frequency bands and Numerology
- > 5G MAC layer and schedulers
  - ^ Principles of MAC layer design
  - ^ MAC scheduler models in 5G
- > Radio Resource Control state machine
- > Transmission modes and multi-antenna support in 5G

3. Assignment: 3 experiments using a network simulator

III. 5G in Operation

1. Opensource 5G systems

- Opensource platforms - OAI RAN
- Building blocks of OAI
  - Architecture of gNodeB stack
  - Architecture of UE stack
- OAI supported hardware and instructions to configure and use with host systems

2. 5G Technology – Practical session

- MAC/PHY operation using OAI with different MCS values, using RFSIM, measure and benchmark the throughput against back-of-the-envelope theoretical calculations [demonstration]
- Three or four more experiments using a network simulator

3. 5G Case Study – 1: Participants from groups and select a topic from the list

- A list of topics in 5G standards will be provided
- Participants pick a topic from the given list, prepare and present

4. Disaggregated implementation support in 5G NR

- Need for functional split options
- Various split options supported in 5G NR
- Disaggregated implementation

5. 5G Procedures

- NAS procedures
- Initial access procedures
- UE procedures
- Connection and mobility management, handover

6. OAI simulators - Practical session/Demonstration of simulators usage

> Design principles and usage of simulators in OAI

> gNB sim, RFSIMULATOR, Channel simulators, PHYSIM

> Run the OAI system with selected set of simulators (Assignment)

7. Introduction to O-RAN

> Why O-RAN?

> Components of O-RAN system

> Architecture framework and interfaces/libraries

> Acceleration technologies – DPDK fundamentals

> Network slicing, RAN intelligent controller (RIC)

8. Run the 5G OAI stack in the lab – Practical session

> Observe the constellation using RFSIM

> Repeat the experiment with B210/X310

> Run the 5G system using RFSIM or SDR in the lab - change the modulation scheme, build the code and run the system

> Run the 5G system with core network

9. 5G Case Study – 2: On the RAN elements by participant groups

> A list of topics in 5G architectures will be provided. Participants select a topic, prepare and present to the class.

10. Case Study – 3: On the core network elements by participant groups

> A list of topics in 5G core network will be provided. Participants select a topic, prepare and present to the class.

11. Case Study – 4: Presentation on a 5G application by participant groups

> **EXAMPLE TOPIC 1**: extended Reality in 5G
> **EXAMPLE TOPIC 2**: IoT applications

IV. AI/ML in 5G

1. Basics of AI/ML tools and techniques

2. Example uses of AI/ML in 5G

3. Network Deployment in the Cloud

4. Tools for cloud-based deployments

5. Key technologies that will be important in 5G advanced and 6G

> Graduation

6. Test – covering all topics covered in the course [Take-home]

7. An open day in 5G Lab and graduation ceremony

> FR1-FR2 integration demo
> Demonstration of VLC systems [subject to feasibility]
> V2X demo [subject to feasibility]

Module II - Only for 9 Months

1. 5G network design and engineering

> Understanding applications and their requirements (TCP, streaming video, real-time voice/video/gaming, real-time control)

> MAC scheduling and network slicing

> Inter-gNB orchestration (for the above purposes)

2. Cloud and AI/ML for network management

> 5G RAN deployment in cloud – typical scenarios

> Fundamental concepts of RIC and RAN management and use of XAPPs
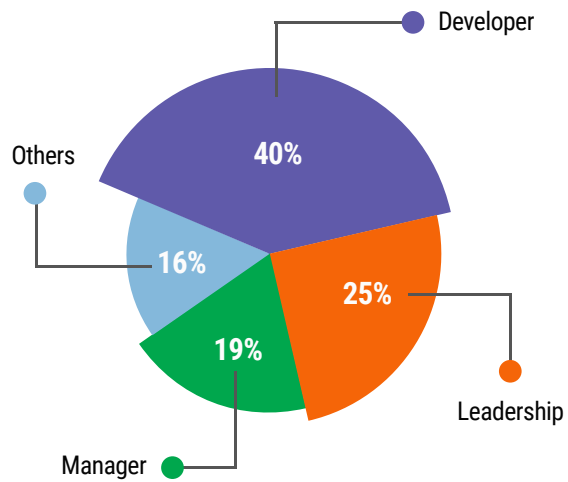
> Network slicing

3. Cloud-enabled 5G applications

> Applications (Healthcare, Industry 4.0, etc)

> MQTT, COAP, TSN, Web-sockets etc

> Demonstration of a robotic arm application

> Edge intelligence

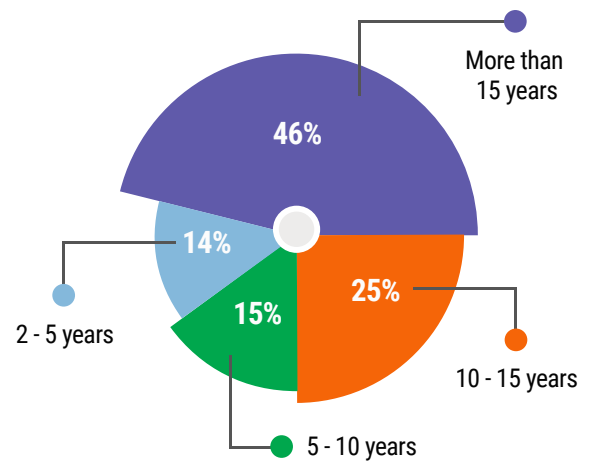> Scheduling for mMTC and URLLC applications

4. Graduation

Download Detailed Curriculum

Participant Profile

Job Role

Developer
40%

Others
16%

Manager
19%

Leadership
25%

Work Experience

More than 15 years
46%

2 - 5 years
14%

5 - 10 years
15%

10 - 15 years
25%

Find out why professionals want to join the programme

"I am currently driving design solutions for IoT, Mobile, Wearable, and Automotive product lines for existing industry market leaders at my organisation. This program will prepare me for the future."

-Raja Mallik, Architect, Carrier, Hyderabad

"I expect to deepen my understanding of 5G systems that will guide me to crack challenging technical interviews of top telecom companies."

-Ruturaj Mandip Mane, Automation Engineer, Parallel Wireless, Pune

"Unlike regular ethernet technologies, 5G has a steep learning curve. And this programme would give me that foundational understanding of 5G."

-Sunil Mekad, Engineer, Juniper Networks, Bengaluru

"I want to pursue my career in wireless communication. Through this programme, I can see myself moving in that direction and applying my learnings suitably in future projects.

-Ujjwal Chitransh, Lead Engineer, Radisys, Chennai

"I have worked on various wireless domain projects. I believe pursuing the 5G Technologies with AI and Cloud programme will lead me toward the fulfilment of my career goal."

-Dhruvkumar Raval, Saankhya Labs, Lead Engineer, Bengaluru

"I want to gain a deeper understanding of 5G, its applications, network planning and management, which would enable me to contribute better to this field."

-Harshini B, Member Of Technical Staff, Rakuten Symphony, Bengaluru

"I have worked on multiple telecom technologies, from circuit to packet switching. However, 5G is the future, and I find the need to be updated with the current technologies for my profession."

-Shubhada, Sub Divisional Engineer, BSNL, Bengaluru

"I am working on wireless domain products. I know RF discrete components and want to improve my knowledge of 5G systems and their architecture. This also helps understand customers in a better way."

-Sai Jagini, Senior Engineer, Analog Devices, Bengaluru

"I would like to get a full grip on core 5G stack development with AI and Cloud so that my career opportunities would not be limited to OEMs but extended to other sectors."

-Ruthwar Kumar Ambeer, Senior Principal Engineer, Oplus RD, Hyderabad

"IISc being the top university in advanced research, involved in many indigenous initiatives, makes this programme attractive to me, as I will learn from research experts."

-Namit Kumar, Senior Principal Engineer, Hughes Systique, Milton Keynes

"Through this programme, I expect to build capabilities to decode all 5G layers protocol messages, 5G deployment strategy, and 5G technologies with AI and Cloud."

-Vinuth Shetty, Senior Test Engineer, Marquis Technologies, Bengaluru

Note: These are edited versions based on the details submitted by various programme applicants.

What is the format?

9-Month Executive Programme

PG Level Advanced Certification in
5G Technologies with AI and Cloud

6-Month Executive Programme

PG Level Advanced Certification in
5G Technologies

Campus Visit of 2 Days to IISc, Bangalore

Live Interactive Sessions by
IISc Faculty and Industry Experts

Best-in-class Self-learning Content, Projects,
Case Studies and Hands-on Sessions

The programme will be delivered on TalentSprint's digital platform ipearl.ai

What are the key learning outcomes?

Upon completion, you will be able to

Understand and apply
5G applications

Understand key business areas
for building 5G solutions

Build and run the
5G system

What is the eligibility?

» **Education**
Working professionals with BE/BTech/ME/MTech in any stream, BCA, B.Sc. CS, MCA, M.Sc. CS

» **Experience**
Minimum 2 years

How can I enroll for this programme?

Take assistance from Relationship Manager

1 Apply for the Programme

2 Submit Documents**

3 Selection by IISc Committee*

4 Join the program

*Selection for the programme will be done by IISc and is strictly based on the education, work experience, and motivation of the participants.

**Scanned copies to be submitted within 7 days 1. Education Certificate 2. Experience Letter/Latest Pay Slip

What will be my investment?

PG Level Advanced Certification in 5G Technologies with AI and Cloud

9 Months

₹3,20,000 + GST

Flexible EMI Options
starting at ₹20,978 / Month

PG Level Advanced Certification in 5G Technologies

6 Months

₹2,80,000 + GST

Flexible EMI Options
starting at ₹18,356 / Month

[Nominate your Employee to Avail Special Benefits](#)

Scholarships are available

To be borne by participants

(i) Application fee of ₹2,000

(ii) Campus visit fee will be based on actuals and to be borne by the participants.

Fees paid are non-refundable and non-transferable.

About TalentSprint

10 Years of Excellence   **200K** Lacs Empowered Professionals   **95%** Completion Rate   **85** Net Promoter Score

Established in 2010, TalentSprint is a part of NSE group and a global edtech company that brings transformational high-end and deep-tech learning programs to young and experienced professionals. The company's digital learning platform ipearl.ai offers a hybrid onsite/online experience to seekers of deep technology expertise. TalentSprint partners with top academic institutions and global corporations to create and deliver world class programs, certifications, and outcomes.Its programs have consistently seen a high engagement rate and customer delight. It is a leading Innovation Partner for the National Skill Development Corporation, an arm of the Ministry of Skill Development and Entrepreneurship, Government of India. A recipient of various prestigious accolades, TalentSprint was recently honored with the Indian Achievers Award 2022, for its excellence in building deeptech talent in India. For more information about TalentSprint, visit TalentSprint website

References :

1. PwC   2. Economic Times   3. E&Y Report

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