INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

5G COMMUNICATIONS								
V Semester: ECE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AECD27	**Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Analog and Digital communications								

I. COURSE OVERVIEW:

This course provides a comprehensive introduction to the next generation of wireless communication 5G and its rapidly evolving ecosystem. This course explores critical enabling technologies such as massive MIMO, millimeter wave (mmWave) communication, network slicing, and advanced radio access techniques. Students will gain a thorough understanding of the 5G architecture, including both core and access networks, and key communication protocols. It covers deployment models, performance evaluation through KPIs, and the integration of 5G with legacy networks. Emerging trends, including the transition toward 6G, are discussed, with real-world case studies highlighting applications in smart cities, healthcare, and Industry 4.0.

II. COURSES OBJECTIVES:

The students will try to learn

I. The evolution and vision of 5G, along with its architecture and key design requirements.

II. Explore 5G radio access technologies, including spectrum, waveforms, and advanced antenna techniques.

III. Investigate the enabling technologies in 5G such as IoT, AI/ML, edge computing, and D2D communication.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO1 Recall the requirements and key functionalities of 4G LTEA/5G NR technology used in 5G communications.

CO2 Compare various channel access technologies and modulation techniques used in 5G wireless systems.

CO3 Explain the Service-Based Architecture (SBA) of the 5G Core Network and its significance in enabling modular, service-oriented network functions.

CO4 Analyze the role of Artificial Intelligence (AI) and Machine Learning (ML) in optimizing network performance, resource management, and predictive maintenance in 5G.

CO5 Understand Device-to-Device (D2D) communication and assess its benefits for improving spectral efficiency and reducing core network load.

CO6 Examine practical 5G deployments through case studies focused on real-world applications in Smart Cities, Industry 4.0, and Healthcare sectors."

IV. COURSE CONTENT:

MODULE - I: Introduction to 5G Networks (08)

Evolution from 1G to 5G, Need and vision for 5G, 3GPP and ITU-T contributions to 5G standardization, Use cases and application scenarios: Enhanced Mobile Broadband (Embb), Ultra-Reliable Low Latency Communications (URLLC), Massive Machine-Type Communications (mMTC), Key requirements and performance targets of 5G, 5G architecture overview (Core network and Access network).

MODULE –II: 5G Radio Access Technologies (09)

5G New Radio (NR) – Overview, mmWave and Sub-6 GHz spectrum bands, Orthogonal Frequency Division Multiplexing (OFDM) and numerology in 5G, Massive Multiple-Input Multiple-Output (MIMO) and beamforming techniques, Spectrum sharing and Dynamic Spectrum Access (DSA), Non-orthogonal Multiple Access (NOMA).

MODULE –III: 5G Network Architecture and Protocols (10)

Service-Based Architecture (SBA) in 5G Core, Network Slicing: Concept, implementation and use cases, Software Defined Networking (SDN) and Network Function Virtualization (NFV).

Protocol stack (RRC, PDCP, RLC, MAC, PHY), Dual Connectivity and Carrier Aggregation, Mobility Management in 5G.

MODULE –IV: Key Technologies Enabling in 5G (09)

Internet of Things (IoT) in 5G, Edge and Fog Computing, Artificial Intelligence and Machine Learning in 5G networks, Device-to-Device (D2D) Communication, Energy efficiency and Green communications, Security and Privacy challenges in 5G.

MODULE –V: 5G Deployment and Future Trends (09)

5G NR deployment strategies (Standalone and Non-Standalone), 5G Performance Analysis and KPIs, Coexistence with legacy networks (4G LTE, Wi-Fi),6G Vision and future directions, Case studies on 5G in Smart Cities, Industry 4.0, and Healthcare, Regulatory and standardization outlook

V. TEXT BOOKS:

1. Fundamentals of 5G Communications: Connectivity for Enhanced Mobile Broadband and Beyond, 1st Edition. Mc Graw Hill, 2021
2. Afif Osseiran, Jose F Monserrat, Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016
3. Harri Holma, Antti Toskala, Takehiro Nakamura, “5G Technology 3GPP NEW RADIO”, John Wiley & Sons First Edition,2020

VI. REFERENCE BOOKS:

1. Erik Dahlman, Stefan Parkvall, Johan Skold“5G NR: The Next Generation Wireless Access Technology” Academic Press (Elsevier), 2nd Edition, 2020
2. Srinivas R. Kota, Krishna Sivalingam “5G Networks: Fundamental Requirements, Enabling Technologies, and Operations Management” Springer, 1st Edition, 2020
3. Ying Zhang, “Network Function Virtualization Concepts and Applicability in 5G Networks”, John Wiley & Sons, 2018.

VII. ELECTRONICS RESOURCES:

1. NPTEL :: 5G Wireless Standard Design
2. NPTEL :: Evolution of Air Interface Towards 5G

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank

3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation