EOPE3001 WIRELESS COMMUNICATION (3-0-0)

Course Objectives:

This course explores wireless communication fundamentals, covering channel characteristics, fading models (Rayleigh, Rician), and digital modulation performance. Students will analyze diversity techniques, multiple access methods (TDMA, CDMA, OFDMA), and cellular network principles. Emphasis is placed on modern standards (LTE, 5G-NR), including mmWave, Massive MIMO, and capacity optimization for resource-efficient system design.

Module-I: (05 hours)

Wireless Channel Fundamentals: Wireless channel characteristics, Path loss and shadowing models, Time-varying channel impulse response, Narrowband vs. wideband fading channels, Introduction to statistical fading models.

Module-II: (08 hours)

Fading Models and Digital Modulation Performance: Detailed fading models: Rayleigh, Rician, Flat and frequency-selective fading, Performance of digital modulation schemes (e.g., BPSK, QAM) over fading channels, Link-level performance evaluation in wireless channels.

Module-III: (06 hours)

Diversity Techniques and Performance Analysis: Time, frequency, and space diversity, receive diversity techniques: Selective Combining (SC), Maximal Ratio Combining (MRC), Equal Gain Combining (EGC), Transmit diversity (e.g., Alamouti scheme), Performance analysis in Rayleigh fading channels.

Module-IV: (04 hours)

Multiple Access and Cellular Network Fundamentals: Multiple Access Techniques: TDMA, FDMA, CDMA, OFDMA, Cellular network concepts: Frequency reuse, spatial reuse, Co-channel interference, Spectral efficiency and Grade of Service (GoS), Capacity improvement: Cell splitting and sectorization.

Module-V: (07 hours)

Channel Capacity and Evolution of Cellular Standards: Channel capacity: AWGN, Flat and frequency-selective fading, Multi-user capacity and opportunistic communication, Uplink (MAC) and downlink (broadcast) channel capacity, Overview of cellular standards: LTE and LTE-Advanced, 5G-NR architecture and features: slicing, beamforming, Understand the significance of the mmWave spectrum in 5G and beyond, Explain the principle of Massive MIMO and spatial multiplexing.

Course Outcome:

Upon completion of the course, the students will be able to:

CO1: Classify the wireless channel of a given wireless communication system into the available analytical or empirical models

CO2: Apply appropriate techniques to mitigate the impact of channel impairments

CO3: Analyse the capacity and reliability of wireless communication systems

CO4: Design and Develop resource efficient and eco-friendly wireless technologies.

CO5: Design and assess modern wireless communication systems considering channel capacity, standard evolution (LTE/5G), and resource efficiency.

Text Books:

1. Andrea Goldsmith, “Wireless Communications”, Cambridge University press, 2006.
2. David Tse and Pramod Viswanath, “Fundamentals of Wireless Communication”, Cambridge University Press, South Asian Edition, 2006
3. T.S. Rappaport, “Wireless Communication, Principles and Practice”, PHI, 2002.
4. Simon Haykin and Michael Moher, “Modern Wireless Communications”, Pearson Education, 2007

Supplementary Reading:

1. A. Goldsmith, “Wireless Communications: From Fundamentals to 5G”
2. T. S. Rappaport, “Millimeter Wave Wireless Communications”
3. 3GPP documents on 5G NR (Optional for advanced learners)