

EC412: Fundamentals of MIMO

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Fundamentals of MIMO	3	1	0	Communication Systems

Course Objective: To introduce the basic concepts of MIMO systems and their significance in wireless communication. The mathematical foundations of MIMO systems include channel modeling and capacity analysis.

Course Outcomes:

- CO1: Explain the principle of MIMO systems and their advantages over SISO (Single Input Single Output Systems).
- CO2: Analyze MIMO channel models and compute the capacity of MIMO systems under different conditions.
- CO3: Design and evaluate MIMO techniques such as spatial multiplexing, diversity, and beamforming.
- CO4: To study the practical implementation challenges and solutions in MIMO systems
- CO5: Identify and address practical challenges in implementing MIMO systems in real wireless communication.

S. No.	Content	Contact Hours
Unit 1	Overview of wireless communication systems Evolution from SISO to MIMO Benefits of MIMO: Capacity, Diversity, and Multiplexing Applications of MIMO in modern wireless standards (4G, 5G, Wi-Fi)	6
Unit 2	Channel modeling basics: Rayleigh, Rician, and Nakagami fading MIMO channel matrix representation Spatial correlation and its impact on MIMO performance Keyhole effect and other practical channel impairments	10
Unit 3	Shannon's capacity for SISO systems, MIMO capacity under different channel conditions (CSI known/unknown at the transmitter), Water-filling algorithm for capacity maximization, Ergodic and	8

	outage capacity	
Unit 4	Spatial Multiplexing: BLAST (Bell Labs Layered Space-Time) architectures Diversity Techniques: Alamouti code, OSTBC (Orthogonal Space-Time Block Codes) Beamforming: Principles and algorithms (e.g., Zero-Forcing, MMSE) Hybrid techniques: Combining multiplexing and diversity	8
Unit 5	MIMO in 4G LTE and 5G NR, Massive MIMO: Concept and challenges, MIMO-OFDM (Orthogonal Frequency Division Multiplexing) system, MIMO in mmWave communications- Introduction to simulation tools (MATLAB, Python) Simulating MIMO channels and analyzing performance metrics (BER, Capacity, Hardware implementation challenges: Antenna design, RF impairments, and signal processing	10
Total		42

Books:-

S. No	Name of Books/Authors/Publisher
1	MIMO Wireless Communications/Claude Oestges and Bruno Clerckx/Academic press 2010
2	Fundamentals of Wireless Communication/David Tse and Pramod Viswanath/Cambridge University Press/2005
3	Space-Time Wireless Systems: From Array Processing to MIMO Communications/H. Bölskei, D. Gesbert, C. Papadias, and A.-J. van der Veen/Cambridge University Press/2006
4	MIMO-OFDM Wireless Communications with MATLAB/Yong Soo Cho, Jaekwon Kim, Won Young Yang, and Chung G. Kang/John Wiley & Sons (Asia) Pte Ltd/2010
5	Wireless Communications: Principles and Practice/Theodore S. Rappaport/Cambridge University Press/2024