

Course Code	Course Title	L	T	P	C
1152EC224	MIMO WIRELESS COMMUNICATION	2	0	2	3

a) Course Category

Program Elective

b) Preamble

This course covers the fundamentals of Multiple Input Multiple Output (MIMO) antenna based wireless communication systems. MIMO is now an essential part of modern wireless communication systems, such as 3G, 4G, WLAN / Wifi, LTE, WiMax, etc. MIMO brings to the domain of wireless communications, spectral efficiency and reliability gains. With multiple antennas at the transmitter and receiver it helps design wireless communication systems that can use the additional spatial dimension over and above the well investigated time frequency dimensions to fetch myriads of new gains. MIMO is expected to be one of the enabler of 5G communication systems.

c) Prerequisite

Nil

d) Related Courses

Wireless Digital Communication

e) Course Outcomes

On successful completion of the course, the students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Classify and explain the diversity schemes involved in MIMO with advantages, applications, channel models and power allocation	K2
CO2	Calculate the capacity of deterministic and random MIMO channels and fading channels	K3
CO3	Explain the different space time coding techniques like STBCs, STTCs and Space time turbo codes	K2
CO4	Describe various algorithms used to detect the received signal in MIMO systems like Maximum likelihood, MMSE, ZFE	K2
CO5	Discuss the advances in MIMO Communication Systems	K2

f) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	-	-	L	-	-	-	-	-	-	-	-	-
CO2	M	M	L	-	M	L	-	-	M	M	-	M	-	-
CO3	M	M	L	-	H	-	-	-	-	-	-	M	-	M
CO4	M	M	M	-	H	-	-	-	H	H	-	M	-	M
CO5	M	M	M	-	H	L	L	L	-	-	M	M	-	-

g) Course Content

UNIT I INTRODUCTION TO MIMO CHANNEL MODELS 9

Diversity-multiplexing trade-off, transmit diversity schemes, advantages and applications of MIMO systems, Fading Channel Models: Uncorrelated - fully correlated - separately correlated - keyhole MIMO fading models, parallel decomposition of MIMO channel, Power allocation in MIMO: Uniform - adaptive - near optimal power allocation

UNIT II MIMO CHANNEL CAPACITY 9

Capacity for deterministic MIMO Channels: SISO – SIMO – MISO – MIMO, Capacity of random MIMO channels: SISO – SIMO – MISO - MIMO (Unity Channel Matrix, Identity Channel Matrix), Capacity of independent identically distributed channels, Capacity of separately correlated Rayleigh fading MIMO channels, Capacity of keyhole Rayleigh fading MIMO channel

UNIT III SPACE-TIME CODES 9

Advantages, code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Space-time codes over separately correlated MIMO channel, Space-time turbo codes, BLAST Architectures: VBLAST – HBLAST – SCBLAST - DBLAST.

UNIT IV MIMO DETECTION TECHNIQUES 9

Maximum Likelihood, Zero Forcing, Minimum Mean Square Error, Zero Forcing Equalization with Successive Interference Cancellation, Minimum Mean Square Error Successive Interference Cancellation, Lattice Reduction based detection

UNIT V ADVANCES IN MIMO 9

Spatial modulation, MIMO based cooperative communication and cognitive radio, multiuser MIMO, cognitive-femtocells and large MIMO systems for 5G wireless, MIMO Applications in RADAR, Satellite Communication, Wi-Fi

h) Practical Exercises

15

- 1 Performance analysis of 2 x 2 MIMO system using different modulation techniques with ML detection algorithm
- 2 Performance analysis of 2 x 2 MIMO system using different modulation techniques with ML detection algorithm in correlated and uncorrelated channel conditions
- 3 Performance analysis of 2 x 2 MIMO system using different modulation techniques with ML detection algorithm
- 4 Performance analysis of 2 x 2 MIMO system using different modulation techniques with V-Blast detection algorithm
- 5 Performance analysis of 2 x 2 MIMO system using different space time coding techniques with ML detection algorithm
- 6 Performance analysis of 2 x 2 MIMO system using different space time coding techniques with V-Blast detection algorithm
- 7 Performance analysis of Multi-user MIMO system using BPSK modulation technique with SIC and V-Blast detection algorithm

Total 60 Hrs

i) Learning Resources

Text Books

1. Tolga M. Duman and Ali Ghayeb, "Coding for MIMO Communication Systems", John Wiley & Sons Ltd., 2007.
2. Ezio Biglieri, Robert Calderbank and Anthony Constantinides. "MIMO Wireless Communications"
3. R. S. Kshetrimayum, "Fundamentals of MIMO Wireless Communications", Cambridge University Press, 2017.

Reference Books

1. B. Kumbhani and R. S. Kshetrimayum, "MIMO Wireless Communications over Generalized Fading Channels", CRC Press, 2017
2. T. L. Marzetta, E. G. Larsson, H. Yang and H. Q. Ngo, "Fundamentals of Massive MIMO", Cambridge University Press, 2016.

Online Resources

1. <http://nptel.ac.in/courses/117105132>