# GUJARAT TECHNOLOGICAL UNIVERSITY

## WIRELESS COMMUNICATION TECHNOLOGY (44)

WIRELESS MIMO COMMUNICATION

**SUBJECT CODE:** 2734403

M.E. 3RD SEMESTER

**Type of Course**: Purpose of the course is to provide a comprehensive coverage of coding techniques for multiple- input, multiple-output (MIMO) communication systems

**Prerequisite:** basic fundamentals of wireless communication systems

**Rationale:** To learn about basic MIMO communication systems, Space-time block codes, Space-time trellis codes, MIMO systems for frequency-selective (FS) fading channels, Turbo codes and iterative decoding for MIMO systems.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | | | |
| L | T | P | C | ESE (E) | PA (M) | ESE (V) | | PA (I) | | |
| | | | | | | ESE | OEP | PA | RP | |
| 3 | 2# | 2 | 5 | 70 | 30 | 20 | 10 | 10 | 10 | 150 |

**Contents:**

| Sr. No. | **Topics** | **Teaching Hrs.** | **Module Weightage** |
|---|---|---|---|
| 1 | FADING CHANNELS AND DIVERSITY TECHNIQUES<br>Wireless channels, Error/Outage probability over fading channels , Diversity techniques, Channel coding as a means of time diversity, Multiple antennas in wireless communications | **4** | **12** |
| 2 | CAPACITY AND INFORMATION RATES OF MIMO CHANNELS<br>Capacity and Information rates of noisy, AWGN and fading channels, Capacity of MIMO channels, Capacity of non-coherent MIMO channels, Constrained signaling for MIMO communications. Matlab exercise | **8** | **22** |
| 3 | SPACE-TIME BLOCK AND TRELLIS CODES<br>Transmit diversity with two antennas: The Alamouti scheme, Orthogonal and Quasi-orthogonal space-time block codes – Linear dispersion codes, Generic space-time trellis codes, Basic space-time code design principles, Representation of space-time trellis codes for PSK constellation, Performance analysis for space-time trellis codes, Comparison of space-time block and trellis codes, Matlab exercise | **8** | **22** |
| 4 | CONCATENATED CODES AND ITERATIVE DECODING<br>Development of concatenated codes – Concatenated codes for AWGN and MIMO channels – Turbo coded modulation for MIMO | **8** | **22** |

| | | | |
|---|---|---|---|
| | channels – Concatenated space-time block coding. Matlab exercise | | |
| 5 | SPACE-TIME CODING FOR FREQUENCY SELECTIVE FADING CHANNELS<br>MIMO frequency-selective channels – Capacity and Information rates of MIMO FS fading channels, Space-time coding and Channel detection for MIMO FS channels , MIMO OFDM systems., Matlab exercise | **8** | **22** |

**Reference Books:**


1. Tolga M. Duman and Ali Ghrayeb, "Coding for MIMO Communication systems", John Wiley & Sons, West Sussex, England, 2007.
2. A.B. Gershman and N.D. Sidiropoulus, "Space-time processing for MIMO communications", Wiley, Hoboken, NJ, USA, 2005.
3. E.G. Larsson and P. Stoica, "Space-time block coding for Wireless communications", Cambridge University Press, 2003.
4. M. Janakiraman, "Space-time codes and MIMO systems", Artech House, 2004.
5. H. Jafarkhani, "Space-time coding: Theory & Practice", Cambridge University Press, 2005.


**Course Outcomes:**

After learning the course the students should be able to:

1. Clearly identify and design the remedies for fading channels in MIMO systems

**List of Experiments:**

Based on the contents of the syllabus, MATLAB exercise problems may be given.

**Design based Problems (DP)/Open Ended Problem:**

1. To model a specific fading channel
2. To model a diversity technique.
3. To model a frequency-selective fading channel for mimo.
4. To model a mimo-ofdm combination.

**Major Equipments:**

USRP/DSP/FPGA development board

**List of Open Source Software/learning website:**

Scilab, NPTL

**Review Presentation (RP):** The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.