

Wireless Access

Syllabus

Master's Program in Telecommunication Engineering – First Year, Second Semester

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Information and teaching materials available at:

<http://acts.ing.uniroma1.it/wa.php>

Course Topics

1. Resource Allocation Policies (*e.g., Frequency Management*)

- **Partitioning vs. Sharing** – Whether resources are divided or shared among users.
 - **Open vs. Closed Systems** – Accessibility of systems to multiple users or networks.
 - **Coexistence and Cooperation Between Systems** – Techniques enabling simultaneous operation of multiple systems.
 - **Orthogonal, Quasi-Orthogonal, and Non-Orthogonal Resource Sharing** – Levels of separation to mitigate interference.
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2. Multi-User Communication Systems (MU)

- **Orthogonal Multiplexing Techniques:**
 - *Time*: TDMA (Time Division Multiple Access)
 - *Frequency*: FDMA (Frequency Division Multiple Access)
 - *Code*: CDMA (Code Division Multiple Access)
 - *Space*: SDMA (Spatial Division Multiple Access)
 - *Combined Techniques*: Single-carrier and Multi-carrier (e.g., OFDMA)
 - **Impulse Radio Systems:**
 - DS-IR (Direct Sequence Impulse Radio)
 - TH-IR (Time Hopping Impulse Radio)
 - **Access and Synchronization Linkage**
 - **Communication Architectures:**
 - FDD (Frequency Division Duplexing)
 - TDD (Time Division Duplexing)
 - Full-Duplex Systems
 - **Interference Models and Performance Analysis:**
 - Standard Gaussian Approximation
 - Pulse Collision Models
 - Theoretical MU Channel Capacity
 - **Interference Management and Cancellation**
 - **Non-Orthogonal Multiple Access (NOMA) Techniques**
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3. The Wireless Channel

- **Characterization of Time-Varying and Frequency-Selective Channels:**
 - Coherence Time and Coherence Bandwidth
 - Mobility and Doppler Effects
- **Statistical Models:**

- Path Loss and Fading
 - **Power Delay Profile**
 - **Channel State Information (CSI):** Acquisition and Management
 - **Channel-Based User Selection**
 - **Multi-User Channel:** Spatial Coherence
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4. Statistical Models for Access Systems

- **Birth and Death Processes:**
 - Pure Birth and Death, Poisson Processes
 - Inter-Arrival Time Distributions, Moments
 - **Markov Processes and Chains:**
 - Definitions, Characteristics, Transition Diagrams
 - Homogeneous and Stationary Chains
 - Periodic/Aperiodic, Recurrent, Ergodic Properties
 - **Queueing Theory:**
 - System Types and Classifications
 - Steady-State Probabilities
 - Example Models: M/M/1, M/M/1/k
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5. Resource Allocation Techniques

- **Random Access:**
 - ALOHA, Slotted ALOHA, Stability
 - Capture Effect, CSMA
 - Hidden and Exposed Terminal Problems
 - Handshaking Protocols, MACA
 - **Scheduled Access (Scheduling):**
 - Centralized and Distributed Polling
 - Performance Metrics: System Time, Queue Time
 - Impact of Arrival/Service Statistics
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6. Resource Management in Open Systems

- **Coexistence and Cognitive Networks:**
 - Individual and Cooperative Spectrum Sensing
 - Pilot Channels, Inter-System Communication
 - Cognitive Routing
 - AI and Machine Learning in Radio Emission Classification
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7. MAC Standards for Wireless Networks

- **IEEE Standards:**
 - 802.11 (Wi-Fi)
 - 802.15.1 (Bluetooth)
 - 802.15.3
 - 802.15.4 (Zigbee)
- **3GPP Standards:**
 - 4G, 5G, 6G