

Department of Electrical Engineering, IIT Madras

ESB-128; Q-Slot (Tuesday, 2pm to 5pm)

9 credits; Jan-May, 2020

EE 6323: Wireless Systems Design

Motivation: Wireless systems are digital communication systems today and are invariably packet transport oriented with a block-modulated air interface. This course gives an exposure to block modulation fundamentals, and air-interface design to ensure high quality signal recovery for a specific example. RF system design details, and a detailed link budget for this example link will be presented by experts from Data Patterns (India) Pvt. Ltd. who have recently designed and developed a high-capacity radio link in co-operation with IIT Madras.

There will be a few visits to this industry, where experts will also describe the data flow details from IP layer to the way the coded bits get mapped to the physical layer of this radio link, and how the receiver recovers from timing jitter when streaming time-sensitive data. Some aspects of antenna and mast designs (including mechanical issues) will also be addressed by the industry experts.

Part-1: Introduction to block modulation

- 1.1 How to map a continuous time channel to an equivalent discrete time channel?
- 1.2 The good and bad of TDMA and DS-CDMA – spectral efficiency, power-control, peak power
- 1.3 Why the evolution from symbol-by-symbol modulation to block modulation?
- 1.4 Generalised block modulation with special focus on OFDM
- 1.5 The impact of Cyclic Prefix in OFDM links

Part-2: Estimation and Detection in OFDM Links

- 2.1 Synchronisation in OFDM links (timing, frequency, frame-boundary)
- 2.2 Channel estimation in OFDM links – from the sublime to the ridiculous
- 2.3 Coded OFDM – LLR estimation and bit detection

Part-3: From Design to Development to Product Realisation (Experts from Data Patterns)

- 3.1 Detailed transceiver design for a high-speed OFDM link
- 3.2 RF link budget, theoretical sensitivity, and measured sensitivity for target throughput
- 3.3 Antenna subsystem and mast control
- 3.4 How to send streaming traffic with jitter guarantees – “flow control using buffer management”
- 3.5* Supporting P2P, PMP, and FH along with EOW signals using the same link
- 3.6* Supporting different interfaces (E1, E3, Ethernet, Optical)

Textbooks: OFDM basics from “*Baseband Receiver Design for Wireless MIMO-OFDM Communications*”, Tzi-Dar Chiueh, Pei-Yun Tsai, I-Wei Lai, Wiley-Blackwell; 2nd Edition (June 2012), and a few sections from “*Fundamentals of Wireless Communications*”, David Tse, Pramod Viswanath.

Assessment Method:

Simulation Assignments – 30; Mini-Project – 30; End Sem (TBD) – 40; The TAs for this course will be Mr. Abhay Mohan (abhay@tenet.res.in) and Mr. Dibyajyoti Basak (dbasak@tenet.res.in). Contact me at ESB-334B, x4420, giri@tenet.res.in, for more details. Soft-copies of additional material will be made available at www.ee.iitm.ac.in/~giri and/or on Moodle.