# Department of Electrical Engineering – Jan-Apr, 2015

## EE6141: Multi-Carrier Communications

**Course Contents:**

1. Digital Communication Review:  Linear symbol-by-symbol modulation, Optimal Detection in AWGN channels, ISI (Frequency Selective) channels, Multiple Access using TDMA/FDMA/CDMA schemes, Peak Power versus Average power requirements, Timing alignment, Equalisation

2. Multi-carrier Systems:  Motivation for Block Modulation, Single-carrier vs Multi-carrier, OFDM system, OFDMA versus OFDM, Role of FFT, Peak to Average Power, Distributed and Localized mapping, Coded OFDM/OFDMA, Intro to MIMO coded OFDM

3. OFDM Receiver Algorithms: Synchronization, Impact of Timing and Frequency Sync Errors (MSE Analysis) Channel Estimation and Equalization in OFDM/OFDMA, Zero forcing and MMSE algorithms, Training sequence design, Uplink Ranging in OFDMA

4. Adaptive Modulation: Information theoretic approach, Water-filling solution, Bit loading algorithms, Rate Adaptation in Cellular OFDMA

5. Generalised Multi-carrier Systems – Block modulation with zero-padding, PN sequences, MC-DS-CDMA, interleaved FDMA (IFDMA), and DFT-precoded OFDM (SC-FDMA) –Transceiver Block Diagrams

**6. NEW TOPIC** -- Advanced Block Modulation Technologies: Filtered Multicarrier Schemes (including Filterbank at Tx and/or at Rx), Continuous Phase OFDM, Channel Shaping/Truncation in Cellular OFDM/OFDMA.

7. MIMO-OFDM**: Fundamental MIMO concepts, Spatial diversity, Spatial Multiplexing, Space-Frequency coding, introduction to Multi-user MIMO
** The extent of coverage of this topic will depend on time and tide!

**Evaluation details for the Course (**Tentative) **:**
Short-tests (2x5=10 marks), Mid-Sem (20 marks), Computer-based Assignment (10 marks), End-Sem* (45 marks), Mini-project Presentation (15 marks).
* Endsem can be changed to 40 marks and mini-project to 20 marks if students put in sincere effort for their mini-project.

Regularly check the URL  **http://www.ee.iitm.ac.in/~giri/teaching.html** for updates and news.
**Text Book:**
Y.S.Cho, J.Kim, W.Y.Yang, and C.G.Kang, "MIMO-OFDM Wireless Communications with Matlab", Wiley (Asia) and IEEE Press,  2010.

**References :**
(i) T.D.Chiueh and P.Y.Tsai, "OFDM Baseband Receiver Design for Wireless Communications", Wiley, 2007
(ii) L. Hanzo, M. Munster, B.J. Choi, and T.Keller, "OFDM and MC-CDMA for Broadband Multiuser Communications, WLANs, and Broadcasting", Wiley, 2003.
(iii) J. Proakis, "Digital Communications", New York - McGraw Hill, 2001
(iv) D. Tse and P. Vishwanath,"Fundamentals of Wireless Communications", Cambridge Press, 2005