

Digital Communications (3 DAY COURSE)

SYLLABUS

DSP Theory Review

- ADCs and DACs / signal conditioning
- Antialias and reconstruction filters
- Distortion, quantisation error and noise
- The Nyquist sampling rate
- z-domain representation and transforms
- FIR and IIR Digital Filters
- Poles and zeroes and the Z-domain
- Linear/non-linear phase
- Minimum/non-minimum phase

Single Carrier Data Communications

- Information theory
- AM/FM/PM modulation
- ASK/PSK/FSK signalling
- Complex signal representations
- Symbol constellations
- QPSK and QAM digital communications
- Pulse shaping
- Matched filtering techniques
- Inter-Symbol Interference (ISI)
- Orthogonal carrier principles
- Data equalisation

Adaptive DSP for Communications

- Adaptive applications (equalisation, beamforming)
- Adaptive architectures
- LMS Algorithm
- Non-canonical LMS algorithms
- RLS and QR algorithms
- Decision Feedback Equalisation
- Fractionally spaced equalisers
- Blind equalisation

Spread Spectrum Communications

- Time/frequency/code DMA (TDMA/FDMA/CDMA)
- Spread spectrum techniques
- Coding gain
- Direct sequence CDMA
- Multiple access interference
- PRBS sequence generation
- OVVSF- orthogonal variable spreading function
- Walsh codes and multipath
- The near far problem
- Power control
- The rake receiver

OFDM Communications

- Historical perspective: DMT
- Motivation for multi-carrier vs single-carrier
- Introduction to OFDM
- The structure of an OFDM signal

- Sub-carrier symbol structure
- Generation of OFDM symbols using the IFFT
- Cyclic prefix (guard interval)
- OFDM signal bandwidth
- OFDM dynamic range considerations
- Peak-to-average power ratio (PAR)
- Crest factor measurements and limits
- RF Amplifier clipping considerations
- Minimising / reducing PAR
- SC-FDMA

Propagation Channels

- Time & frequency channel dispersion
- AWGN and Multipath Propagation Channels
- Delay Spread Values and Time Variations
- Loss of orthogonality in CDMA signals
- Loss of orthogonality in OFDM signals
- Fast and slow fading environments
- Complex baseband multipath channels

Single Carrier Synchronisation

- Optimal receiver structure
- Maximum Likelihood parameter estimation
- Phase and frequency recovery
- Phase Locked Loops (PLLs)
- The Costas loop
- Squaring Loops
- Numerically Controlled Oscillators
- Symbol recovery
- Equalisation techniques
- Error Vector Magnitude (EVM) measurements

OFDM Synchronisation

- Inter-Carrier Interference (ICI)
- Sensitivity to synchronisation errors
- Symbol timing recovery
- Carrier frequency recovery
- Frequency domain equalisation
- Use of training symbols and the cyclic prefix
- Frame Synchronisation

MIMO

- Spectral efficiency and capacity
- Transmit and receive diversity
- The Alamouti Scheme
- Delay Diversity and Cyclic Delay Diversity
- Beamforming
- Spatial multiplexing
- Singular Value Decomposition
- Equalising and predistortion in MIMO systems
- Precoding and combining in MIMO systems
- Codebooks for MIMO