# DSP Theory, Architectures & Algorithms

## SYLLABUS

### *Signal Processing Review*

- Signals, systems and applications
- Amplification, distortion and noise
- The 90s DSP revolution to software radio today
- SFDR - Spurious free dynamic range

### *The Generic DSP System*

- ADCs, DACs and signal conditioning
- Antialias and reconstruction filters
- Quantisation
- Noise and distortion
- The Nyquist sampling rate
- Undersampling techniques

### *Transform Domain Analysis*

- Elementary signals
- Continuous time and discrete time signals
- Linear systems
- Convolution
- z-domain system representation
- z-domain system analysis

### *Frequency Domain Analysis*

- Response of linear systems to sinusoids
- Periodic, aperiodic and random signals
- The Discrete Fourier Transform (DFT)
- The Fast Fourier Transform (FFT)
- Spectral leakage and windowing
- Time/frequency representation
- Danielson-Lanczos lemma
- Cooley-Tuckey algorithm
- Other FFT algorithms

### *Digital Filtering*

- Finite Impulse Response (FIR) filters
- The “intuitive” digital filter
- Digital filter design parameters and methods
- Linear and non-linear phase
- Minimum and non-minimum phase
- Infinite Impulse Response (IIR) digital filters
- IIR filter stability
- z-domain poles and zeroes
- Bit true/fixed point implementation

### *Adaptive DSP Algorithms*

- The generic adaptive filter
- Adaptive filter architectures
- Least squares minimisation
- Least Mean Squares (LMS) algorithm
- Channel equalisation / inverse system identification
- Feedback suppression
- Acoustic echo control / noise control
- RLS and QR algorithms

### *DSP Baseband Processing*

- Decimation and interpolation techniques
- Filter banks
- Polyphase implementation
- Oversampling techniques
- Quantisation noise shaping
- Sigma delta ADCs/DACs

### *Digital Communications*

- Information theory
- AM/FM/PM modulation
- ASK/PSK/FSK digital signalling
- Pulse shaping and matched filtering
- Raised cosine and root raised cosine filters
- QPSK and QAM digital communications
- Signal constellations
- Other modulation techniques
- Data equalisation
- Error control and coding

### *DSP for Mobile and Wireless*

- Time/frequency/code division multiple access
- Spread spectrum modulation
- CDMA scrambling and channelisation
- Single carrier vs multicarrier
- Introduction to OFDM
- Channel modelling

### *DSP (Software) Enabled Radio Architectures*

- Undersampling strategies
- Direct digital downconverters (DDC)
- f2/4 based systems
- Bandpass sigma delta
- QAM (Quadrature Amplitude Modulation)
- NCO (Numerically Controlled Oscillators)
- Synchronisation

### *DSP on FPGAs*

- Overview of today’s FPGA technology
- Integer, floating point and fixedpoint arithmetic
- Multiply, divide and square root implementation
- Digital filter implementation
- Retiming and pipelining techniques