Advanced Digital Signal Processing with MATLAB® (15 + 25 hours (40 hours))

This course mainly deals with using MATLAB® Signal Processing toolbox for Digital signal processing, analysis, visualization, and algorithm development. The training covers various topics such as filter design, windowing techniques, transforms, multi-rate signal processing, statistical signal processing, parametric modeling etc.

COURSE CONTENT :

Introduction to DSP (2 hours)	• Introduction to DSP • Sampled data systems • Aliasing and antialiasing • Reconstruction • Practical limitations • Frequency & amplitude resolution • Quantization and timing errors • Correlation and convolution • Frequency analysis • Fourier transforms • Frequency 'leakage' • Windowing • Multi-rate signal processing
Transforms (2 hours)	• Fourier Transform • Z – Transform • DCT Transform • Hilbert Transform • Wavelet Transform
Filters (5 hours)	FIR Filter - FIR digital Filters • FIR filter basics • Analysis of FIR filters • Frequency & impulse responses • The window design method • Optimization design methods • Practical limitations of FIR filters IIR Filter - • IIR filter basics

	• Analysis of FIR filters • Frequency & impulse responses • IIR filter design • Poles, zeroes and filter response
Cepstral analysis (1 hour)	• Complex Cepsturm • Inverse complex cepstrum • Real cepstrum and minimum phase reconstruction
Statistical signal processing (3 hours)	• Introduction to statistical parameters • Autocorrelation matrix • Power spectral density (PSD) • Cross power spectral density • Finding PSD using various Methods (periodogram, modified periodogram, covariance, Eigen vector, burg, yule walker, Welch, MUSIC Algorithm, Root MUSIC Algorithm) • Spectrogram • Transfer function estimation
Parametric modeling (2 hours)	• Introduction to signal modelling • Study of Auto Regressive Moving Average Models (ARMA), AR Models and MA models • Estimation of model parameters using various methods like Yule-Walker, prony etc)
DSP with MATLAB® (3 hours)	• Introduction to DSP Toolbox • Signal processing functions in MATLAB® (conv, conv2, corrcoef, cov, cplxpair, deconv, fft, fft2, fftshift, filter2, freqspace, ifft, ifft2,unwrap) • Time domain analysis of a signal • Frequency domain analysis of a signal
Digital Filter Design in MATLAB® (2 hours)	• Discrete-Time Filters (Direct form I, Direct form II, lattice filters) • 1_D Median filtering • Butterworth filter design • Chebyshev Type I filter design (pass band ripple) • Chebyshev Type II filter design (stop band ripple) • Raised cosine FIR filter design • Recursive digital filter design
Window Design (2 hour)	• Rectangular window • Hamming window • Hanning window

	• Bartlett window • Kaiser window etc
Transforms **(2 hour)**	• Discrete fourier transform • Discrete cosine transform • Hilbert transform • Discrete wavelet transform • inverse transforms
Multi-rate Signal Processing **(2 hours)**	• Decimation • Interpolation • Up-Sampling • Down-Sampling • Re-Sampling
Linear Systems **(1 hour)**	• Stabilize polynomial • *z*-transform partial-fraction expansion • conversion of digital filter parameters to transfer function form/ pole-zero form etc
Cepstral analysis **(1 hour)**	• Complex cepstral analysis • Inverse complex cepstrum • Real cepstrum and minimum phase reconstruction
Statistical signal processing **(4 hours)**	• Cross Correlation • Covariance • Data matrix for autocorrelation matrix estimation • Power spectral density (PSD) • Cross power spectral density • Finding PSD using various Methods (periodogram, modified periodogram, covariance, Eigen vector, burg, yule walker, Welch, MUSIC Algorithm, Root MUSIC Algorithm) • Spectrogram • Transfer function estimation
Parametric Modeling **(4 hours)**	• Autoregressive (AR) all-pole model parameters estimated using Burg method • Estimate AR model parameters using covariance method • Estimate AR model parameters using modified covariance method • Estimate autoregressive (AR) all-pole model using Yule-Walker method • Cross power spectral density

	• Prony method for filter design
Waveform Generation (30 min)	• Swept-frequency cosine • periodic sinc function • Pulse train • Saw-tooth or triangle wave
GUI's (1 hour)	• Filter Design and Analysis Tool • GUI-based filter design • Open interactive digital signal processing tool • Open Filter Visualization Tool
Bi-level Waveform Measurements (30 min)	• Duty cycle of pulse waveform • Fall time of negative going bi-level waveform transitions • Period of bi-level pulse • Separation between bilevel waveform pulses • Bilevel waveform pulse width • Slew rate of bilevel waveform