Signals and Systems - Video course

What is Signal and System Theory? The black-box approach. Physical instances and their adaptation in the framework.
Formal definition of 'signal' and 'system'. The domain and range variables, continuous and discrete signals and cont. and discrete systems. Cont./discrete vs analog/digital. Domain and range operations and transformaations, and their effects upon signals.
Characterization of systems: memory, linearity, causality, time-invariance, stability. Examples and counterexamples.
Linear and time invariant systems. The Dirac impulse as a limit of a sequence of cont. fns. Mathematical difficulties with handling Dirac impulsers: brief, adequate discussion. Representation of cont. signals using impulses. Kronecker impulses and representation of discrete signals using Kronecker impulses. The general 'impulse response' of any system. Impulse response of linear time-varying systems. Impulse response of linear time-invariant systems. Evolution of the convolution integral and the convolution sum. Algebraic properties of the convolution operation. Block diagram representations for interconnections of systems. Characterizing a system from its impulse response. Characterizing interconnected systems.
Differential Equations review. To represent a system using differential equations. Non-uniqueness. The need for auxiliary conditions. Reflection of linearity and time-invariance. Causality: initial rest and final rest constraints. Difference equations, introduction. Forward and backward solution. Non-uniqueness, auxiliary conditions. Reflection of linearity, time-invariance, causality.
A discussion of the continuous-time complex exponential, various cases. Cont. time systems and complex exponentials. Periodic signals: definition, sums of periodic signals, periodicity of the sum. Harmonically related periodics. Expressing a periodic signal as a sum of complex exponentials. The Fourier series: analysis and synthesis equations, orthogonality of the Fourier basis. Signal approximation using truncated Fourier series. Brief discussion of convergence issues and conditions for existence of the FS. Aperiodic signals and their representation: the transition from the FS to the Fourier Transform. Finite power and finite energy signals. Brief discussion of convergence issues and conditions for existence of the FT. Extension of the FT for finite power signals: frequency domain Dirac impulses. Properties of the FS and FT: particular emphasis on convolution.
A discussion of the discrete-time complex exponential, various cases. Discrete time systems and complex exponentials. Periodic discrete signals: sampling periodic cont.-time signals. Periodic signal as a sum of complex exponentials. The discrete-time Fourier series: analysis and synthesis equations, orthogonality of the Fourier basis. Signal approximation using truncated Fourier series. Convergence issues and the interpretation of the FS as a set of simultaneous linear equations. The DFT: N-point DFT of an M-point signal. Aperiodic signals and their representation: the transition from the DTFS to the discrete-time Fourier Transform. Finite power and finite energy signals. Brief discussion of convergence issues and conditions for existence of the DTFT. Extension of the DTFT for finite power signals: frequency domain Dirac impulses. Properties of the DTFS and DTFT: particular emphasis on convolution.
The principle of cont. signal sampling. The primary objective: perfect reconstruction. Ideal sampling and the sampling theorem: over- and under-sampling. Reconstruction theory: finite order interpolators and reconstruction distortion; ideal reconstruction. Non-ideal sampling and reconstruction. Sampling of discrete-time signals.
Laplace Transform as a generalization of the FT. The region of convergrnce and its properties. Pole-zero plots. Inverse transformation: role of the ROC in ensuring uniqueness. Properties of the LT. Inference of the FT from the LT. System characterization from the pole-zero plot. One-sided LT. The z-Transform as a generalization of the DTFT. The region of convergrnce and its properties. Pole-zero plots. Inverse transformation: role of the ROC in ensuring uniqueness. Properties of the ZT. Inference of the DTFT from the LT. System characterization from the pole-zero plot. Cont. to discrete system transformations. One-sided ZT.

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