**SUMMARY OF ELEC 5452 TOPICS COVERED BY DR MCLERNON (JAN-MAY 2024)**

Below is a broad summary of what we covered in my lectures.

* Overview of DSP applications.
* List advantages of DSP over analoque signal processing and advantages of digital comms (using DSP) over analoque comms.
* Generic five block diagram for DSP setup and what each block does. What the spectrum of the signal (analogue and digital) looks at ouput of each of five blocks. Limitations of DSP (aliasing, quantisation, finite wordlength, etc.) covered in detail with explanation of sinc(x) distortion of DAC.
* Sampling Theorem. How an ADC works – bits per sample, quantisation levels, etc. SNR calculations
* MAC’s and relationship to implementation/sampling frequency, bandwidths, etc. Ability to do calculations on MAC time restrictions.
* Normalised/un-normalised Hz and rad/sec. Converting bewteen four plots Ability to transform between all four plots and correctly label x-axes.
* Discrete-time sequences, delay/advance/scale/etc.. Evaluating periodicity. Calculation of the period of any sequence or sum of different sequences. Plot various discrete-time sequences made up of step functions, delta functions, etc.
* Different types of filter – LP, HP, BP and BS. Ability to plot these (using both positive and negative frequencies) in any of the four normalised/un-normalised Hz and rad/sec formats.
* Convolution, graphical implementation. Three different realisations/visualisations – e.g., (i) x(0)h(n) + x(1)h(n-1)+x(2)h(n-2) etc (ii) reverse one sequence, multiply overlapping elements with second sequence, sum, shift one sample, repeat. (iii) matrix/vector implementation.
* Linear difference eqns. Calculate of magnitude freq response of system and plot it. Evaluate phase response.
* Z-transform. H(z) given LDE. LDE given H(z). Pole/zero plot. Stability requirement on poles. Rough evaluation of freq response from pole/zero plot of H(z). Calculation of H(z) from LDE. Case study one section– notch filter design. Go from LDE, to H(z), to pole/zero plot to rough estimate of frequency response from pole-zero plot.
* Calculation of z-transforms for exponentials, steps, cos, sine, exponentially decaying cos and sine.
* Frequency response, evaluation, steady-state response. DTFT. DFT and zero padding for increasing resolution. Difference between DFT and FFT. Properties of DTFT.
* Notch filter design and implementation in detail going from pole zero plots to linear difference equations.
* Use of DTFT to design low pass filter and limitations of this design. Do calculations. Filter design either via optimisation for FIR (PARKS-McCLELLAN/REMEZ EXCHANGE algorithm) or BILINEAR TRANSFORM for IIR.
* High Speed Linear Convolution using FFT and zero padding.
* Circular convolution and multiplication of DFTs. Three different visualisations of circular convolution. Why circular convolution is important in OFDMA for 4G and 5G using a cyclic prefix.
* Using DTFT/DFT/FFT for spectral analysis. Understand and be able to clearly explain all the trade-offs regarding window length, different windows, SNRs, etc when trying to identify both the the amplitudes and the frequencies of sums of different sinusoids (with different amplitudes and frequencies).
* Explanation of FFT, spectrogram, some basic mathematical derivations, etc. Other low complexity algorithms like solving linear eqns for a Toeplitz, symmetric matrix relationship as used in speech codec.

**Dr McLernon 19 May 2024**