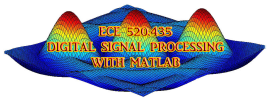

ECE 520.435 Digital Signal Processing with MATLAB

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Problem Set 2

Problem 1: The Energy, **E**, and Power, **P**, of a sequence **x[n]** over an interval $-N \leq n \leq N$ is defined as:

$$E_N = \sum_{n=-N}^{N} x[n]x^*[n] = \sum_{n=-\infty}^{\infty} |x[n]|^2$$

$$P_N = \frac{1}{2N+1} \sum_{n=-N}^{N} x[n]x^*[n] = \frac{1}{2N+1} \sum_{n=-N}^{N} |x[n]|^2$$

Write functions that compute the energy and power of an input sequence **x[n]**. *(Loops are not allowed)*

Problem 2: Write a function in MATLAB, namely $[y, n] = addsignal(x_1, n_1, x_2, n_2)$, that adds two discrete sequences $x[n_1]$ and $x[n_2]$. *Note: The sequences can be of different length, defined on negative indices and on different domains*

Problem 3: Write a function in MATLAB, namely $[y, n] = multsignal(x_1, n_1, x_2, n_2)$, that multiplies two discrete sequences $x[n_1]$ and $x[n_2]$. *Note: The sequences can be of different length, defined on negative indices and on different domains*

Problem 4: Write a function in MATLAB, namely $[y, n] = conv(x_1, n_1, x_2, n_2)$, that computes convolution of two discrete sequences. *Note: The sequences can be of different length, defined on negative indices and on different domains*

Problem 5: Modify/Use the **conv(.)** from Problem 4 to compute the cross-correlation, r_{yx}, and the auto-correlation, r_{xx} of discrete sequences where:

$$r_{yx}(k) = y(k) * x(-k)$$

$$r_{xx}(k) = x(k) * x(-k)$$

and $x(n) = (0.9)^n$, $0 \leq n \leq 20$ and $y(n) = (0.8)^{(-n)}$, $-20 \leq n \leq 0$.

Problem 6: Generate the complex-valued signal: $x[n] = e^{(-1+j0.3)n}$ for $-10 \leq n \leq 10$ and plot its magnitude, phase, real part and the imaginary part. *Use abs(.), angle(.), real(.), imag(.) and*

subplot(.) commands

Problem 7: A particular LTI system is described by the difference equation:

$$y(n) - 0.5y(n-1) + 0.25y(n-2) = x(n) + 2x(n-1) + x(n-3)$$

1. Computer and plot the impulse response of the system over $0 \leq n \leq 100$. Is the system stable? *Stability means* $\sum_{-\infty}^{\infty} |h(n)| \leq \infty$
2. If the input to the system is $x(n) = [5 + 3cos(0.2\pi n) + 4sin(0.6\pi n)]u(n)$, determine the response $y(n)$ over $0 \leq n \leq 200$

Problem 8: Write a function in MATLAB that computes even-odd decomposition of a complex-valued sequence centered about the origin.

Problem 9: A simple *digital differentiator* is given by:

$$y[n] = x[n] - x[n-1]$$

which computes a backward first order difference for the input sequence. Implement this differentiator, and plot the result on the input sequence $x(n) = sin(\frac{\pi n}{25})[u(n) - u(n-100)]$.

Problem 10: Go through Problem 2 of Week 4&5 Fall 2009 session (Do not submit this). Explore **chirp** command in MATLAB i.e. *help chirp* and re-produce results for quadratic, convex, concave and logarithmic chirps and display the respective spectrograms (see *help spectrogram*). Repeat for complex-valued chirps (you need to modify the commands). Take the linear-chirp sequence and contaminate it with Additive Gaussian noise ($\mu = 2$, $\sigma = 0.5$). Apply a 5-point and a 10-point Moving Average Filter and Display results.

Problem 11: A certain filter is defined by $b = [0.0466, 0.1863, 0.2795, 0.1863, 0.0466]$ and $a = [1, -0.7821, 0.68, -0.1827, 0.0301]$. Compute and display the filters response to a linear chirp having frequencies varying linearly from 0 to 500 Hz.

Problem 12: A certain LTI system is defined by $b = [1]$ and $a = [1, -1.27, 0.81]$. Compute and plot the first 30 samples of the response of the system to a unit step and ramp sequence.

Best of luck with the assignment