Midterm01 Review

1 Administrative

- Midterm01 Thursday 03/03 11:30-12:45
- 1 page of double-sided handwritten notes allowed (Tables are not provided)
- No Calculators
- Covers Chapters 1-3
- Must show work to receive credit

2 Chapter Review

Be sure to understand the homework problems. They are very indicative of the types of problems you can expect to encounter on the exam. Extra sample problems can be found in Schaum's Outlines for Signals and Systems.

Check the syllabus for Course Outcomes. These are the things you should know how to do at the end of class and so I should probably test that you do know it.

2.1 Signals and Systems

Topics

Complex numbers, Euler's formula, signal operations (time shift, scale, and reversal), system properties (memoryless, invertible, causal, stable, linear, time-invariant)

Problems

- OS 1.27, 1.28, 1.54, 1.55, 1.56
- Schaum 1.1, 1.2, 1.32a, 1.34, 1.39

2.2 LTI Systems

Topics

Impulse response, convolution (flip and drag technique), system properties (memoryless, invertible, causal, stable), exponentials as eigen signals

Problems

- OS 2.8-2.11, 2.21, 2.24, 2.29, 2.46
- Schaum 2.4, 2.5, 2.18, 2.19, 2.28, 2.29, 2.30, 2.38, 2.40, 2.41, 2.43, 2.45, 2.58, 2.62

2.3 Fourier Series

Topics

Periodicity of a signal (find fundamental period and frequency), analysis and synthesis equation for FS (periodic signal as linear combination of harmonic complex exponentials), FS Properties (Tables 3.1, 3.2), FS with LTI systems (eigen signal result)

Problems

- OS 3.21, 3.24, 3.25, 3.33
- Schaum 5.4, 5.7(a), 5.9(a), 5.10, 5.12, 5.61(a,b), 6.1-6.6, 6.62, 6.63,

3 Practice Exam Problems

1. Prove the relationship $x(t) * \delta(t - t_0) = x(t - t_0)$.
2. Given $y(t) = x(t) * h(t)$, find $y_s(t) = x(t - t_1) * h(t - t_2)$.Express your answer in terms of $y(t)$.
3. In Signal processing, the cross correlation is a measure of similarity between two signals as a function of a time-lag applied to one of them. It is defined as

$$(f \star g)[n] = \sum_{m=-\infty}^{\infty} f[m]g[n + m]$$

   How can you compute the correlation of two signals using the convolution operator? At what time n is the auto-correlation, $r[n] = (f \star f)[n]$, maximal?

4. Determine whether the following systems are 1) memoryless, 2) causal, 3) stable, 4) linear, and 5) time-invariant. The input to the system is $x(t)$ and the output is $y(t)$.
   (a) $y(t) = x(t) + u(t - 1)$
   (b) $y(t) = x(t) + \int_{-\infty}^{\infty} x(\tau) \left[e^{-(t-\tau)}u(t - \tau)\right] d\tau$
5. The following questions refer to the feedback system defined by

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

   (a) Draw the block diagram for this system.
   (b) Find the response of the system $y_1[n]$ when when the input is $x[n] = u[n - 1] - 2u[n - 4] + u[n - 6]$.
   (c) Find the response of the system $y_2[n]$ to $x[n] = \cos\left(\frac{\pi}{3}n + \frac{\pi}{4}\right) + \sin\left(\frac{\pi}{4}n\right)$. Express your answer in terms of the Fourier Series coefficients, b_k, of output $y_2[n]$.

6. Given the signal $x(t)$ as shown in Figure 1 and $y(t) = u(t+2) - u(t)$, perform the convolution of the two signals. Provide a sketch of the convolution and label the values at $t = -2, -1, 0, 1, 2$.

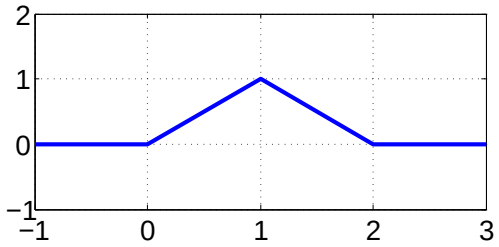

Figure 1: $x(t)$