New Mexico State University
Klipsch School of Electrical Engineering

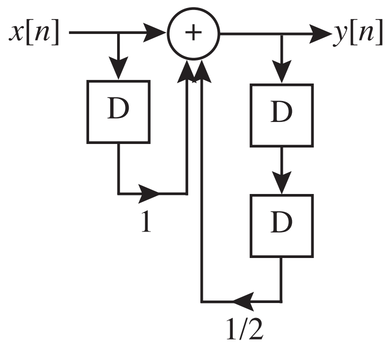
EE312 - Signals and Systems I
Fall 2015
Exam #2

Name: ____________________

Prob. 1	/ 25 points
Prob. 2	/ 25 points
Prob. 3	/ 25 points
Prob. 4	/ 25 points
Total	/ 100 points

Prob. 1

A system is described by the following block diagram.



Assume the system is initially at rest, i.e. $y[-2] = y[-1] = 0$.

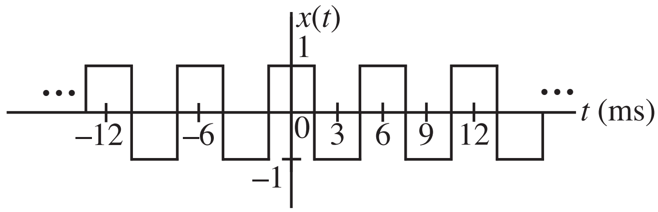
(a) Determine the equivalent linear, constant-cofficient difference equation (LCCDE).

(b) Use the LLCDE in (a) to determine the impulse response, $h[n]$. Please express $h[n]$ in a non-recursive, closed-form.

Hint: Let $x[n] = \delta[n]$ and compute values for $y[n] = h[n]$. Then find a general expression for the values.

Prob. 2

(a) A periodic signal, $x(t)$ is shown below. Use the analysis equation to determine the Fourier Series (FS) coefficients, a_k. Note that 1 ms = 0.001 s.

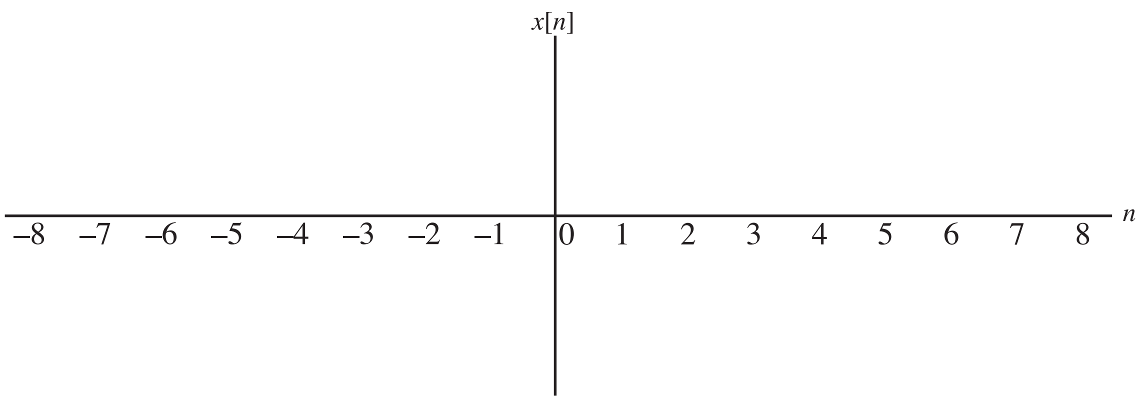


Prob. 2 (cont.)

(b) One *period* of a discrete-time (DT) signal, $x[n]$ is given by

$$-\frac{1}{2}\delta[n+3] + \frac{1}{2}\delta[n+1] + \delta[n] + \frac{1}{2}\delta[n-1] - \frac{1}{2}\delta[n-3] - \delta[n-4].$$

Graph $x[n]$ vs. n for $-8 \leq n \leq 8$. Determine the Discrete-Time Fourier Series (DTFS) coefficients, a_k for $0 \leq k \leq N-1$ where N is the period of $x[n]$ and fill in the table below with your values.



k	a_k
0	

Prob. 3

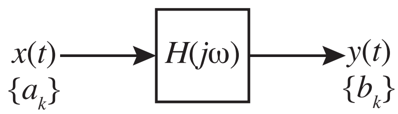
When the periodic signal,

$$x(t) = 1 + \cos(30\pi t) + \sin(40\pi t)$$

is the input to a particular Linear, Time-Invariant (LTI) system with frequency response, $H(j\omega)$, the output of the system is found to be

$$y(t) = \frac{1}{2}\cos\left(30\pi t + \frac{\pi}{2}\right) + 5\sin(40\pi t)\,.$$

This is depicted below.



(a) Determine the fundamental frequency, ω_0 of $x(t)$.

(b) Determine the FS coefficients of $x(t)$, a_k using a direct expansion into complex exponentials.

Prob. 3 (cont.)

(c) Determine the FS coefficients of $y(t)$, b_k using a direct expansion into complex exponentials.

(d) Determine the values of $H(jk\omega_0)$ using the formula, $b_k = a_k H(jk\omega_0)$. You need only compute $H(jk\omega_0)$ for the harmonics, indexed by k, present in $x(t)$.

(e) Circle one: (TRUE / FALSE) The frequency response at *all* the other harmonics not present in $x(t)$ is zero. Give a reason supporting your answer[1].

[1]No credit without the correct reason.

Prob. 4

Let the impulse response of an LTI system, be given by

$$h(t) = \frac{\sin(2000\pi t)}{\pi t}$$

and the input signal be given by

$$x(t) = \cos(1000\pi t) + \cos(3000\pi t)\,.$$

Complete the following parts to determine the output signal, $y(t)$ via a frequency-domain calculation.

(a) Determine the frequency response, $H(j\omega)$ and frequency spectrum of the input, $X(j\omega)$. You may use any method to compute the Fourier Transform (FT) including direct expansion, analysis equation, or Table 4.2 lookup.

Prob. 4 (cont.)

(b) Use the convolution property to determine the frequency spectrum of the output, $Y(j\omega)$.

(c) Determine the output signal, $y(t)$ by inverse-transformation of $Y(j\omega)$. You may use any method to compute the Inverse Fourier Transform (IFT) including synthesis equation or Table 4.2 lookup.