Full Name: ______________________________ **Lab Section:** ____________

EEL 4750 / EEE 5502 (Fall 2018) – HW #01 **Due Date: Aug. 30, 2018**

Homework learning objectives: By the end of this homework, you should have reviewed:

- Sketching discrete-time signals and their operations
- Identifying signal properties
- Computing signal energy and power
- Computing fundamental frequencies
- Understanding series and parallel systems

Question #1: *(2 pts)* How many hours did you spend on this homework?

Question #2: *(6 pts)* Let $x[n] = 5(-1)^{n+2} - 1$ be a discrete-time signal.

(a) Sketch the signal $x[n]$ for $-4 < n < 4$.

(b) Compute the energy of $x[n]$ [for *all* time].

(c) Compute the power of $x[n]$ [for *all* time].

(d) Is $x[n]$ an energy signal, a power signal, or neither?

(e) Is $x[n]$ an even signal, an odd signal, or neither.

(f) Is $x[n]$ causal?

Question #3: *(5 pts)* Sketch and determine the **energy and power** of each signal.

(a) $x_1[n] = 2\,[\delta(n+1) - \delta(n-1)]$

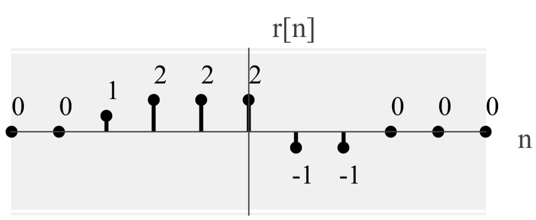
(b) $x_2[n] = \sum_{m=-1}^{2} [u(n-2m) - u(n-1-2m)]$

(c) $x_3[n] = e^{-j\pi n}$ (sketch the real and imaginary part)

(d) $x_4[n] = 2\,[\delta(n+3) - \delta(n+2) + \delta(n+1)]$

(e) $x_5[n] = (-1/2)^n$

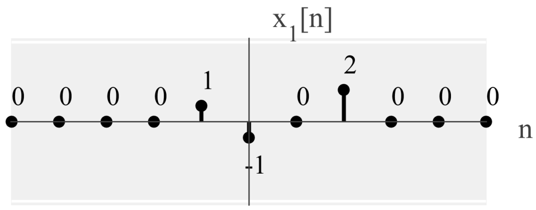
Question #4: *(2 pts)* Consider the following discrete-time signal $r[n]$, shown below.

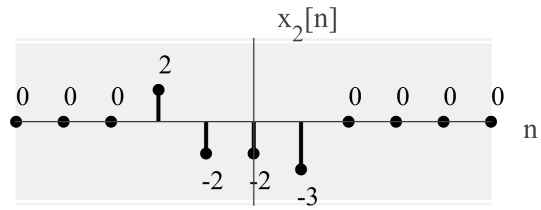


(a) Mathematically express $r[n]$ using only step functions (and shifted step functions).

(b) Mathematically express $r[n]$ using only impulse functions (and shifted impulse functions).

Question #5: *(5 pts)* Let $x_1[n]$ and $x_2[n]$ be the following discrete-time signals.





(a) Sketch $x_1[-n]$

(b) Sketch $x_1[n-2]$

(c) Sketch $x_2[n+1]$

(d) Sketch $-2x_2[2-n]$

(e) Sketch $x_1[-n] - x_2[n+1]$

Question #6: *(6 pts)* Determine whether or not each of the following discrete-time signals are periodic, and if they are, determine their fundamental period.

(a) $x_1[n] = \cos(3\pi n)$

(b) $x_2[n] = \cos(2n)$

(c) $x_3[n] = \cos((2\pi/3)n + \pi/3) + \cos(\pi n)$

(d) $x_4[n] = \delta[n] + \delta[n+1]$

(e) $x_6[n] = \sum_{m=-\infty}^{\infty} \delta[n-m] + \delta[n-10m]$

(f) $x_5[n] = e^{-j(\pi/2)n}$

Question #7: *(7 pts)* Consider the system with output $y[n]$ and input $x[n]$: $y[n] = \sum_{m=-\infty}^{n} |x[m]|^2$

(a) Is the system causal? Why?

(b) Is the system memoryless (instantaneous)? Why?

(c) Is the system BIBO stable? Why?

(d) Is the system linear? Why?

(e) Is the system time-invariant? Why?

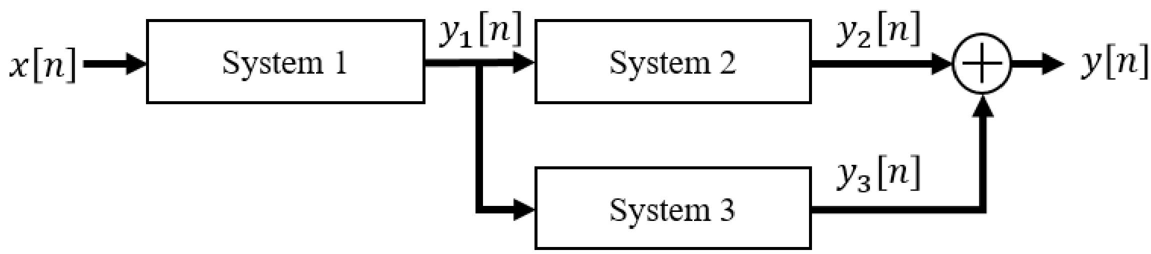
(f) Sketch the output for input $x[n] = \delta[n] - 4\delta[n-1]$

(g) What do you think this system does? What application is the system used for?

Question #8: *(6 pts)* Consider three discrete-time systems (known as systems 1, 2, and 3) with input signals $x_1[n]$, $x_2[n]$, $x_3[n]$ and output signals $y_1[n]$, $y_2[n]$, and $y_3[n]$.

$$\begin{aligned} y_1[n] &= 2x_1[n] \\ y_2[n] &= x_2[n-2] \\ y_3[n] &= 3x_3[n]+1 \end{aligned}$$

(a) Suppose the three systems are connected as shown below:



Write the input-output relationship (i.e., write the output $y[n]$ as a function of the input $x[n]$) for this new system.

(b) Write the output $y[n]$ for an impulse input $x[n] = \delta[n]$

(c) Sketch the output $y[n]$ for an input $x[n] = u[n] - u[n-1]$