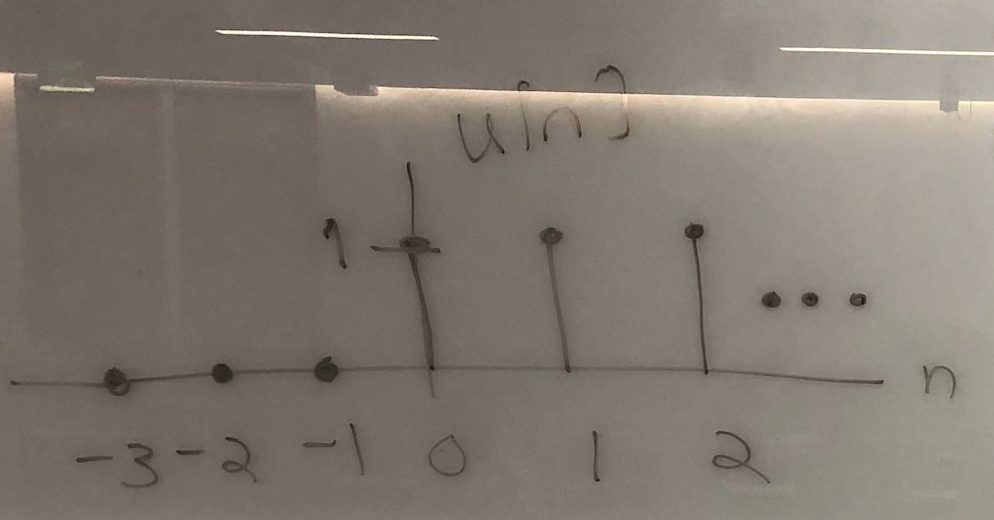
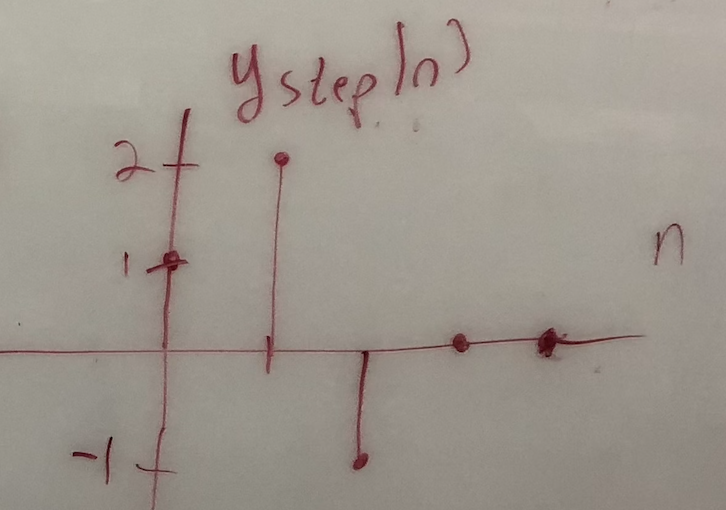
**Tune-Up Tuesday #5 for October 14, 2021**

The tuneup is to solve homework problem 5.3(b) and verify the solution.

**Intro.** A step function *u*[*n*] is a function that turns “on” at the origin and stays on, as plotted on the right. Mathematically,

**Problem.** A linear time-invariant (LTI) system gives the output plotted on the right when the input is . The output, also called the step response, is



We’ll model the unknown LTI system as a finite impulse response (FIR) filter with input signal and output signal

From this information, compute the filter coefficients for and manually verify that the step response of the FIR filter is .

**Deconvolution.** We’ll use deconvolution to compute the filter coefficients. We derive the time-domain deconvolution algorithm by evaluating the output at :

For LTI systems, it is a necessary (but not sufficient) condition for the system to be “at rest”, which means that all initial conditions must be zero. Since we know *x*[*n*] and *y*[*n*], we have one equation and one unknown at *n* = 0:

and we can compute

For this calculation to be valid, the first value of the test signal, *x*[0], cannot be zero.

The second output value is: , and therefore, .

The third output value is: and

In general, .

The MATLAB script [utdeconvolve.m](http://users.ece.utexas.edu/~bevans/courses/signals/tuneups/fall2021/utdeconvolve.m) implements this algorithm.

**Part (a).** Give the vectors for x and y that you used when running [utdeconvolve.m](http://users.ece.utexas.edu/~bevans/courses/signals/tuneups/fall2021/utdeconvolve.m) and the filter coefficients in vector b that the code computes.

|  |  |  |
| --- | --- | --- |
| **x** | **y** | **b** |
| [ 1 1 1 ] | [ 1 2 -1 ] | [ 1 1 -3 ] |
| [ 1 1 1 1 ] | [ 1 2 -1 0 ] | [ 1 1 -3 1] |
| [ 1 1 1 1 1 ] | [ 1 2 -1 0 0 ] | [ 1 1 -3 1 0 ] |
| [ 1 1 1 1 1 1 ] | [ 1 2 -1 0 0 0 ] | [ 1 1 -3 1 0 0 ] |

**Part (b).** Verify that the filter coefficients by using them in the difference equation for the LTI FIR filter

given that the input signal is and the output signal is

This is a closed-form solution for which gives the correct output values for for all *n*. For , the values are [ 1 2 -1 0 0 0 …. ].

**Alternate solution for part (b)**. One could simply compute several values of :

and so forth.