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ECE 503
Professor Premananda Indic
HW 1

1) Problem 1

Given that the system is described as the following,

$$y[n - 3] + 0.3y[n - 2]y[n - 1] + y[n] = u[n]$$

The system response $y_1[n]$ of the input $u_1[n] = 1$is as follows,

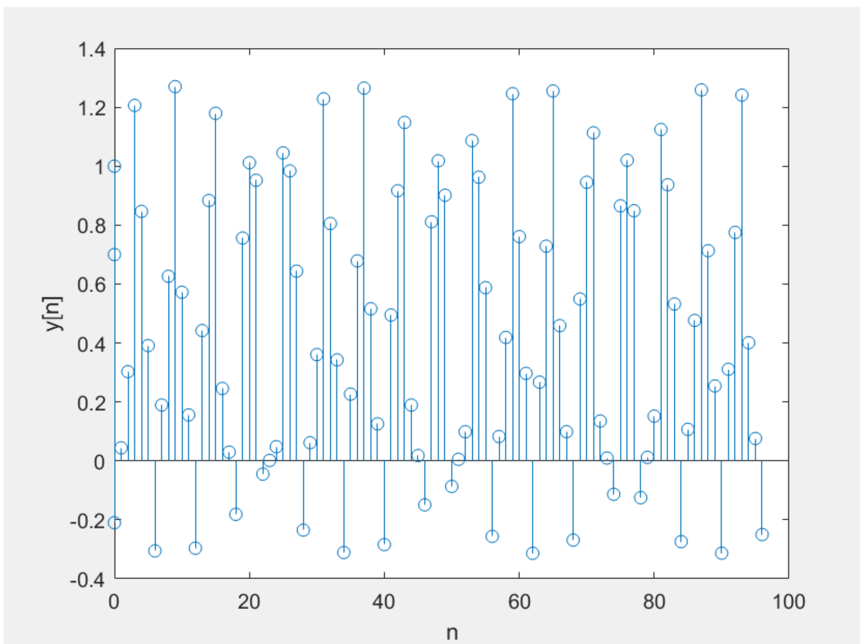

Figure 1. System response to $u_1[n] = 1$.

The system response $y_2[n]$ of the input $u_2[n] = 3$ is as follows,

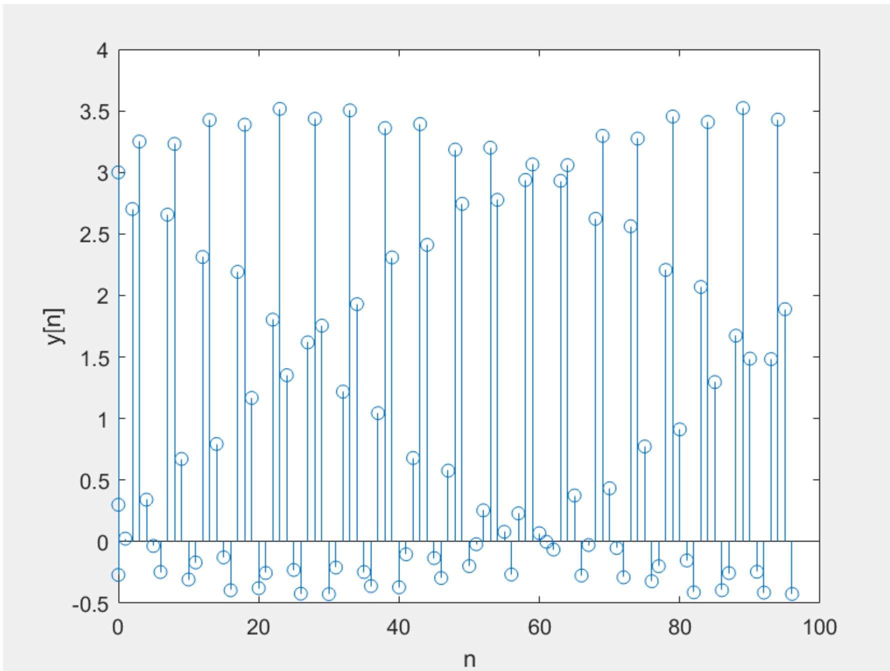

Figure 2. System response to $u_2[n] = 3$.

The system response $y_3[n]$ of the input $u_3[n] = u_1[n] + u_2[n] = 4$ is as follows,

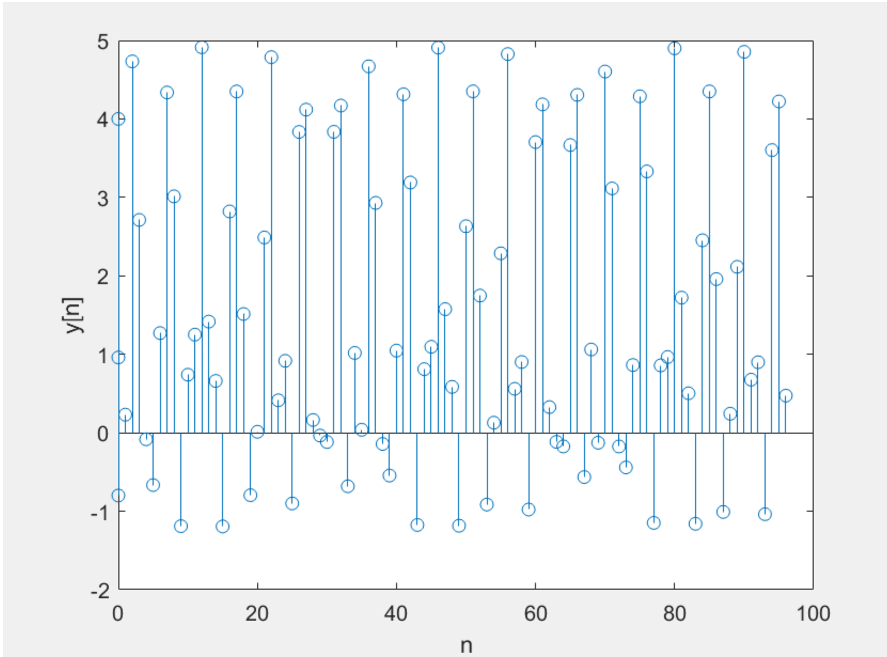

Figure 3. System response to $u_3[n] = 4$.

The linearity of the system can be determined by checking if the difference $y_3[n] - y_1[n] - y_2[n]$ equals the zero vector, which was determined to be false.

2) Problem 2

The discrete time system function is determined to be,

$$y[n] - 1.5y[n-1] + 0.5y[n-2] = u[n]$$

The initial conditions were all 0.2. To determine the zero-input response can be determined by setting the input function $u[n]$ equal to zero and recursively finding the system response. The system response is determined below,

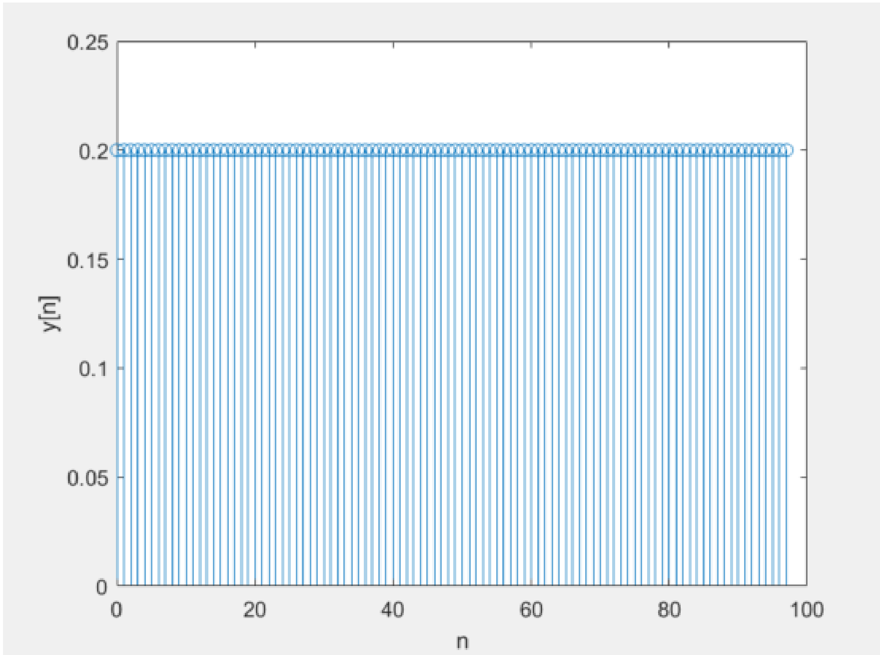

Figure 4. System response with zero-input and all initial conditions set to 0.2.

3) Problem 3

Given the discrete time system function to be,

$$y[n] - 3y[n-1] - 4y[n-2] = x[n] + 2x[n-1]$$

The zero-state response can be determined by setting all initial conditions to zero. The input function is the unit-step function, and the system response is as follows,

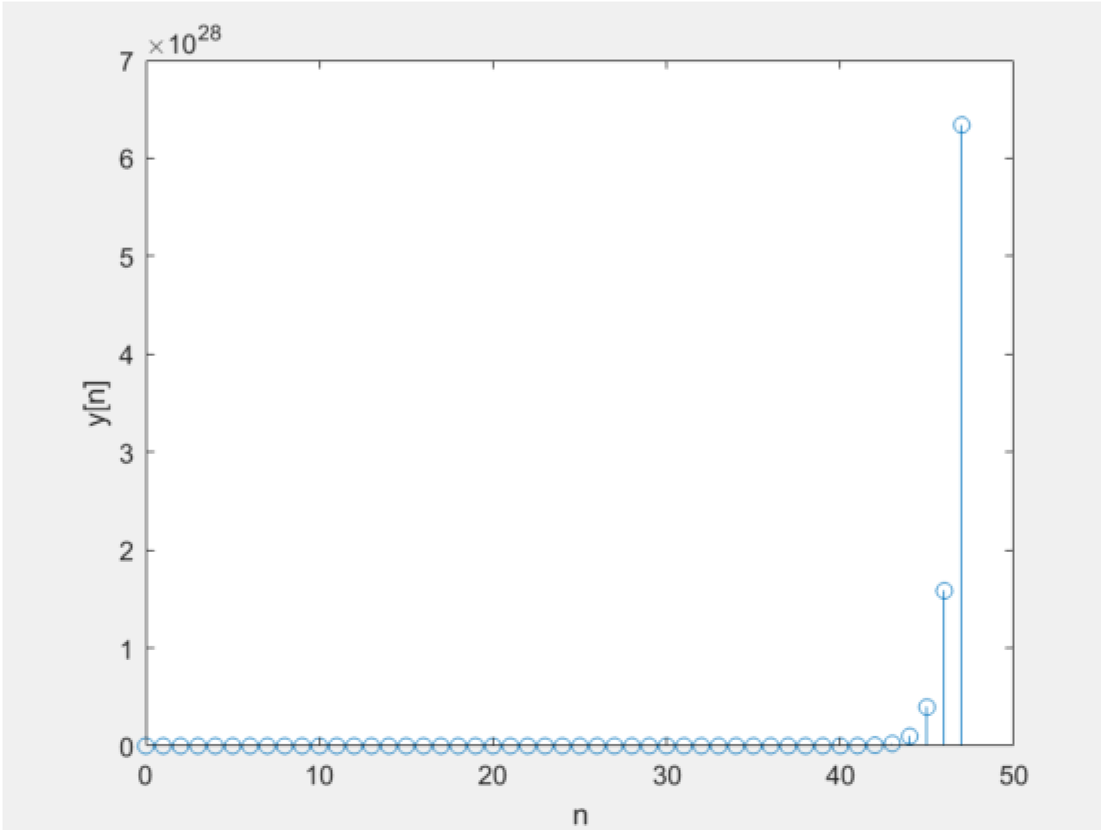

Figure 5. System response with zero-state and inputs to be the unit-step function.

4) Problem 4

Given the system transfer function to be as follows,

$$H(z) = \frac{3 - 4z^{-1}}{1 - 3.5z^{-1} + 1.5z^{-2}}$$

The discrete time function is determined to be as follows,

$$y[n] - 3.5y[n-1] + 1.5y[n-2] = 3x[n] - 4x[n-1]$$

This system is casual because it only depends on present and past values.

To determine if the system is BIBO stable, the poles and zeros of the system must be determined. This can be done via Matlab's "pole" and "zero" functions.

```
systemPoles =

                       3
                     0.5


systemZeros =

                       0
        1.33333333333333
```

Figure 6. The system poles and zeros.

The system has a pole of $z = 3$, which lies outside the unit circle. Thus, the system is not BIBO stable. Since the system is unstable, the system stability is neither asymptotically stable nor marginally stable. This is further supported by the fact that the system eigenvalues are all not less than or equal to 1, which is depicted below,

```
EVector =

       0.948683298050514         0.447213595499958
       0.316227766016838         0.894427190999916


EValue =

                       3                         0
                       0                       0.5
```

Figure 7. The system eigenvalues.

5) Problem 5

Given that the impulse response is $h[n] = (1/3)^n u[n]$, and the input is $x[n] = (1/2)^n (cos(\frac{\pi}{3}n))u[n]$, the zero state response can be determined by finding the convolution of the impulse response and the input function. The resulting convolution is plotted and determined as follows,

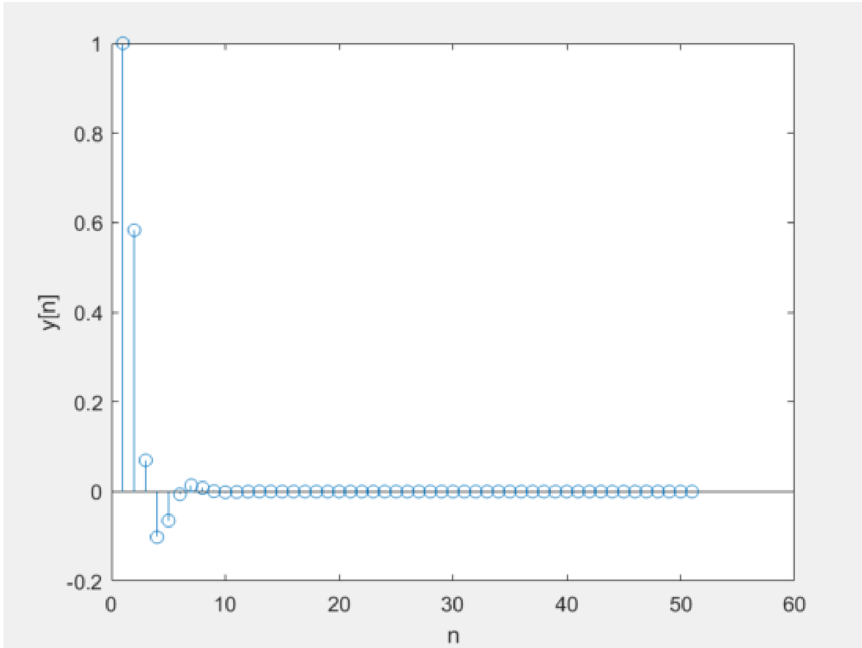

Figure 8. The zero-state response due to a certain impulse response and input function.