

Biomedical Signals & Systems 3A03

Assignment 1

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Linearity

To test linearity, we created a function that evaluated the additivity and scaling properties of our given systems. To show additivity the function added two impulses together ($[x1]$, and $[x2]$) and used this new input to calculate an output. If this output was equivalent to the added values of the individual function outputs when $[x1]$ and $[x2]$ were used as inputs, then the system was said to be additive. Similarly, to test homogeneity the function scaled the outputs of when individual $[x1]$ and $[x2]$ inputs were used. If the sum of those scaled outputs was equivalent to the system output using an input of equivalently scaled sums of $[x1]$ and $[x2]$, then the system was said to be homogeneous. If the system was both additive and homogeneous then it was said to be linear.

Causality

To test causality, we stored the index at which the initial impulse function occurred at, and then ensured that no values occurred prior to that index once it had been passed through the black box.

Time-Invariance

To test time-invariance, we passed an impulse function through each black box system then shifted the system. We determined if the system was time varying based on if the original output and time-shifted outputs had equal y values.

Memory

To test memory, we stored the index at which the initial impulse function occurred at, and then ensured that non zero values only occurred at that stored index once it had been passed through the black box.

System 1

Linear, non-causal, time invariant, has memory. See Figures below.

Test Cases:

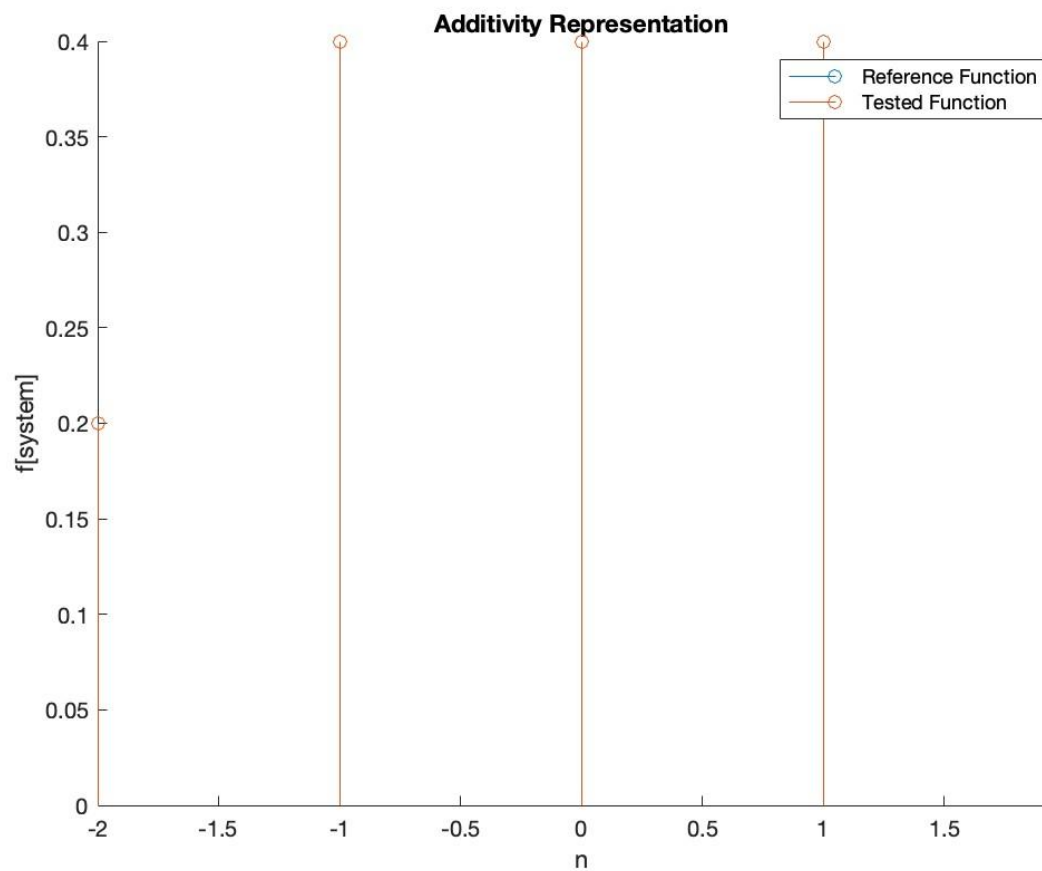
```
[f, f1, f2] = linearity(@system1, -2:2, [0 0 1 0 0], [1 0 0 0 0]);
```

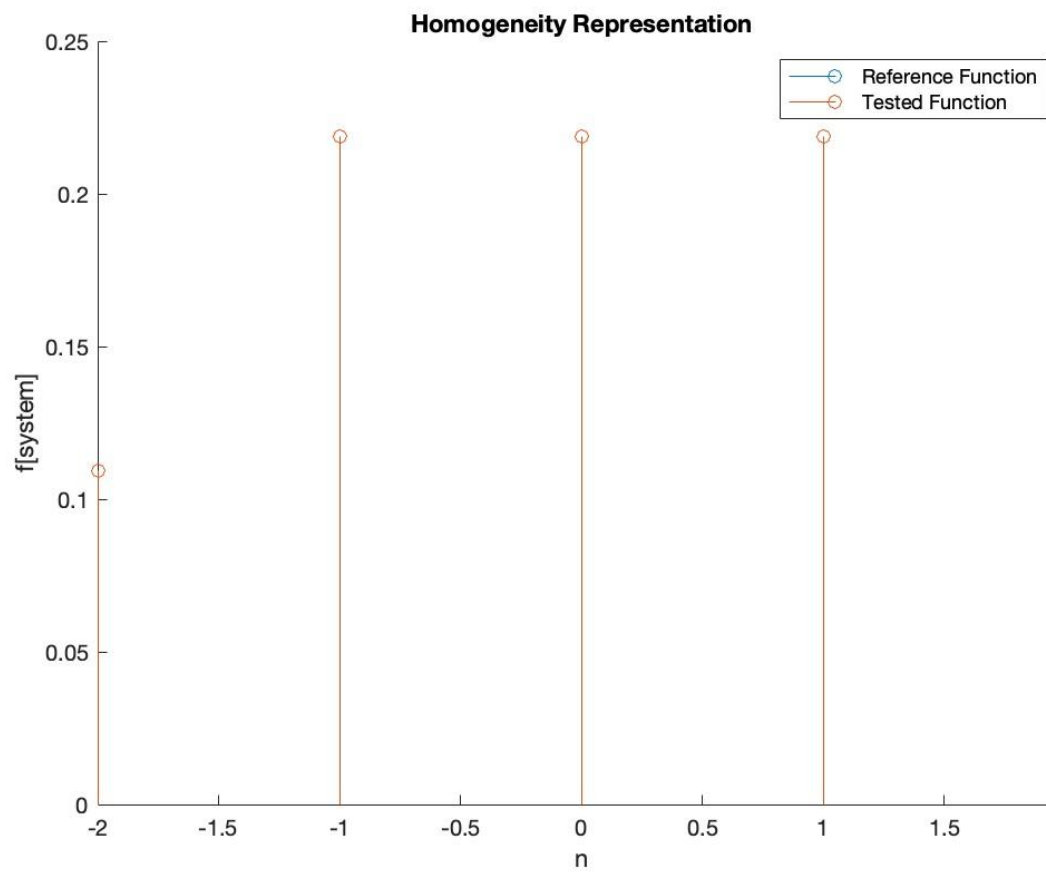
```
[g] = causality(@system1, -2:2, [0 0 0 0 1]);
```

```
[h] = timeinvariance(@system1, -4:4, [0 0 1 0 0 0 0 0]);
```

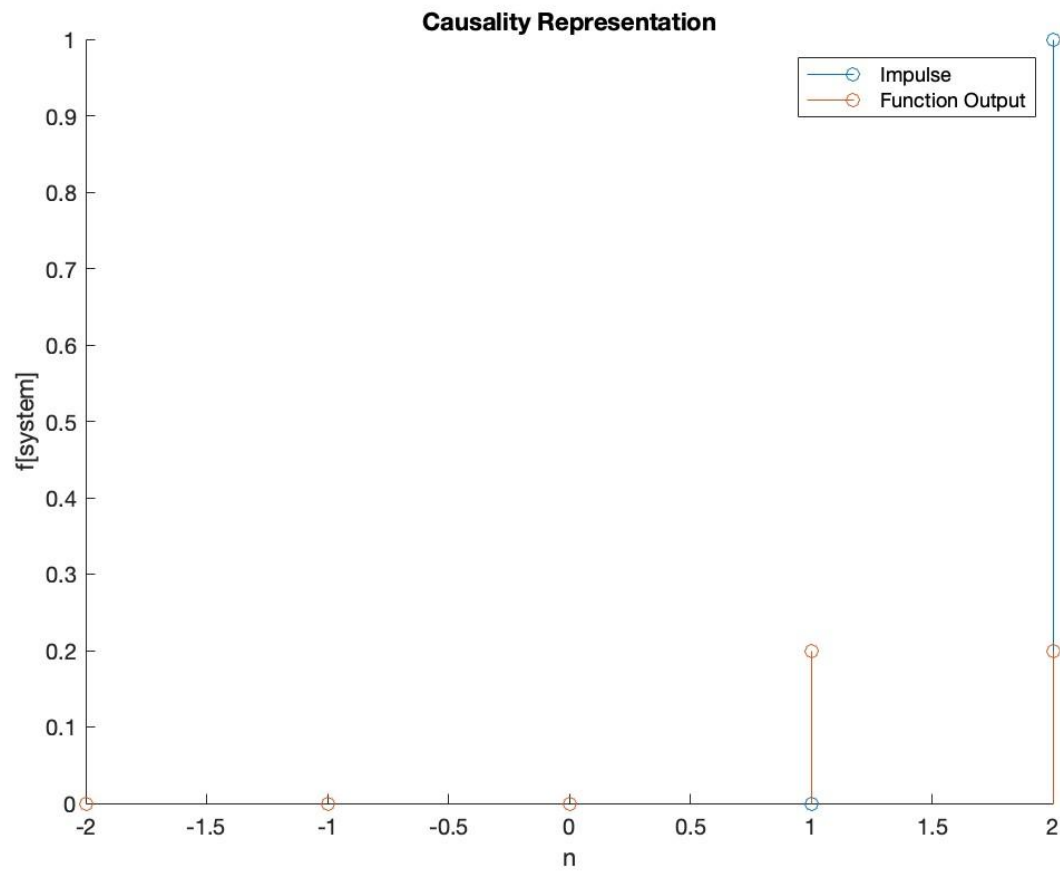
```
[k] = mymemory(@system1, -3:3, [0 0 1 0 0 0 0]);
```

- Linear (both additive and scalable)

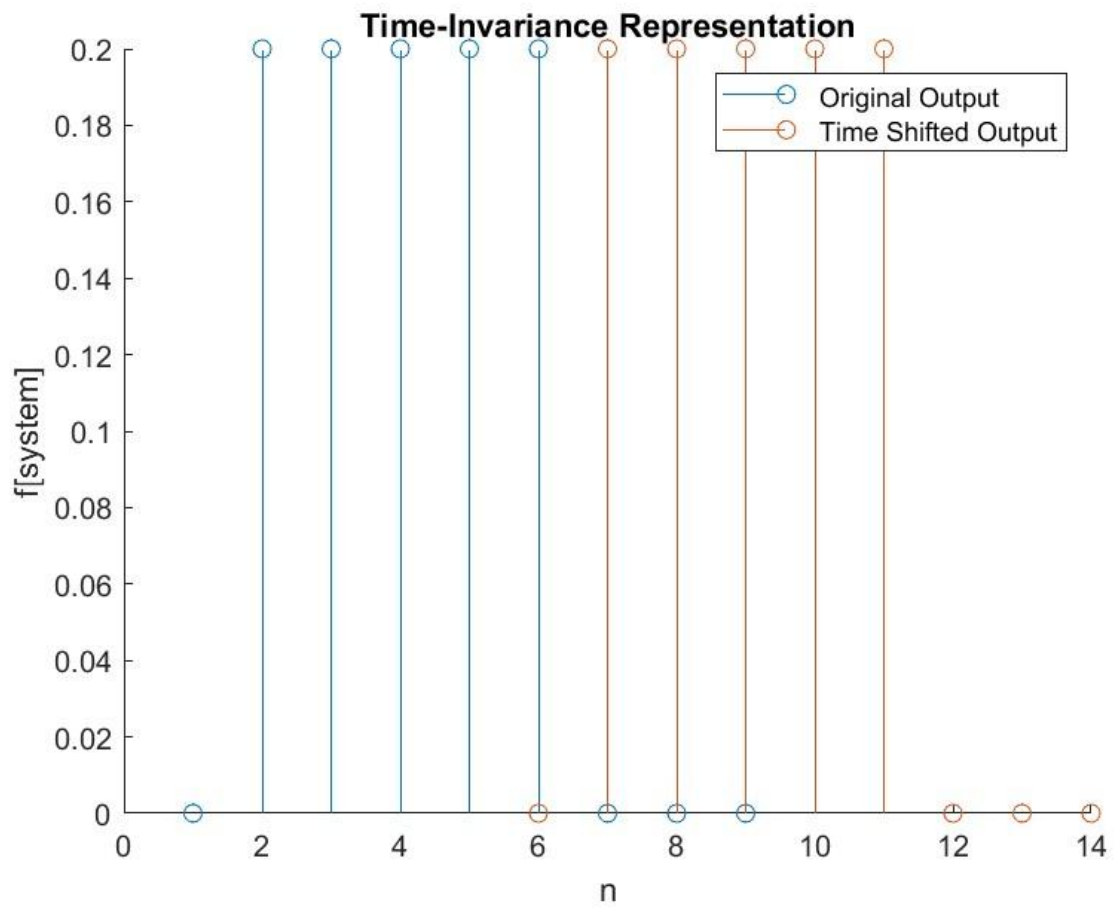




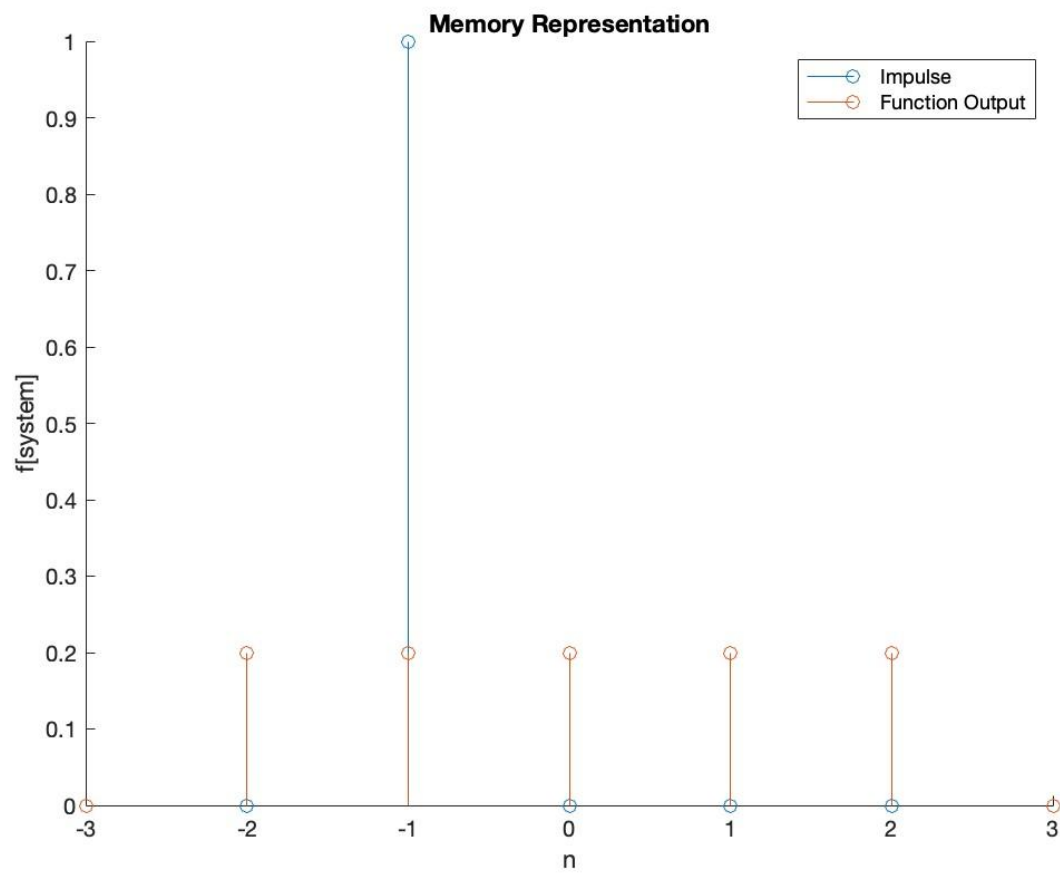
- Non-causal



- Time Invariant



- Has memory



System 2

Non linear, causal, time invariant, has memory. See Figures below.

Test Cases:

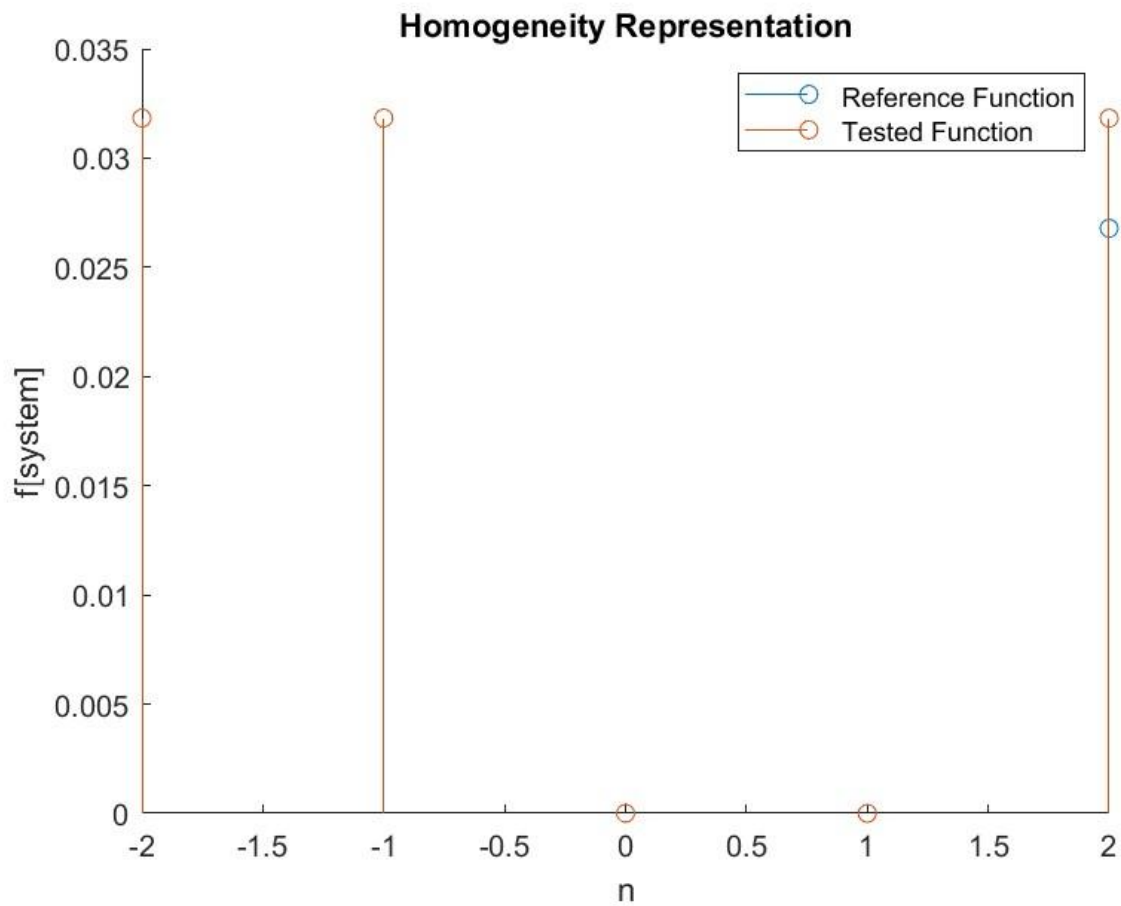
```
[f, f1, f2] = linearity(@system2, -2:2, [0 0 0 0 1], [1 0 0 0 0]);
```

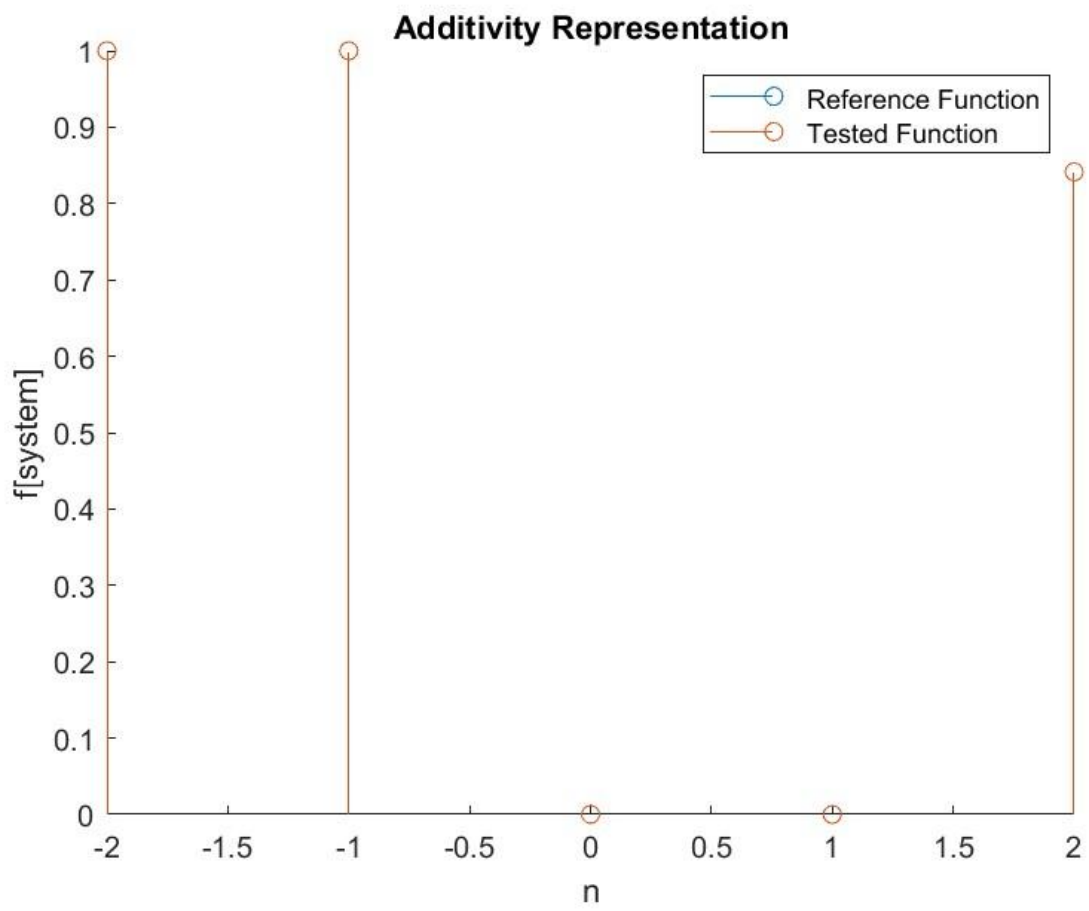
```
[g] = causality(@system2, -2:2, [0 1 0 0 0]);
```

```
[h] = timeinvariance(@system2, -4:4, [1 0 0 0 0 0 0 0 0]);
```

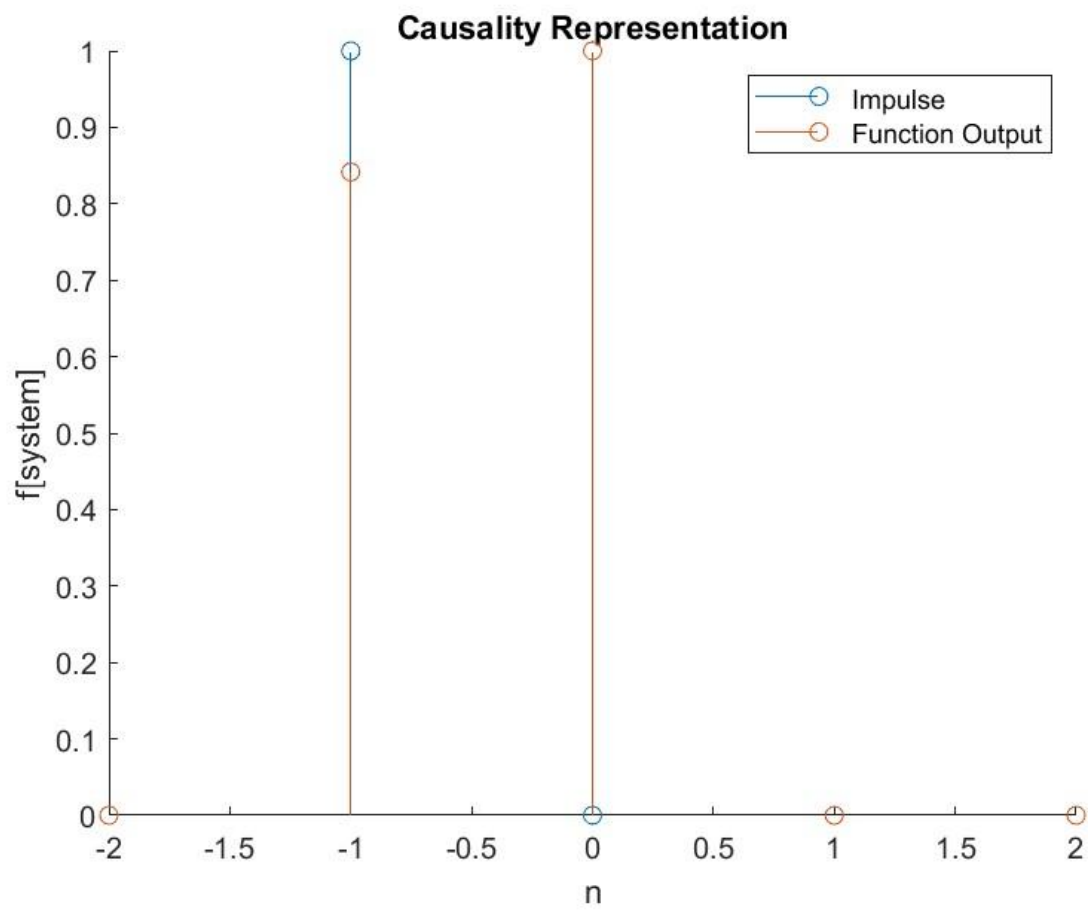
```
[k] = mymemory(@system2, -3:3, [0 1 0 0 0 0 0]);
```

- Non Linear (additive but not scalable)

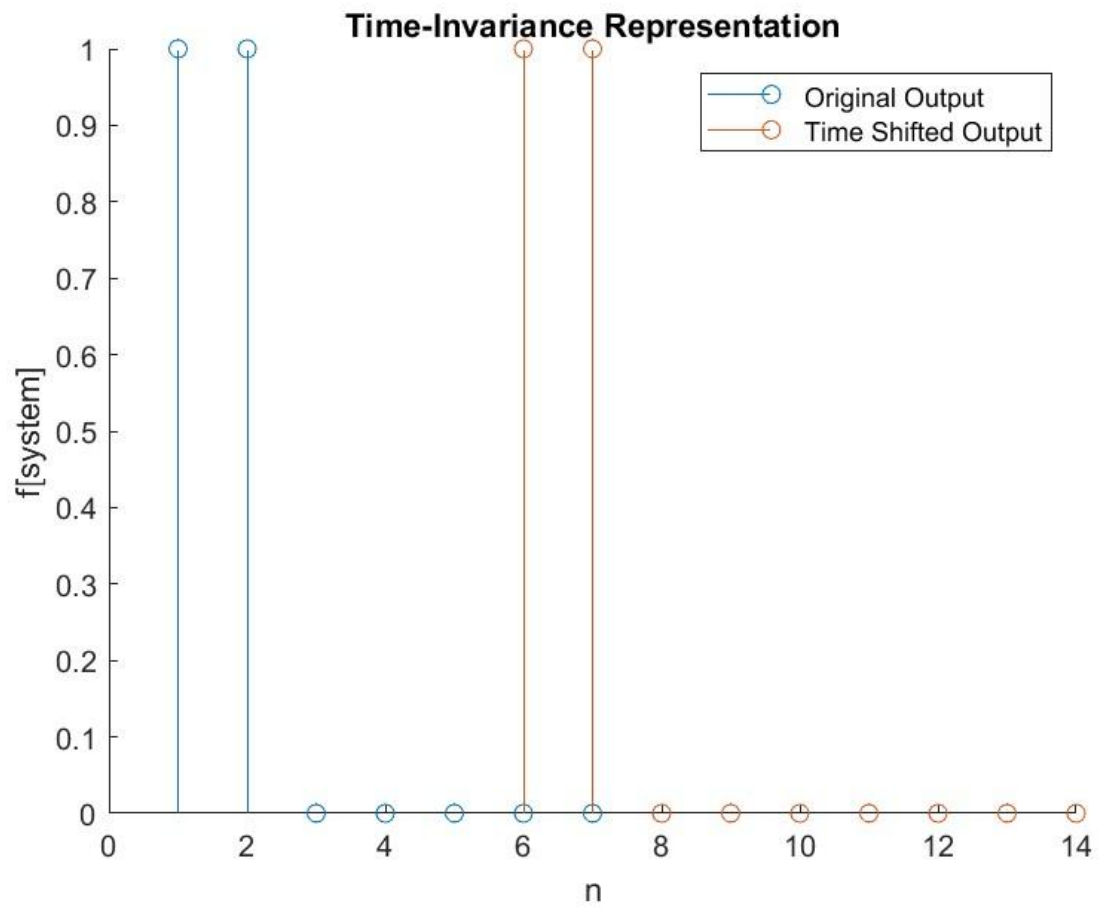




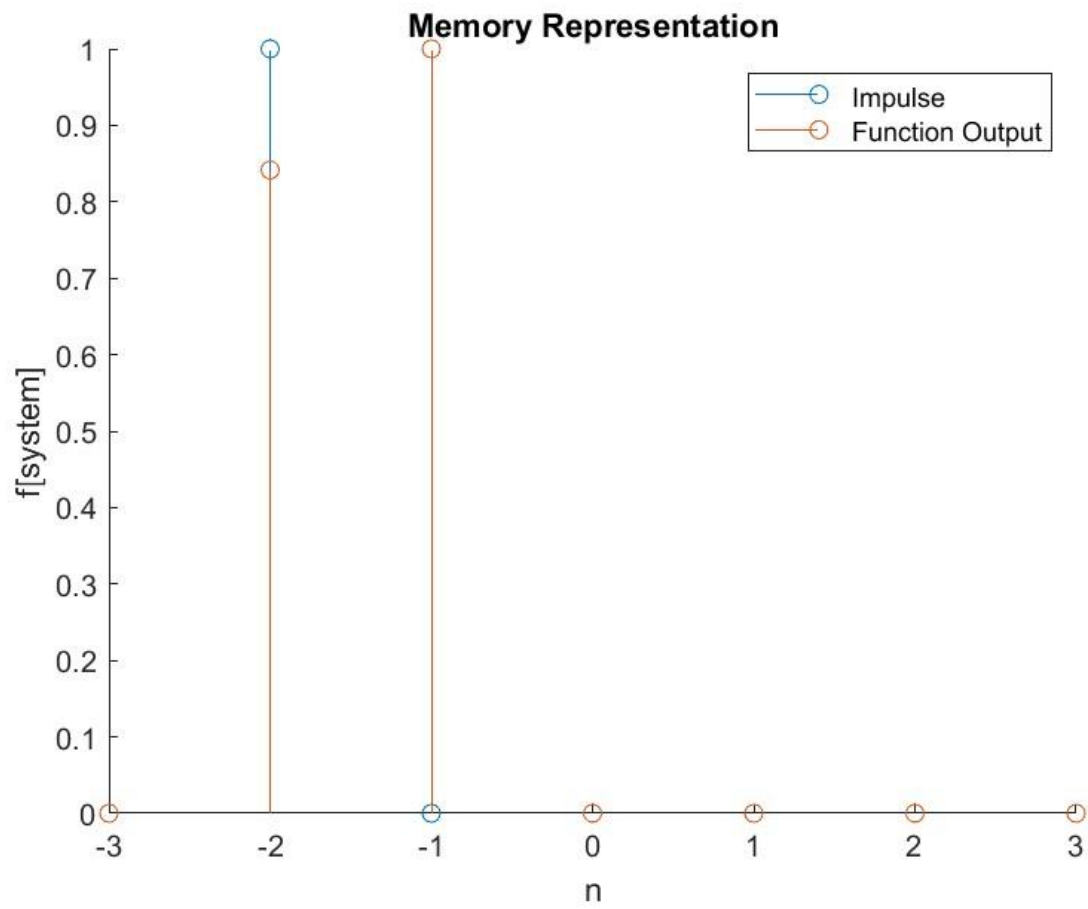
- Causal



- Time-Invariant



- Has Memory



System 3

Linear, causal, time varying, memoryless. See Figures below.

Test Cases:

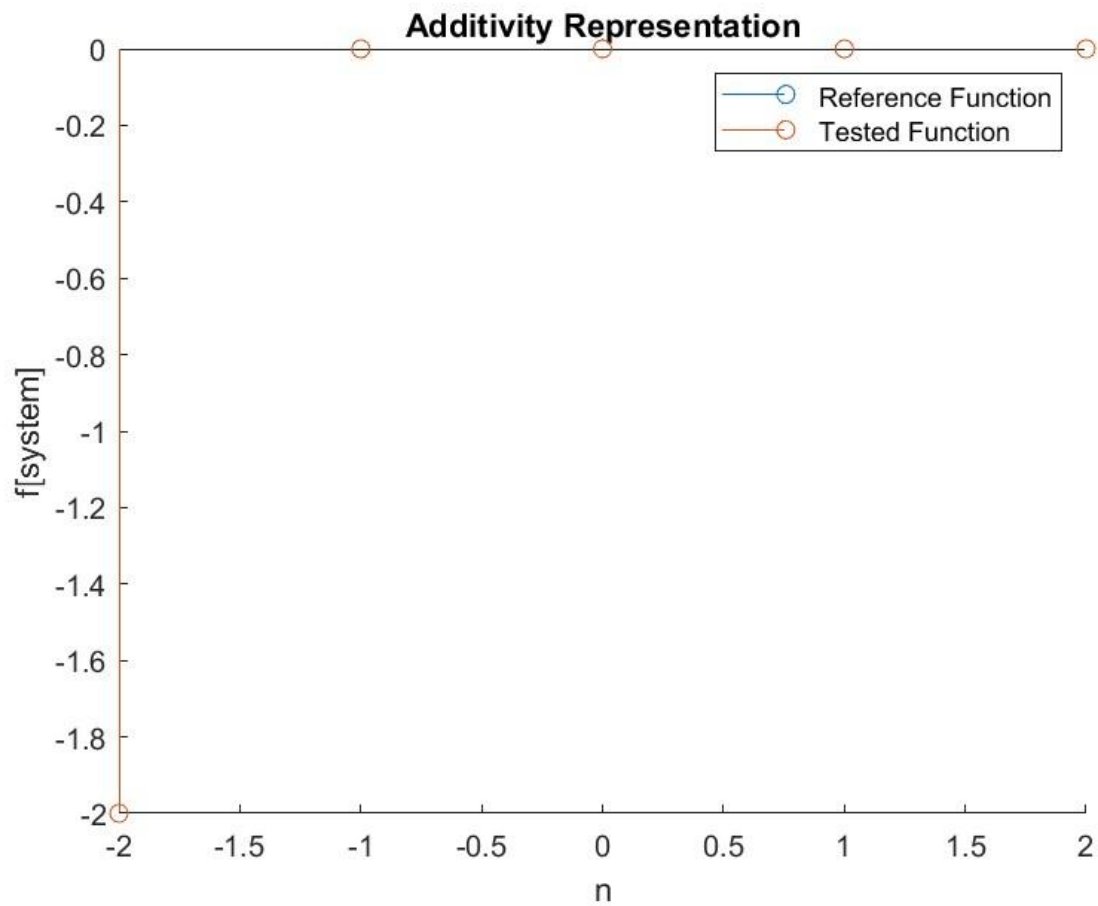
```
[f, f1, f2] = linearity(@system3, -2:2, [0 0 1 0 0], [1 0 0 0 0]);
```

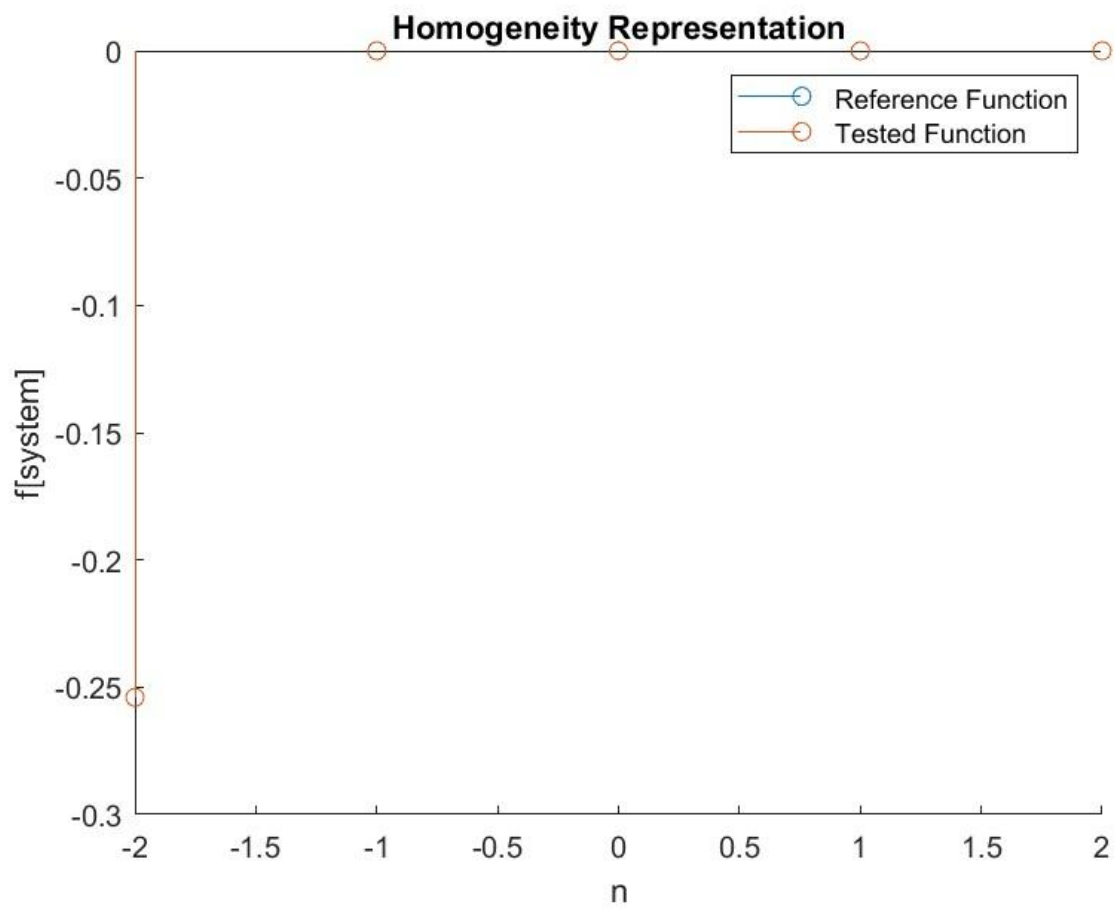
```
[g] = causality(@system3, -2:2, [0 0 0 0 1]);
```

```
[h] = timeinvariance(@system3, -4:4, [0 0 1 0 0 0 0 0 0]);
```

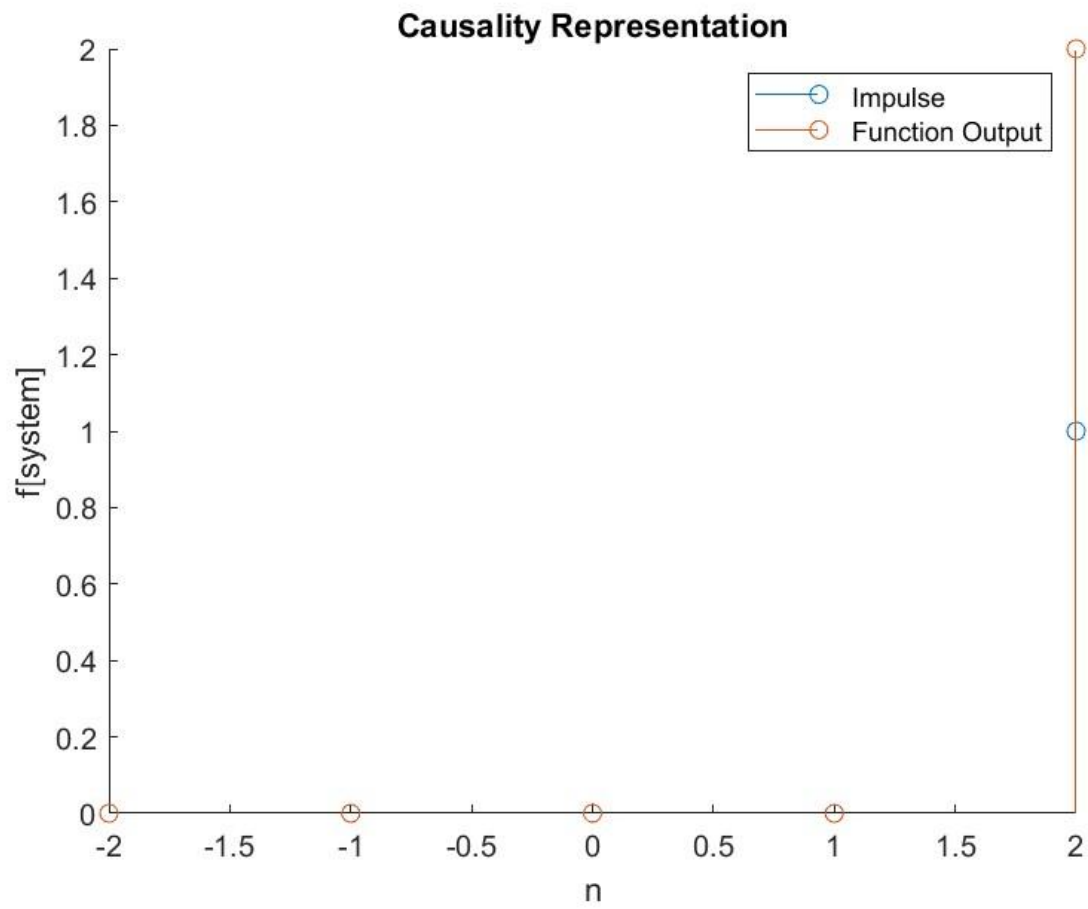
```
[k] = mymemory(@system3, -3:3, [0 0 1 0 0 0 0]);
```

- Linear (additive and homogeneous)

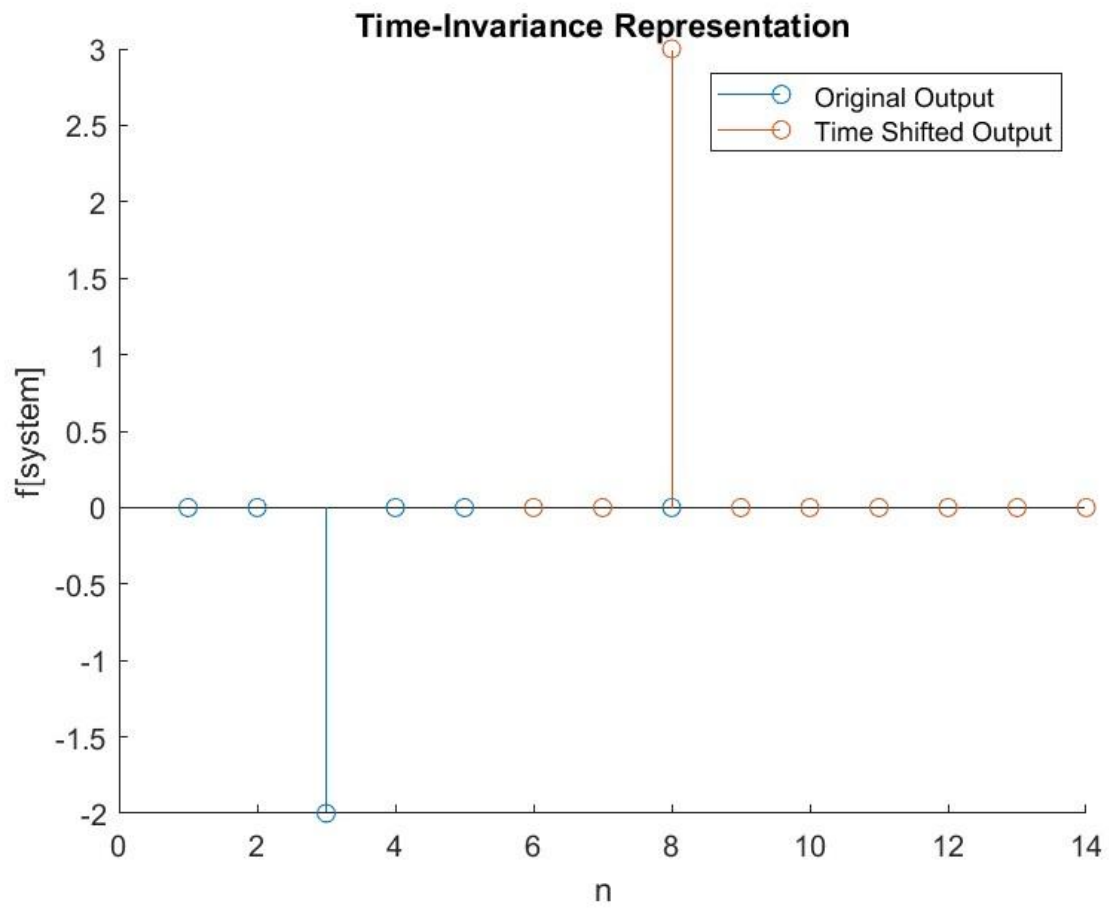




- Causal



- Time-varying



- Memoryless

