

Lab 2: Discrete-Time Signals and Systems

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Exercise 1

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.signal import lfilter

plt.style.use("seaborn") # makes the plots look nicer

# %% Exercise 1

# system coefficients

A = [1, 0.9, -0.81]
B = [1, 0, 0]

# impulse/step input

nspace = np.arange(0, 11)

imp = [1 if n == 0 else 0 for n in nspace]
step = [1 if n >= 0 else 0 for n in nspace]

imp_res = lfilter(A, B, imp)
step_res = lfilter(A, B, step)

plt.figure(1, figsize=(10, 8))

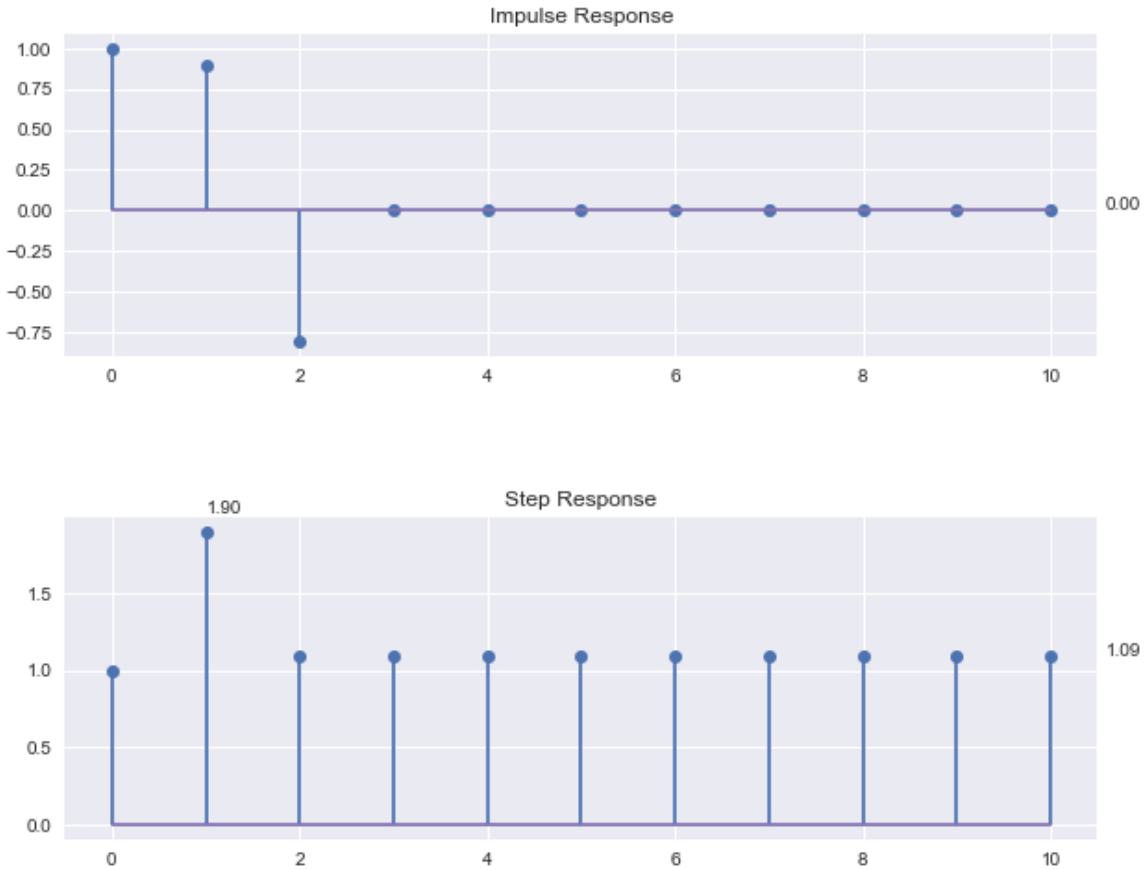
plt.subplot(2, 1, 1)
plt.stem(nspace, imp_res)
plt.grid(True)
plt.title("Impulse Response")

plt.subplot(2, 1, 2)
plt.stem(nspace, lfilter(A, B, step))
plt.grid(True)
plt.title("Step Response")

plt.annotate(
    "%.02f" % step_res[1],
    xy=(1, step_res[1]),
    xytext=(0, 10),
    textcoords="offset points",
)
```

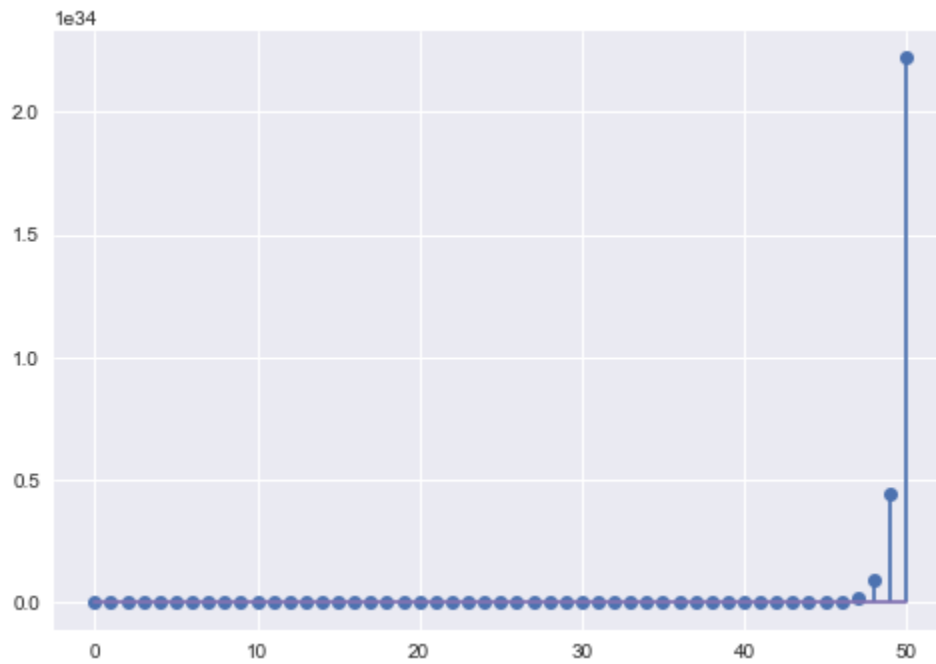
```
plt.annotate(
    "%02f" % step_res[10],
    xy=(10, step_res[10]),
    xytext=(30, 0),
    textcoords="offset points",
)

plt.subplots_adjust(hspace=0.5)
```



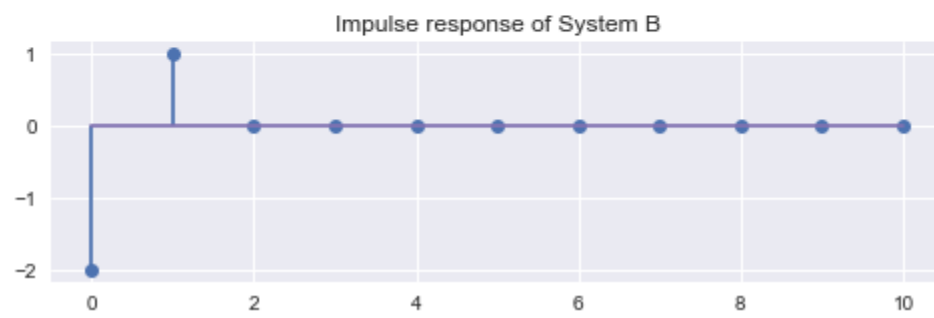
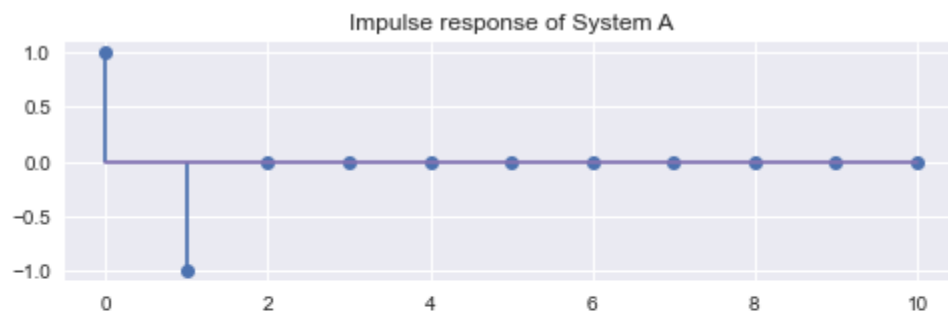
The transient response is labeled at n=1 of the step response (magnitude of 1.90) and the steady-state response is labeled at n=10 (magnitude of 1.09).

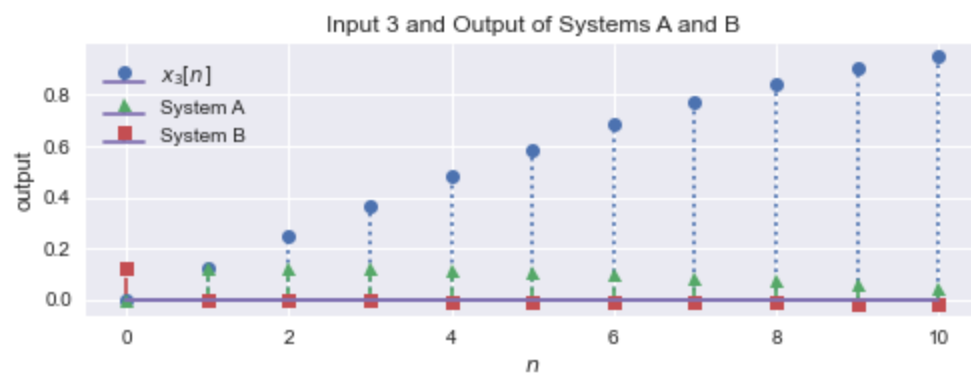
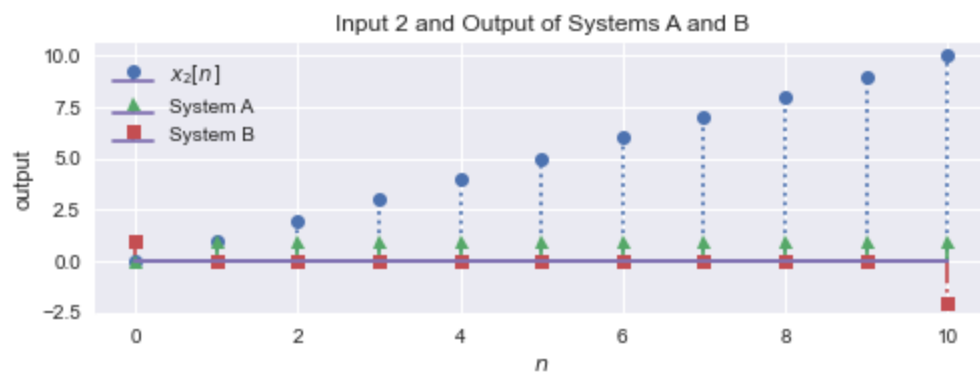
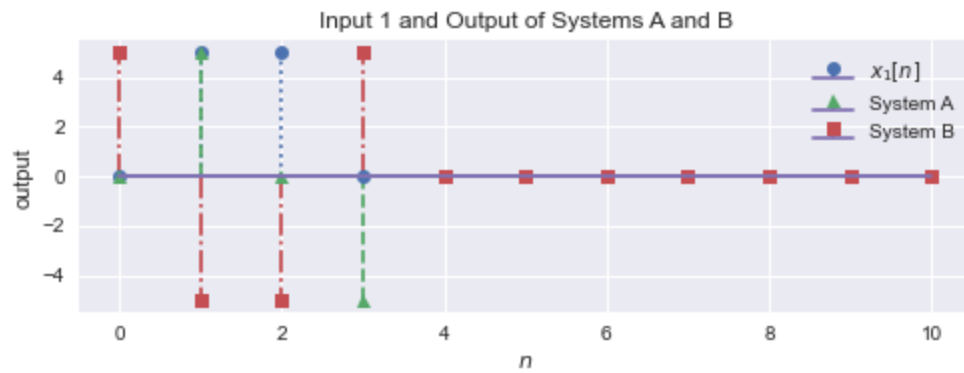
Exercise 2



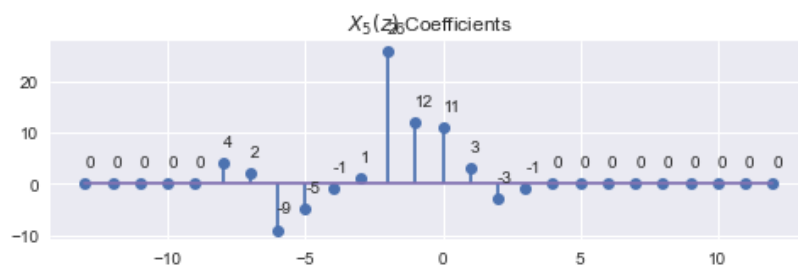
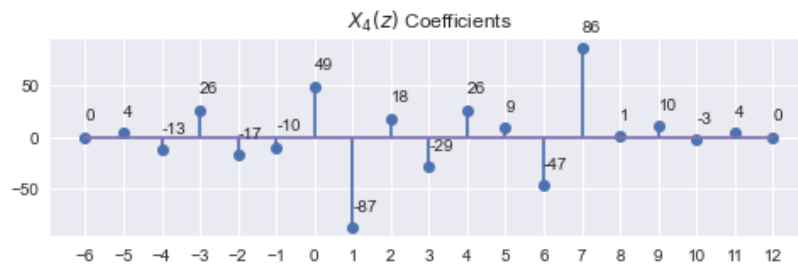
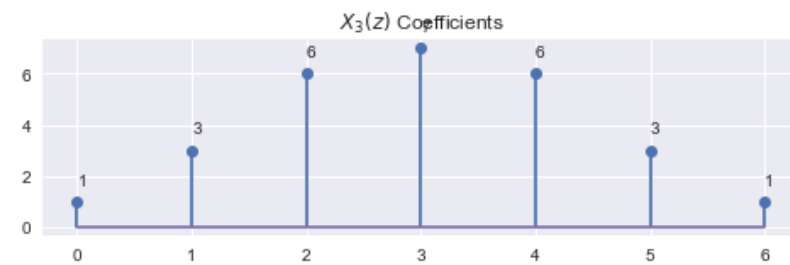
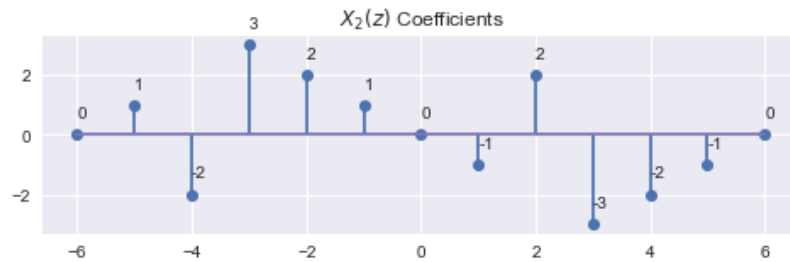
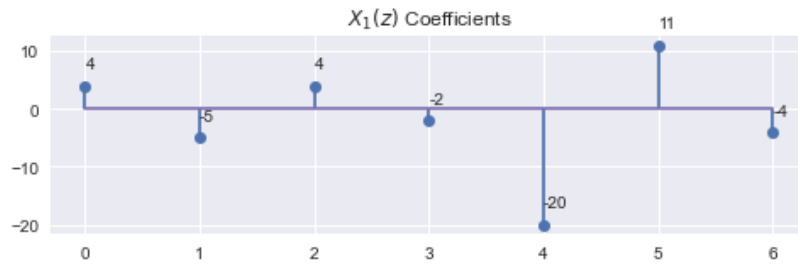
From the graph we can see that this system rises exponentially without a limit, therefore this system is not stable.

Exercise 3





Exercise 4



a) $X_1(z) = z^5 - 2z^4 + 3z^3 + 2z^2 + z - z^{-1} + 2z^{-2} - 3z^{-3} - 2z^{-4} - z^{-5}$

b) $X_2(z) = 1 + 3z^{-1} + 6z^{-2} + 7z^{-3} + 6z^{-4} + 3z^{-5} + z^{-6}$

Exercise 5

