Report for Programming Problems - SnS (Assignment 1)

Q5) In this problem we were given two questions where we were supposed to plot two discrete signals in terms of the unit step function u[n].

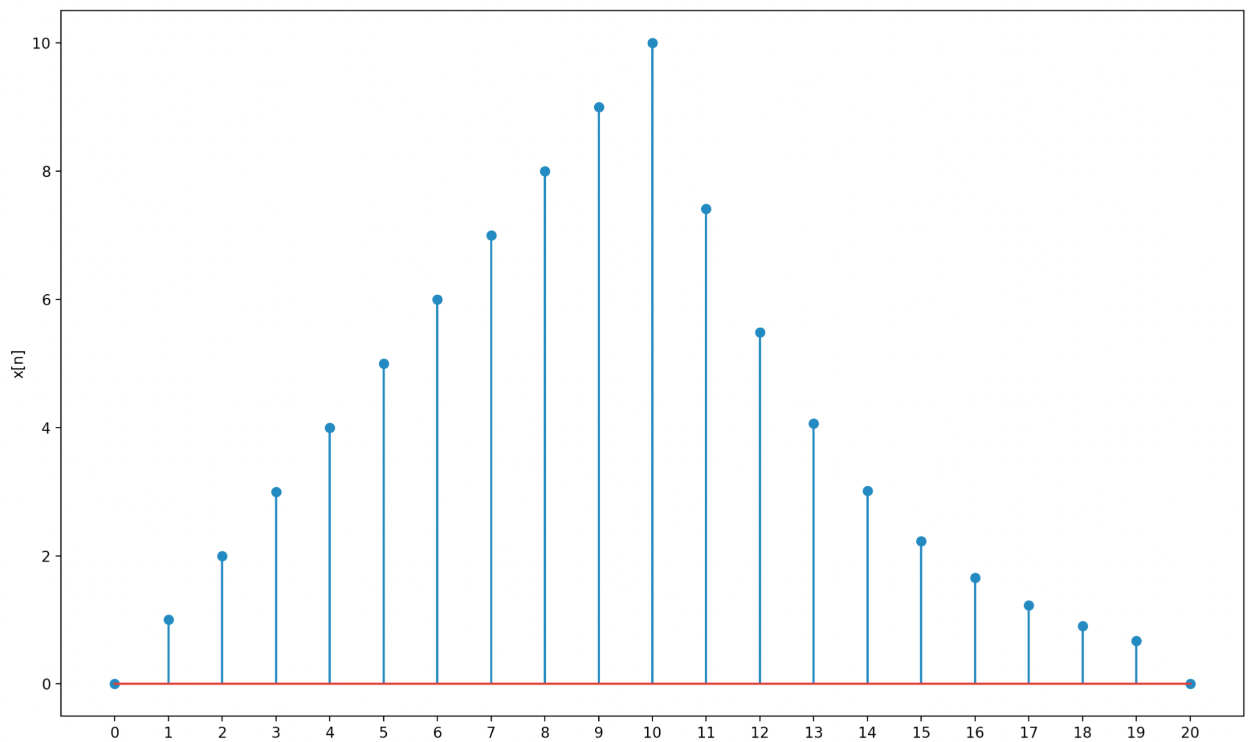
i)

$$x[n] = n[u[n] - u[n - 10]] + 10e^{-0.3}(n - 10)[u[n - 10] - u[n - 20]],\ 0 \leq n \leq 20$$

Above signal is given in the first part and the output for the given discrete values from 0 to 20 is as follows:

```
[0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 7.4081822068171785,
5.488116360940265, 4.065696597405991, 3.0119421191220215, 2.2313016014842986,
1.6529888822158658, 1.2245642825298191, 0.9071795328941252, 0.6720551273974976, 0.0]
```

The plot for the signal is as follows:



Inference and Explanation: We plot this signal by first defining the step function in python and then we write x[n] in terms of the arguments given in the question. Our curve is based on the concept of **time-shifting** in signals as any u[n-m] signal gets shifted **m units to the right** and because of that it is equal to 0 for any value of time less than 'm'. Hence for n < 10, the exponential function part of the signal is zero and because of this we get an exponentially decreasing discrete signal for n > 10 and for values less than 10, x[n] just become equal to n and that can be seen on the plot as well.

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ii)The signal written below is given in the second part:

$y[n] \ = \ cos[0.03\pi n] \ + \ u[n], \ 0 \le n \le 50$

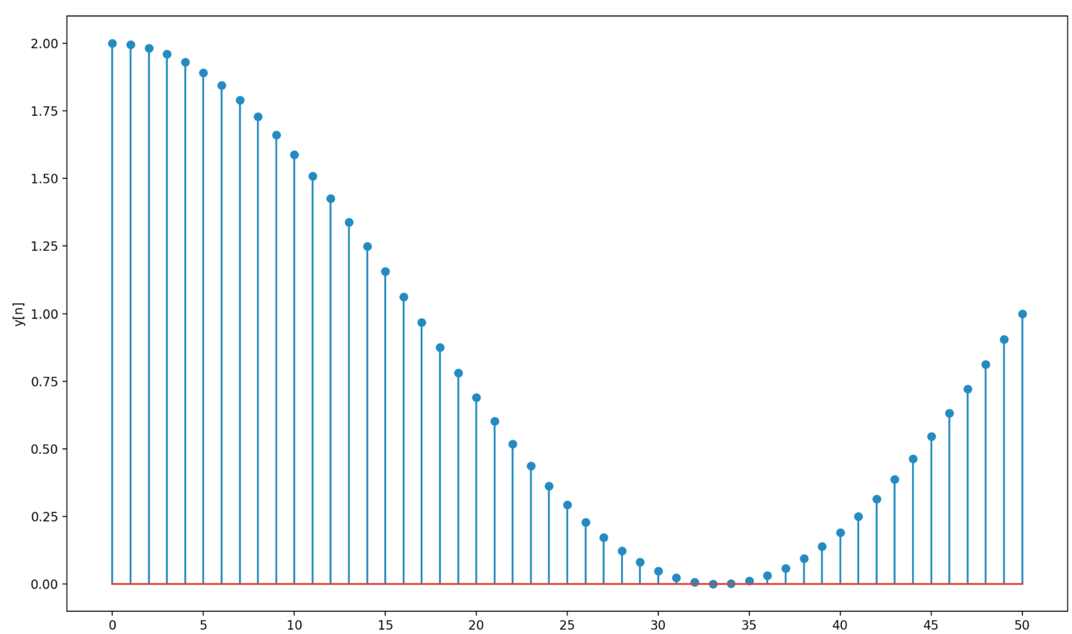
For the input range given:

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44,
45, 46, 47, 48, 49, 50]
```

The outputs are respectively as follows:

```
[2.0, 1.99556196460308, 1.9822872507286888, 1.960293685676943, 1.9297764858882513,
1.8910065241883678, 1.8443279255020153, 1.7901550123756904, 1.7289686274214116,
1.6613118653236518, 1.5877852522924731, 1.5090414157503713, 1.4257792915650729,
1.3387379202452916, 1.248689887164855, 1.156434465040231, 1.0627905195293135,
0.9685892409218719, 0.8746667664356959, 0.7818567586034577, 0.6909830056250527,
0.6028521093652195, 0.518246325898285, 0.43791662214786964, 0.3625760102513106,
0.29289321881345254, 0.22948675722421086, 0.17291942572543828, 0.12369331995613664,
0.08224537431601908, 0.04894348370484647, 0.024083238061252676, 0.007885298685522235,
0.0004934396342684, 0.001973271571728441, 0.01231165940486223, 0.03141683887136881,
0.059119231045774434, 0.09517294753398031, 0.13925797299605613, 0.19098300562505255,
0.2498889303695403, 0.31545289407131105, 0.3870929463470235, 0.4641732050210029,
0.546009500260453, 0.6318754473153214, 0.7210088939607704, 0.8126186854142745,
0.9058916866814851, 0.9999999999999998]
```

<u>The plot for the above signal y[n] is as follows:</u>



<u>Inference and Explanation:</u>

We plot this signal by first defining the step function in python and then we write y[n] in terms of the arguments given in the question. The function has a sinusoidal nature because of it being the sum of the cosine function and the step function. However the function is not periodic. The signal closely resembles a **“rollercoaster”!!.**

Q6)

The signal given in the question is:

$z[n] = u[n] - u[n - 10]$.

For this we are supposed to plot z[n] and then decompose it into its even and odd subplots and plot all the three on one plot.

```
For the given input range: [-20, -19, -18, -17, -16, -15, -14, -13, -12, -11, -10, -9, -8, -7, -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20]
```

The outputs for z[n] are:

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

We get the **odd part of the signal** using the formula:

$z_{odd}[n] = (z[n] - z[-n])/2$

The outputs for the odd part of z[n] are:

```
[0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -0.5, -0.5, -0.5, -0.5, -0.5, -0.5, -0.5, -0.5, -0.5, 0.0, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
```

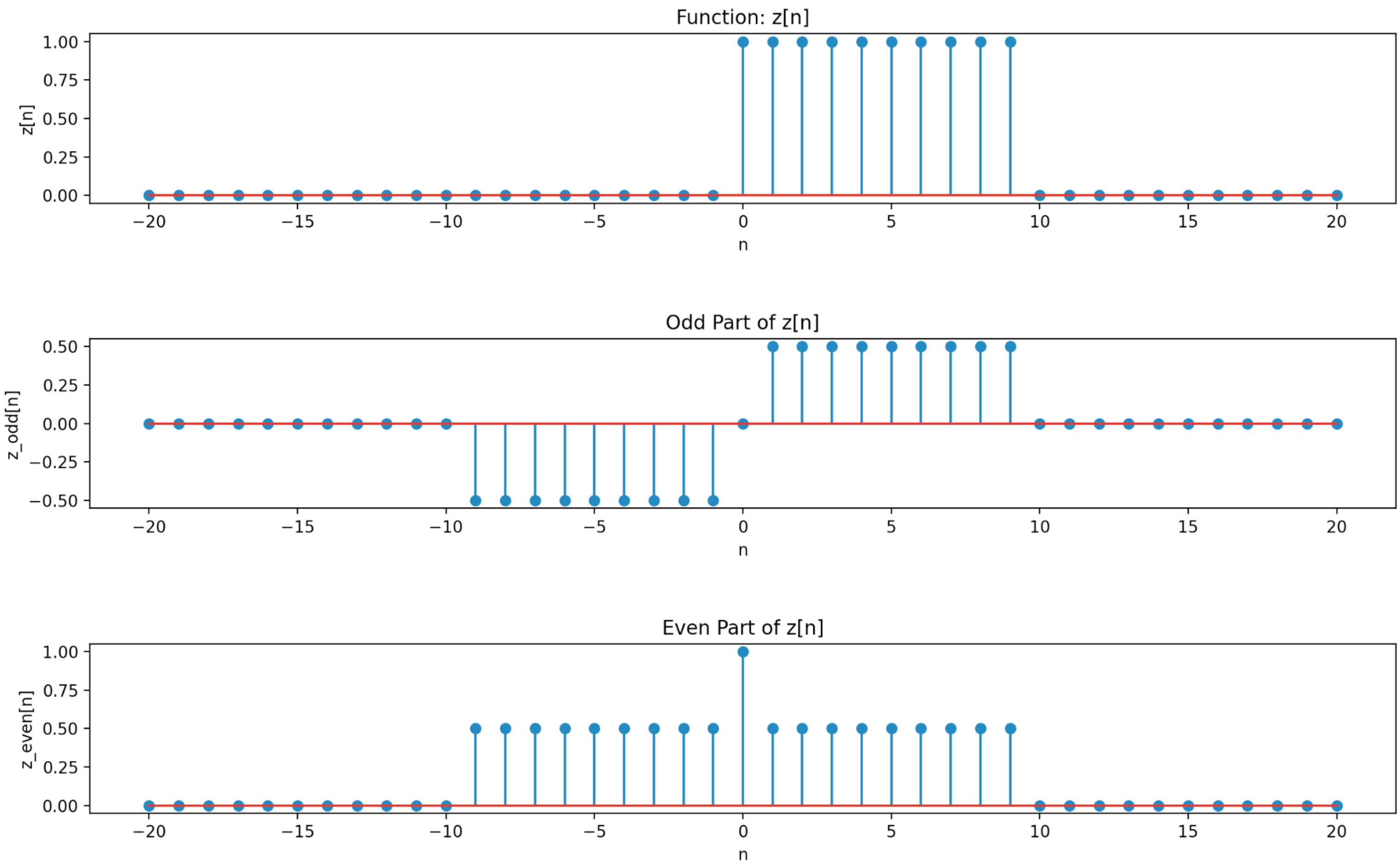
We get the **even part of the signal** using the formula:

$z_{even}[n] = (z[n] + z[-n])/2$

The outputs for the even part of z[n] are:

```
[0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5,
0.5, 0.5, 0.5, 1.0, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.0, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
```

<u>The three plots are as follows:</u>



<u>Inference and Explanation:</u>

We plot z[n] in python first by plotting the unit step function and hence we see due to time shifting, in first plot for z[n] for any value less than 0, z[n] would be zero and for any value greater than or equal to 10 it would be equal to 0 too. For the remaining 2 subplots we simply plot the odd and even functions written above and we can see it in the plot as the odd part is mirrored about the origin and the even part is mirrored about the vertical axis.