Reading: Class notes; The notation $u_0(t)$ and $u_0[n]$ is used to denote the unit step.

Problems:

1. Evaluate each convolution and sketch y as a function of t:

1. $u(t) = e^t u_0(t)$ and $h(t) = u_0(t)$
2. $h(t) = e^{-t} u_0(t)$ and $u(t) = u_0(t)$

2. Find the convolution $u * h$ for the following (the underline is used to denote the $n = 0$ index)):

1. $u[n] = u_0[n]$ and $h[n] = u_0[n]$
2. $u[n] = a^n u_0[n]$ and $h[n] = (-1)^n u_0[n]$
3. $u[n] = \{\underline{1}, -1, 1\}$ and $h[n] = \{\underline{2}, -7, 1\}$
4. $u[n] = u_0[n]$ and $h[n] = \text{rect}(n/2N)$ where

$$\text{rect}(n/2N) = \begin{cases} 1 & |n| \leq N \\ 0 & |n| > N \end{cases}$$

3. Find the impulse response $h[n]$ of the following difference equation:

$$y[n] = 0.5y[n-1] - u[n]$$

1. Use the direct method to evaluate $h[n]$ (with $u[n] = \delta[n]$ as I did in the class);
2. Use convolution to find the response to the input $u[n] = u_0[n]$. Assume $y[-1] = 0$ to solve this problem.
3. Use convolution to find the response to the input $u[n] = (0.5)^n u_0[n]$. Assume $y[-1] = 0$ to solve this problem.

4. Coding question: we will implement convolution of a finite signal in this question using for loops in python. A code file is uploaded on GitHub which implements the convolution using for loop. You need to edit the `convolution` function to correctly implement the convolution. The code also compares the output of the obtained convolution with the output of the inbuilt numpy `convolve` function, and if your code is correct, the difference will be an array of zeros for both subparts of this question. You need to submit plots of both signals and of the convolution. The plotting code is included in the code file.

1. $u[n] = \{\underline{1}, -1, 1\}$ and $h[n] = \{\underline{2}, -7, 1\}$
2. $u[n] = u_0[n] - u_0[n-6]$ and $h[n] = \text{rect}(n/4)$ where

$$\text{rect}(n/4) = \begin{cases} 1 & |n| \leq 2 \\ 0 & |n| > 2 \end{cases}$$

   To implement this sub-part, for both signals we only use finite data corresponding to $n = \{-5, -4, -3, \ldots, 4, 5\}$. Notice that both signals are actually zero when n does not lie in the specified set.