Problem 1

The C is just the C shown in the cirucit. The R is not the resistor shown in the circuit. Since $t_{\text{rise}} = 2.2RC$. The R here only includes the resistance of some plain wire, and possibly some resistance in the button and other components. R is really small and thus the t_{rise} will be really small. Therefore the capacitor would charge very quickly.

Problem 2

Ideally, only the R (shown in the circuit) should have resistance. Therefore,

$$t_{\text{fall}} = 2.2RC = 2.2 \cdot 1000\mu\text{F} \cdot 1\text{k}\Omega = 2200\text{ms} = 2.2\text{s}$$

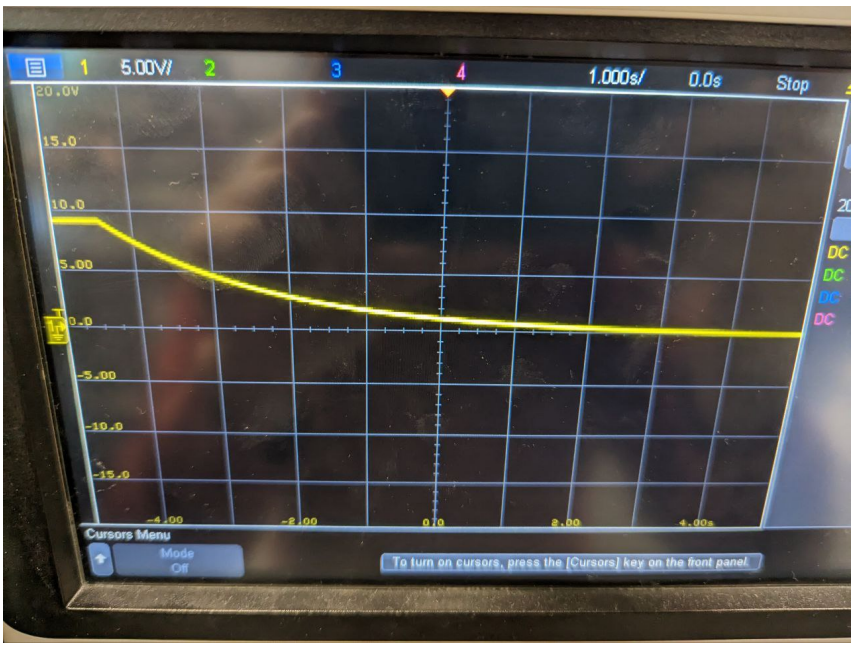
Question 3

It's approximately 7.4s, far larger than $t_{\text{fall, theoretical}}$. This because the acutal circuit have a larger R contributed from the LED and other components (button, wires...)

Question 4

Yes. It's now approximate 15.2s, approimately 2 times than the 7.4s. According to the formula of t_{fall}, we could see that the capcitance should increase approximately 2 times too.

Problem 5



This is the picture taken for the plotted graph. (The vertical axis is voltage, the horizontal axis is second).