



Digital version

ENGS262 Control Systems Lab - Lab Part 1

Mher Saribekyan Mane Hambardzumyan

September 14, 2026

Lab 1

Integrator

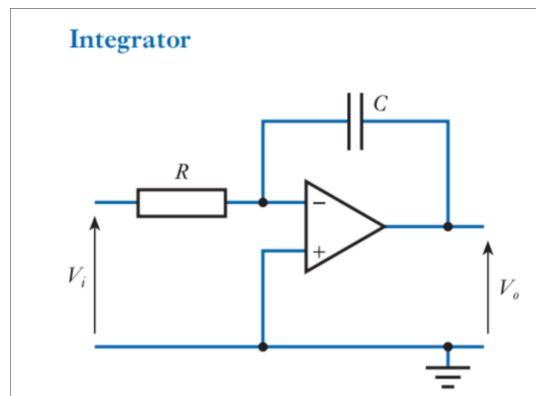
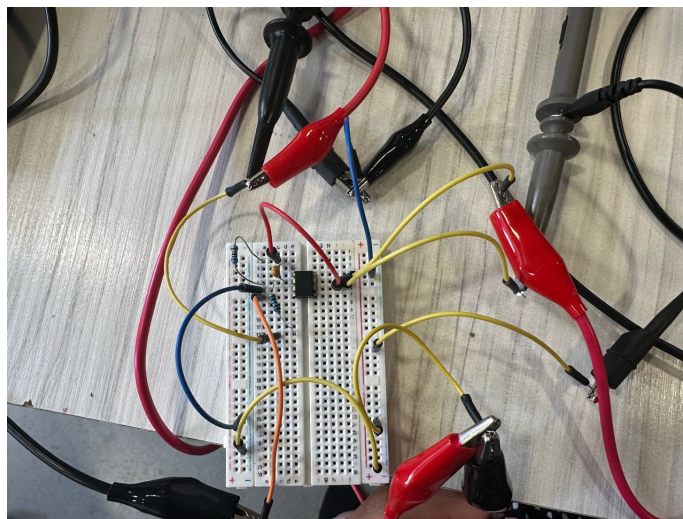


Figure 1: Integrator OpAmp Schematic

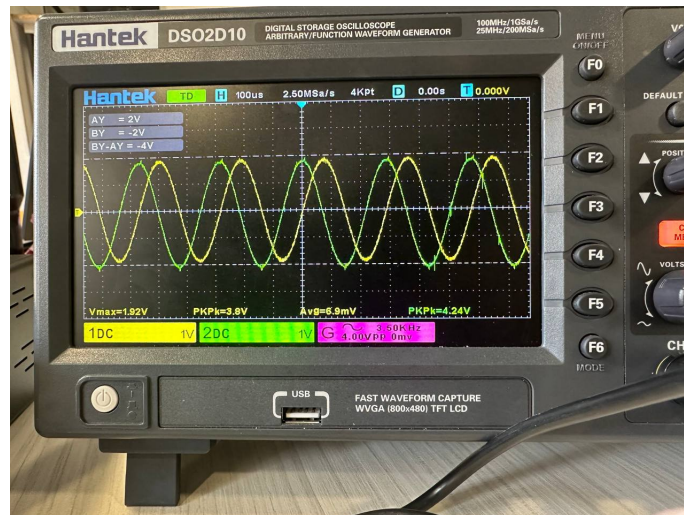
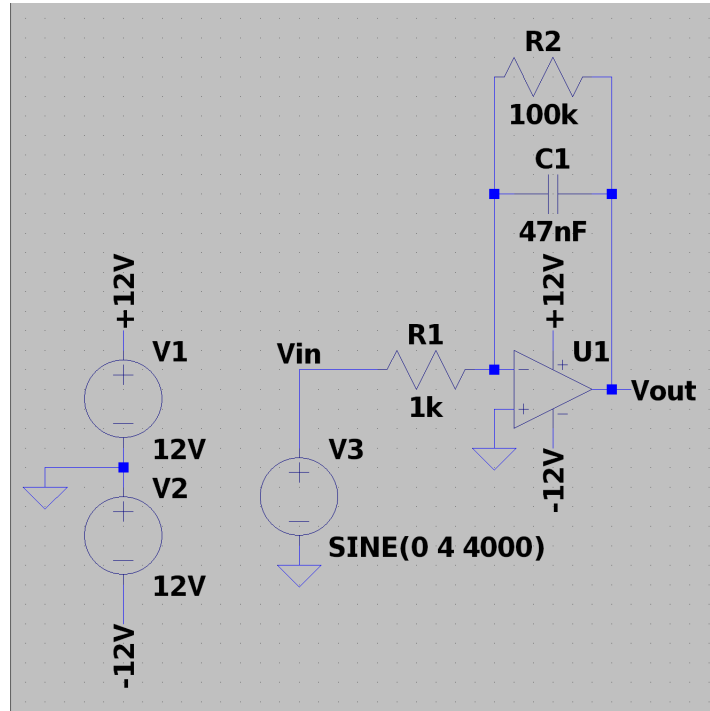
The circuit in Fig1 was assembled. Opamp supply of +10V and -10V were connected.



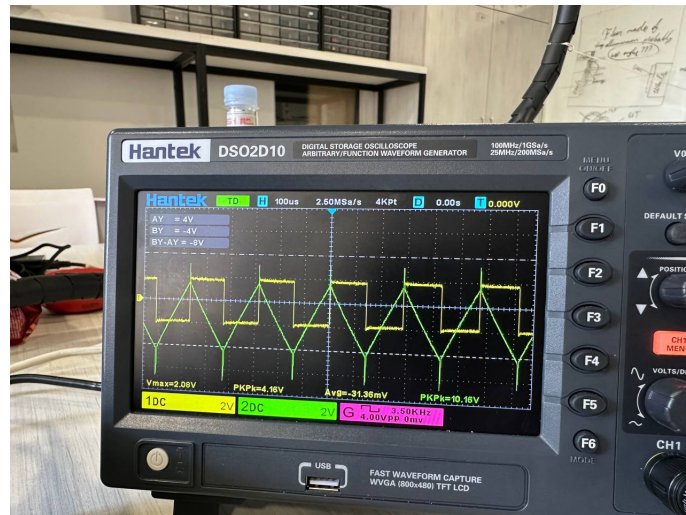
Considering that we provide AC signal, we need to use the formula below to calculate R and C values for unity gain:

$$f_{dB} = \frac{1}{2\pi RC}$$

The values of $R = 1k\Omega$ and $C = 470nF$ give approximately 3.4kHz. 3.5kHz sine wave was provided and the output was observed. A $100k\Omega$ resistor was put in parallel to the capacitor to bring the output around 0V.



Channel 1 is the input, Channel 2 is the output. The input is a sine signal, output we observe a cosine signal, which matches the theory. Integral of sine is negative cosine, however since we assembled an inverted integrator, the output makes sense.

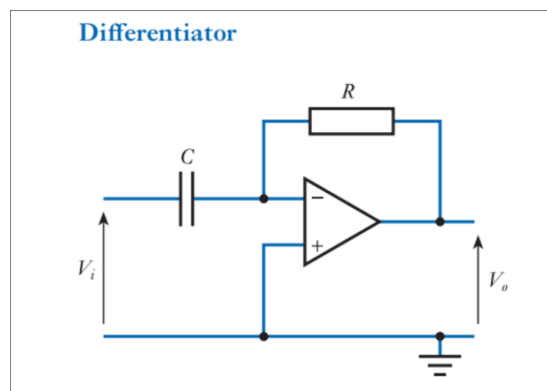


The integral of square wave is a triangle wave, which is what we observe.

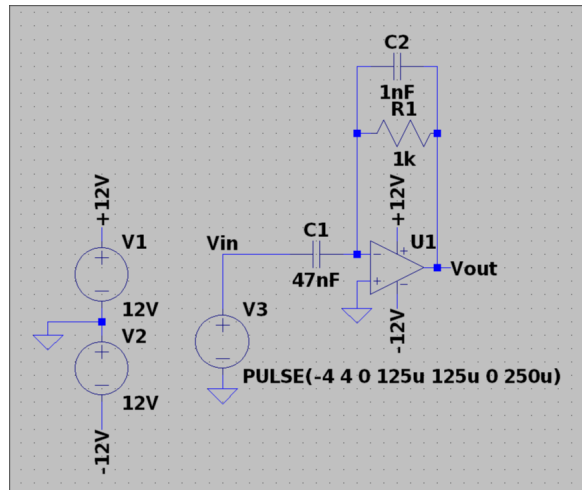


The integral of triangle wave is a quadratic spline, which is what we observe.

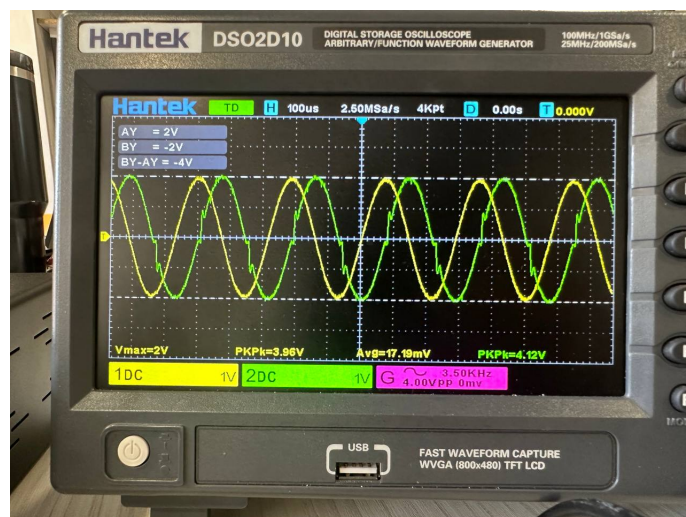
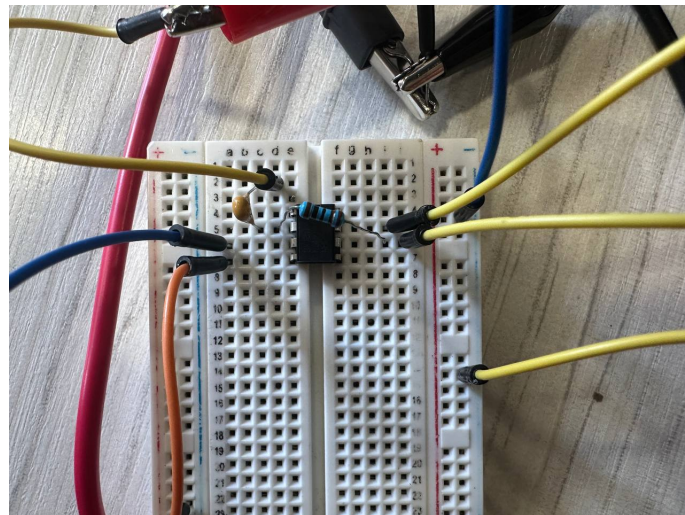
Differentiator



Same calculations as for the integrator, except the resistor and capacitor are swapped.



A small 1nF capacitor was placed parallel to the resistor, to filter the noise.

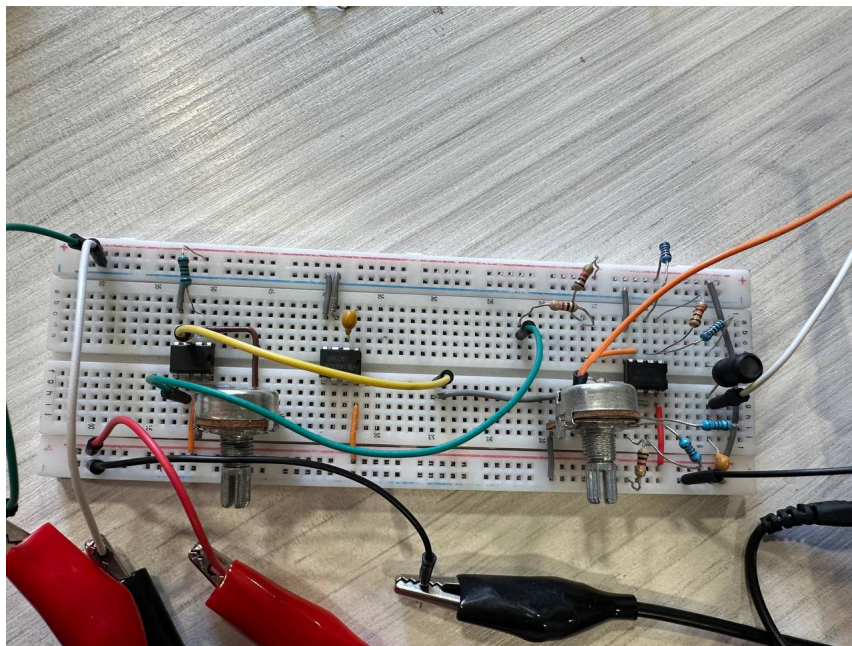
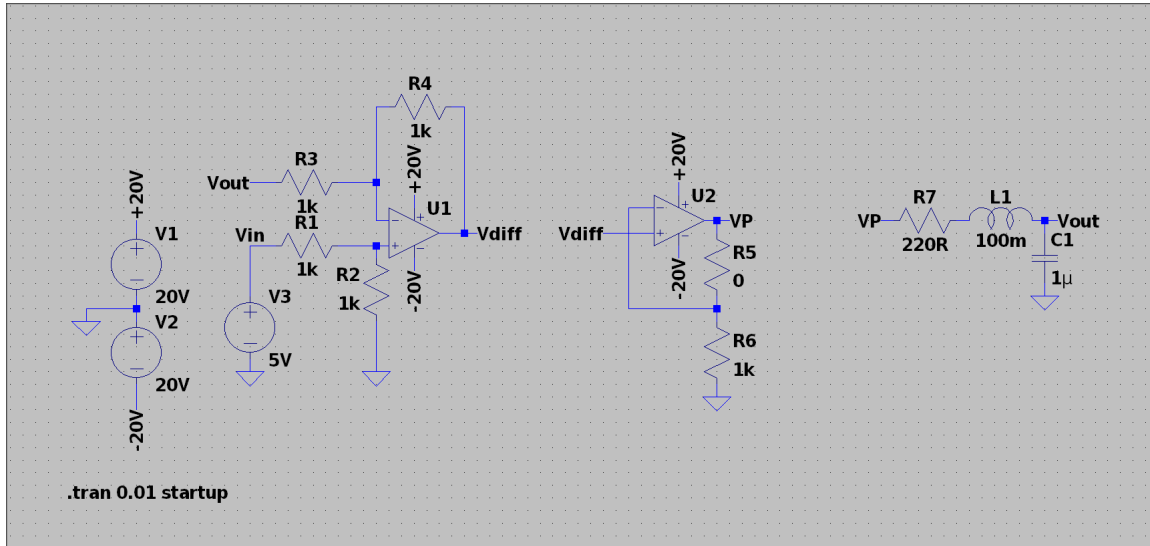


Sine wave was given to the input and the output is a negative cosine wave, which is what we expect.

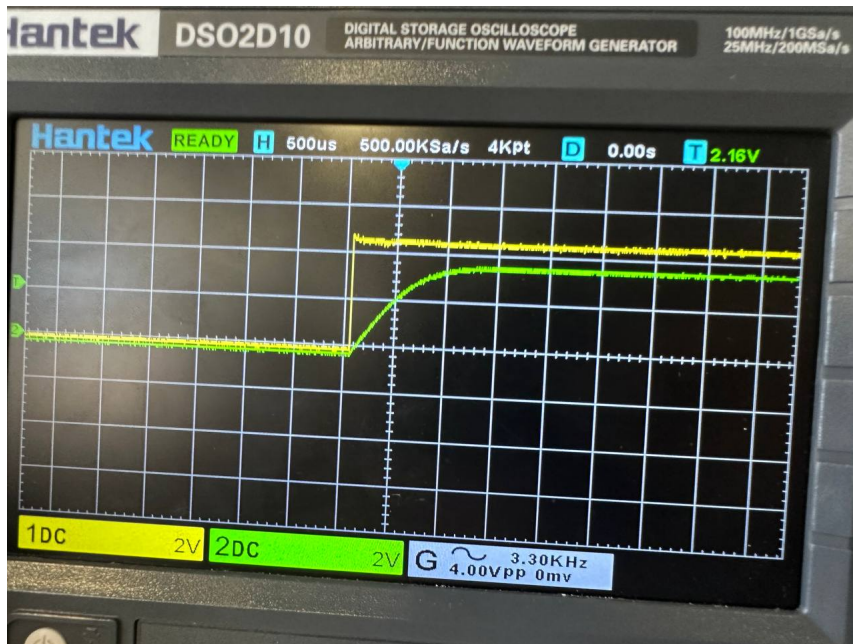
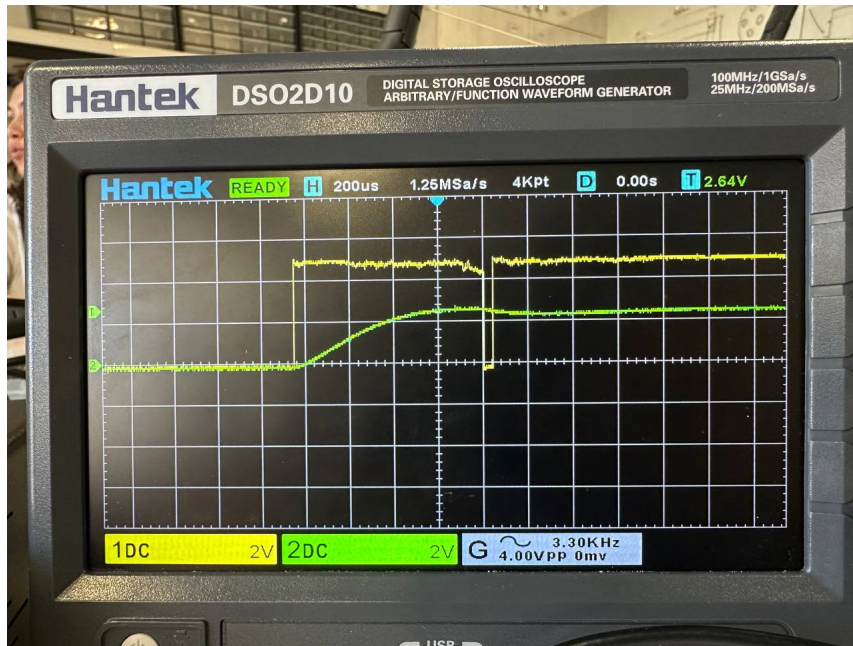
Lab 2

P controller

To make a P controller, a non-inverting amplifier was constructed, with 1k resistor and 100k potentiometer, giving a range of gain from 1 to 101. Input reference of 5V was provided.



Different K_p values were tested. With lower K_p values, output does not reach the input reference. With higher K_p values, they get closer.

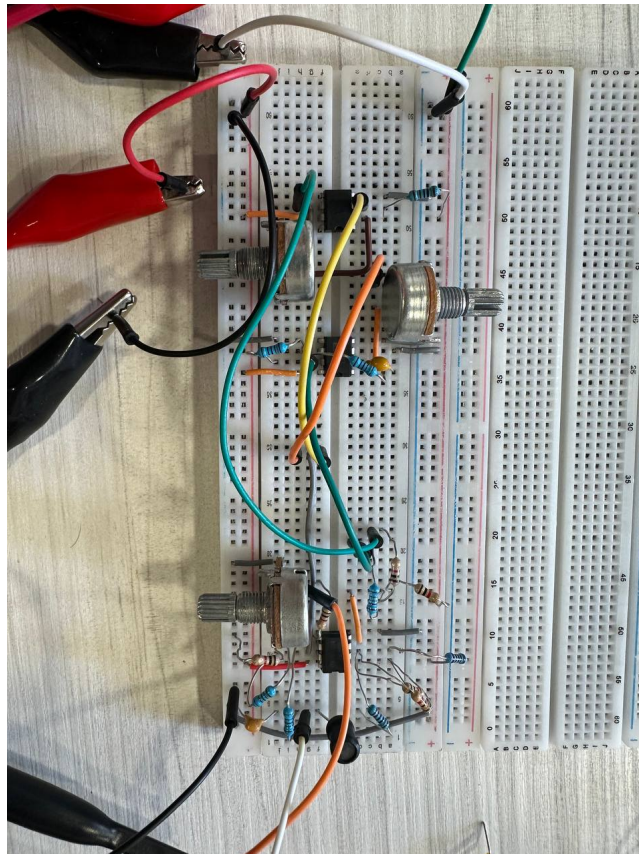
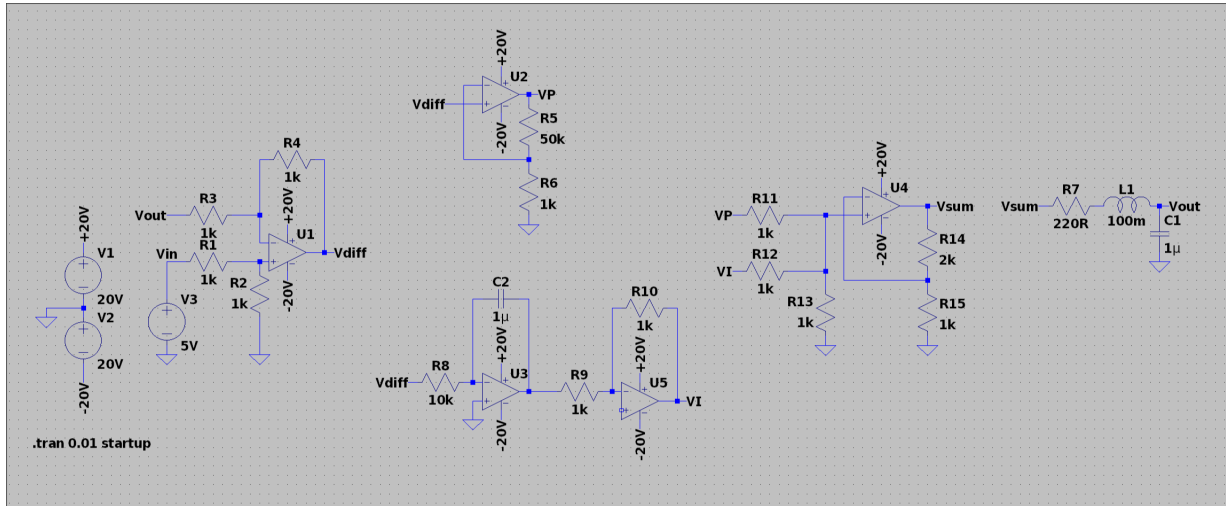


Top picture is with low K_p value, bottom picture is with high K_p value. The higher K_p values is more accurate, although still not perfect.

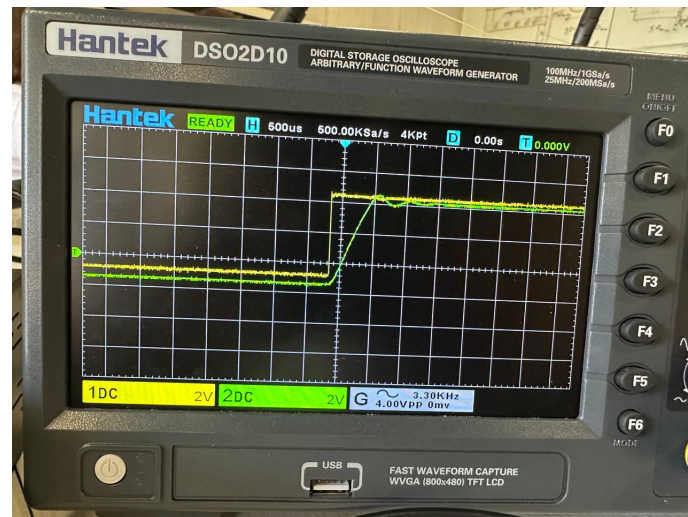
Lab 3

PI controller

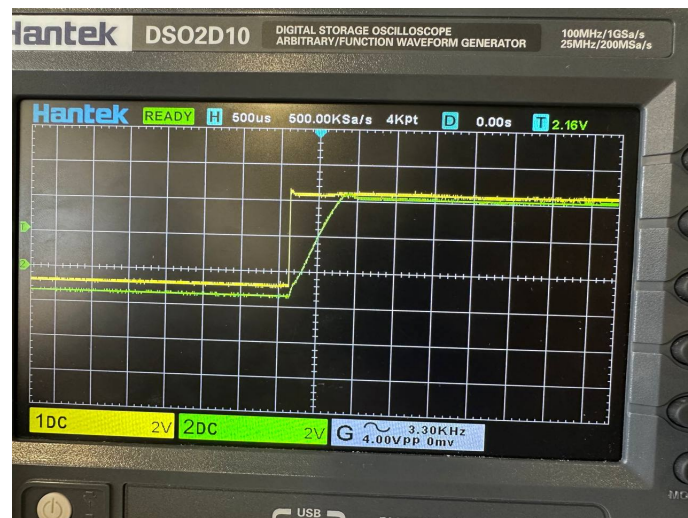
Same circuit as in P, however an integrator, inverting amplifier and an adder were added. For the integrator, 10uF capacitor and 100k Ω potentiometer were used, to give a large range of K_i .



Different K_i values were tested.



With large K_i values, we get oscillations, however the output reaches the input reference.

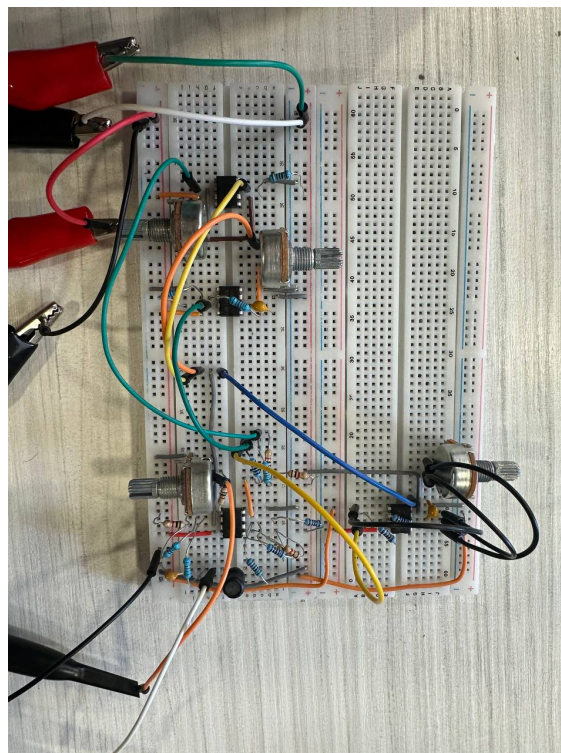
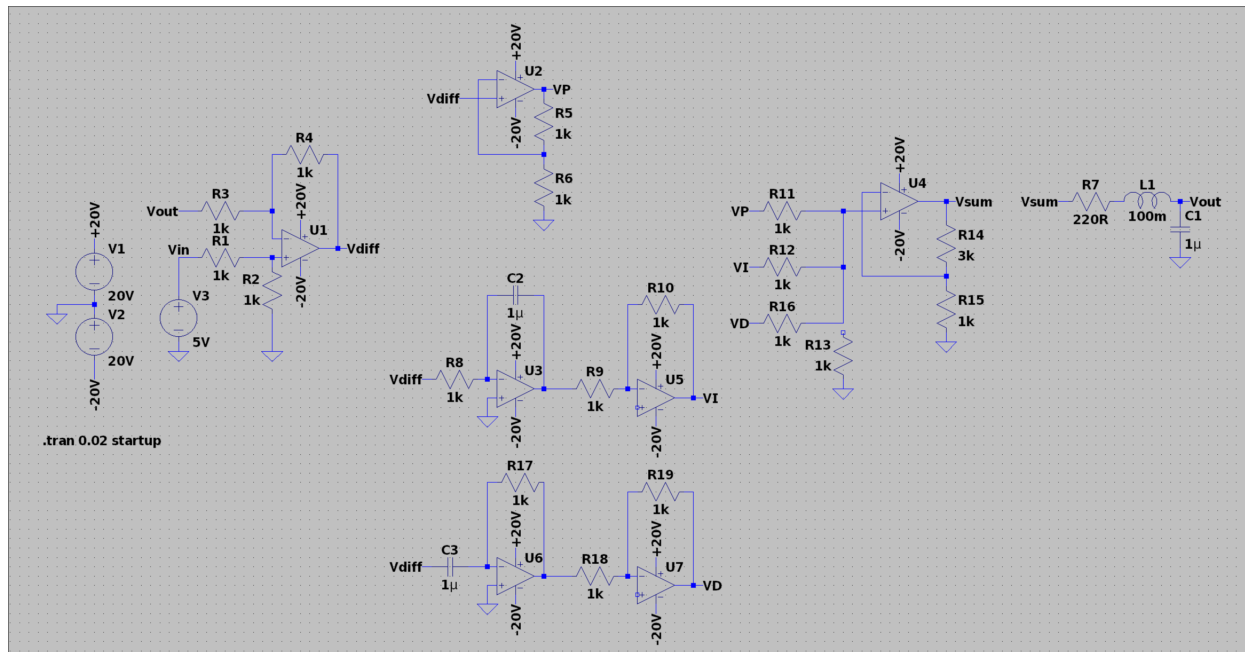


For good K_p and K_i values, we get smooth and fast output, with little oscillations.

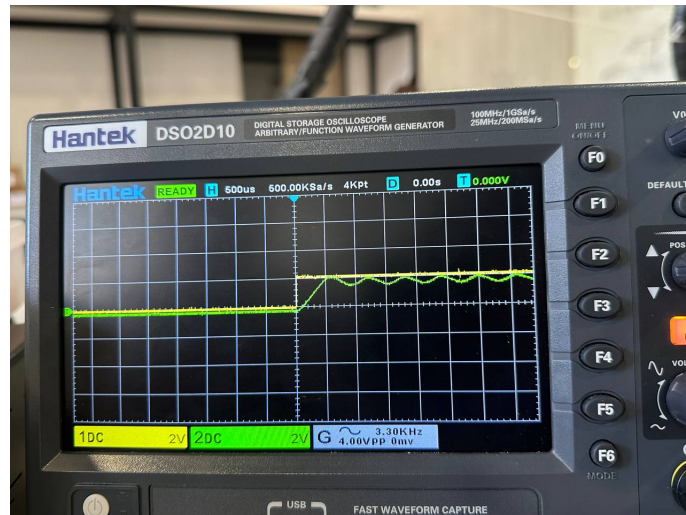
Lab 4

PID controller

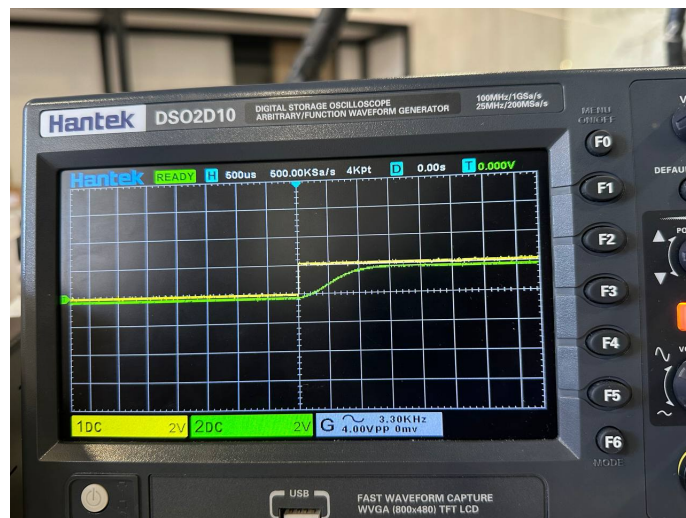
Same circuit as in PI, however a differentiator and an inverting amplifier were added. For the differentiator, 10uF capacitor and 100k Ω potentiometer were used, to give a large range of Kd.



Different Kd values were tested.



With large K_d values, we get oscillations.



For good K_p , K_i and K_d values, we get smooth and fast output, without any oscillations.