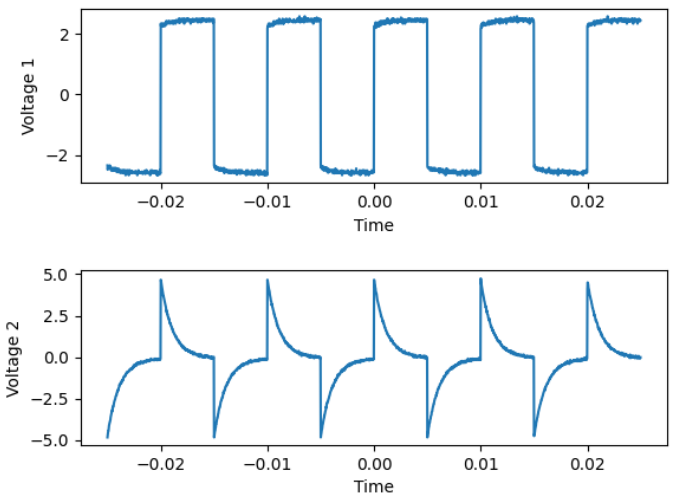
Report for 3Y Electronics 2018

Exercise 5

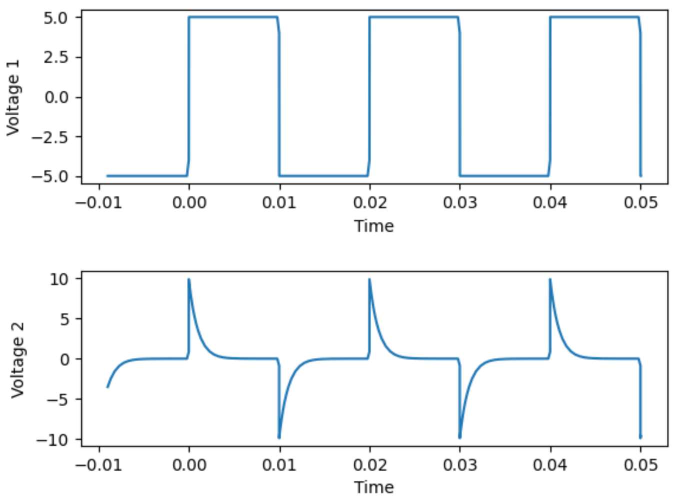
Using equation (2.7), we have

$$V = V_i e^{-t/RC} = 5e^{-t/0.001} = 5e^{-1000t}$$

The data of real measurement is plotted as below



The data of simulation is plotted as below

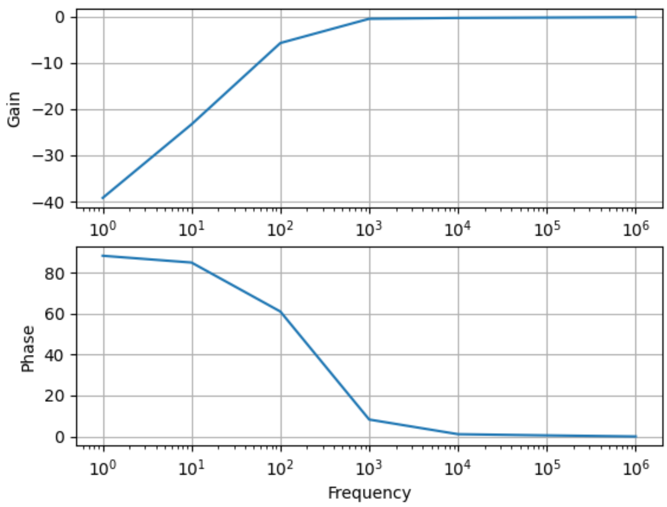


Exercise 7

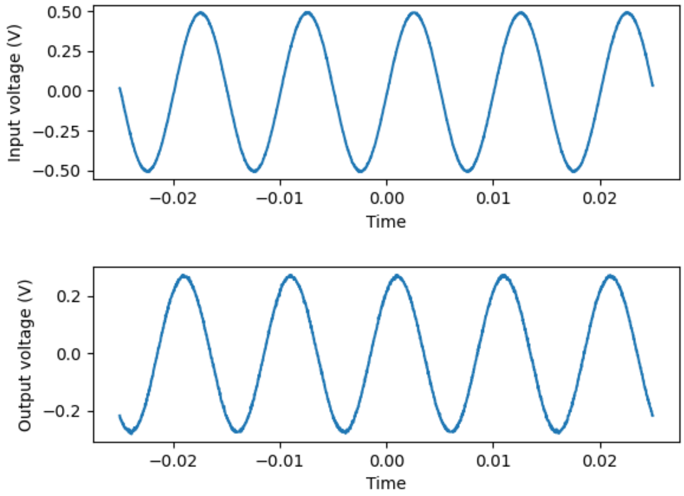
The data we collected is as below.

Frequency (HZ)	Phase (degree)	V1 (V)	V2 (V)	Gain (dB)
1	88.26	1070	11.7	-39.22
10	84.94	1070	73	-23.32
100	61.02	1050	541	-5.76
1K	8.29	1030	970	-0.52
10K	1.14	1030	990	-0.34
100K	0.55	1010	980	-0.26
1M	0.02	980	960	-0.18

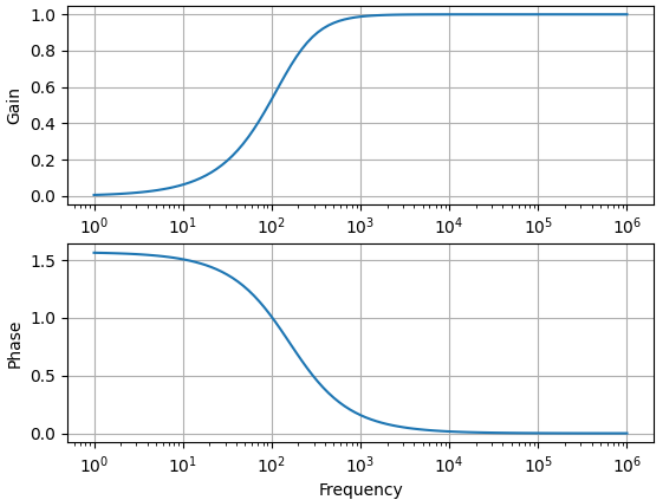
The amplitude and phase are plotted as below.



For real measurement, we have data plotted as below.

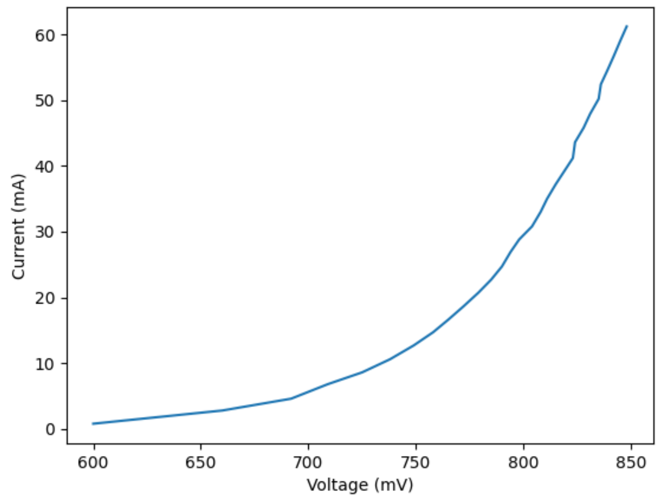


For simulation, the amplitude and phase response for different frequencies is plotted as below.

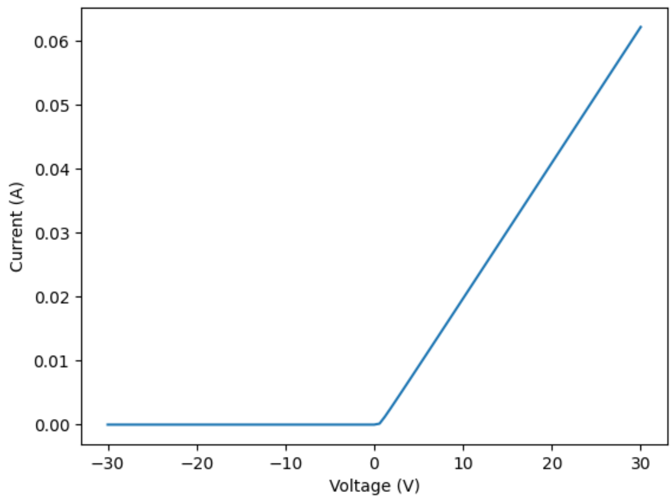


Exercise 12

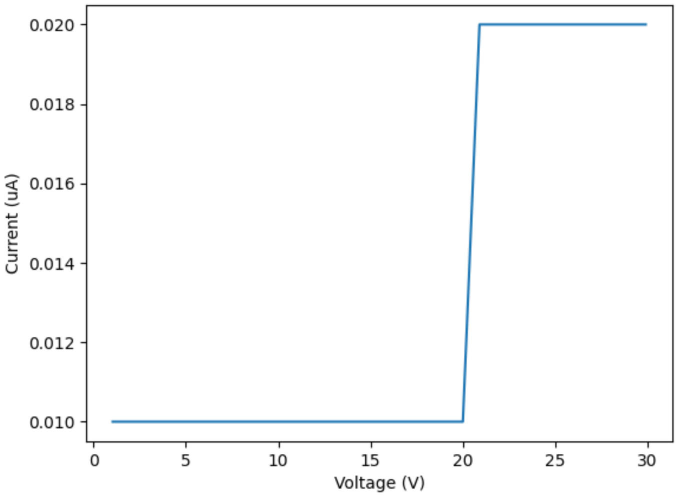
For forward data, the I-V curve of measurement data is plotted as below.



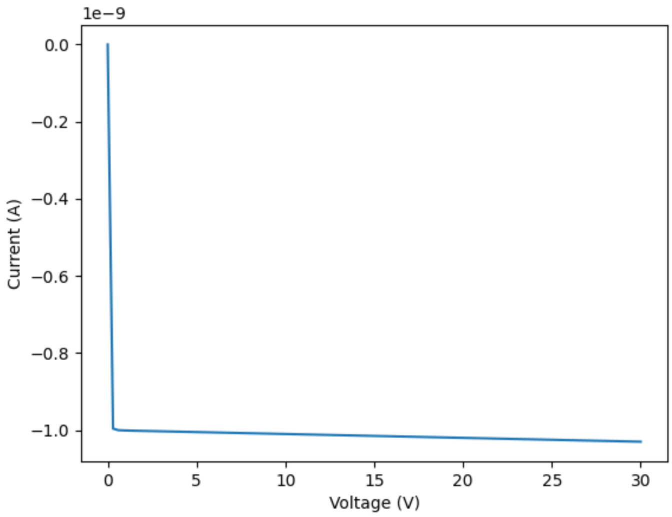
The I-V curve of simulation data is plotted as below.



For reverse data, the I-V curve of measurement data is plotted as below.



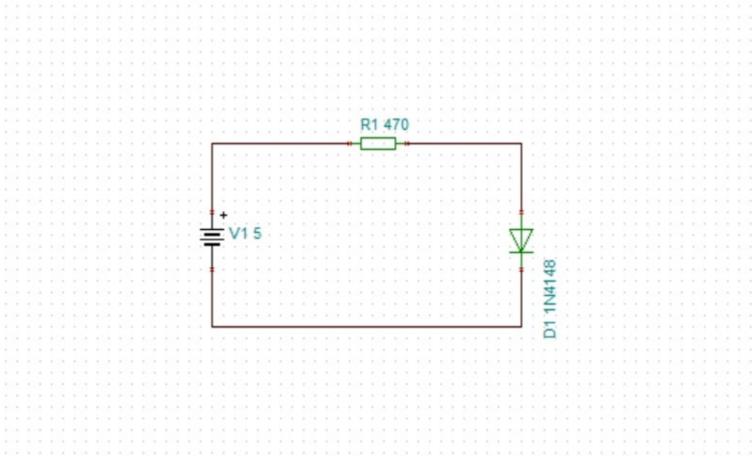
The I-V curve of simulation data is plotted as below.



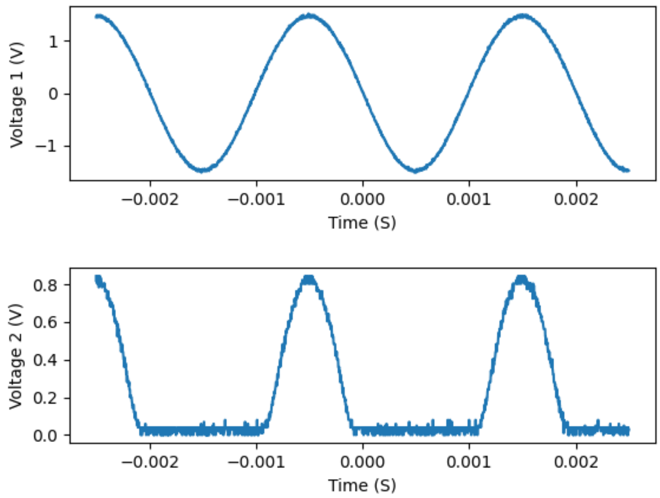
From the curves above, the unidirectional conductivity of diodes can be demonstrated.

Exercise 12b

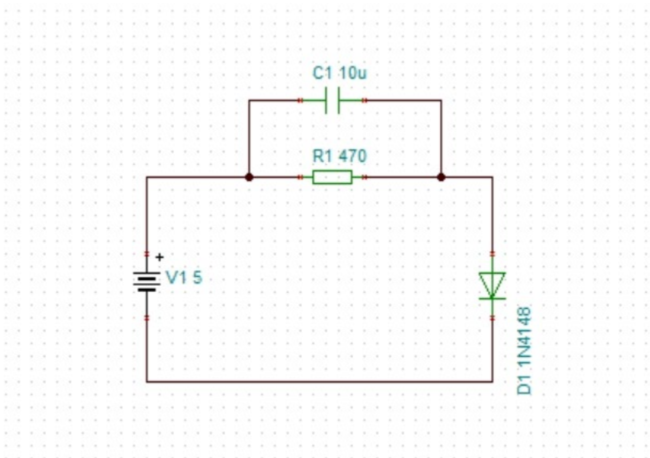
The circuit without the capacitor is shown as below.



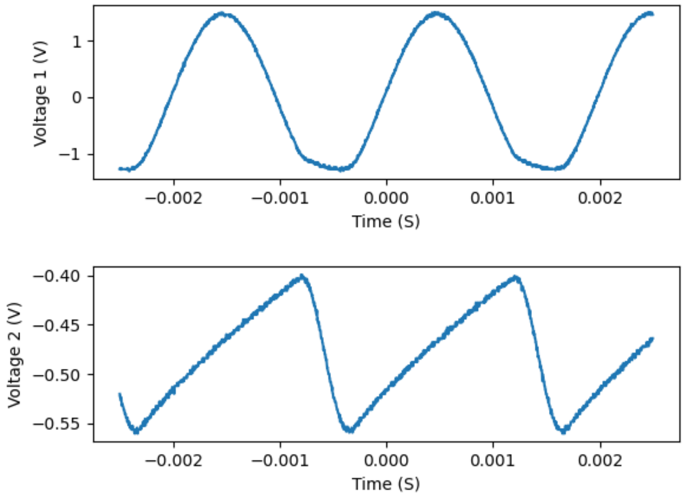
The curve of output vs input is shown as below.



The circuit with the capacitor is shown as below.



The curve of output vs input is shown as below.

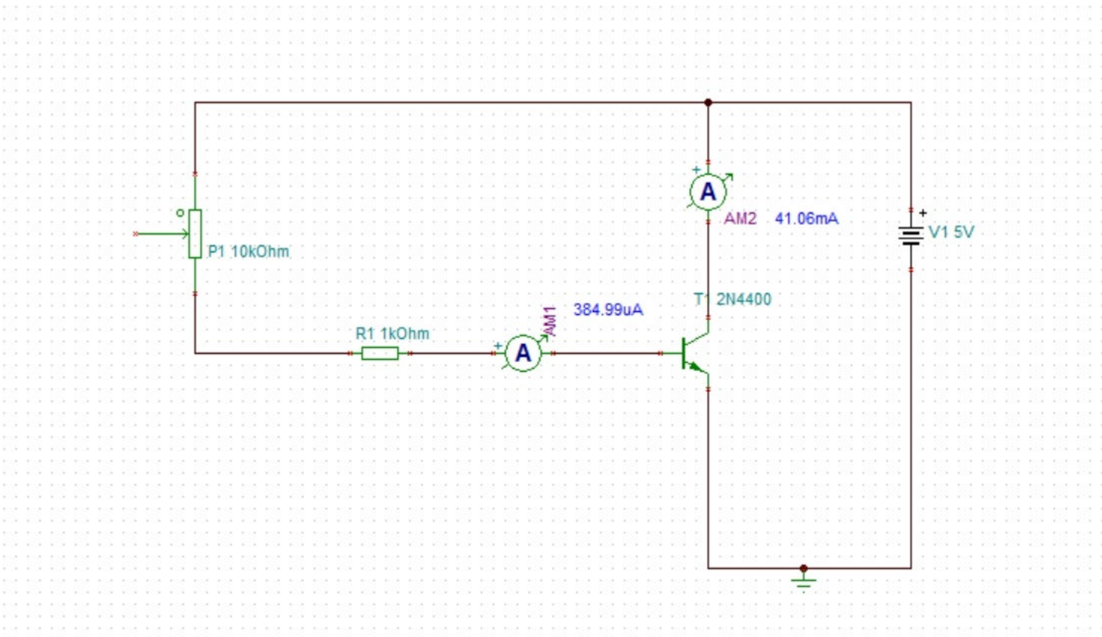


It can be observed that adding a capacitor shortens the proportion of the response voltage valley and reduces the rate of change of the response voltage during the rising phase.

Exercise 19

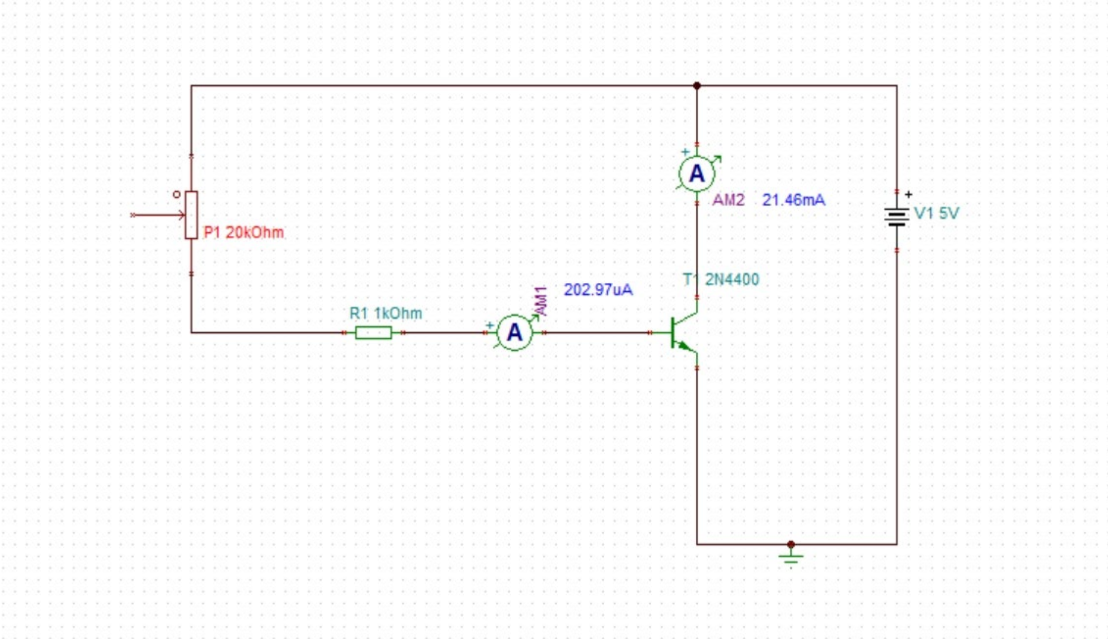
Using different values of resistance, we have results as below.

(1) 10K ohm



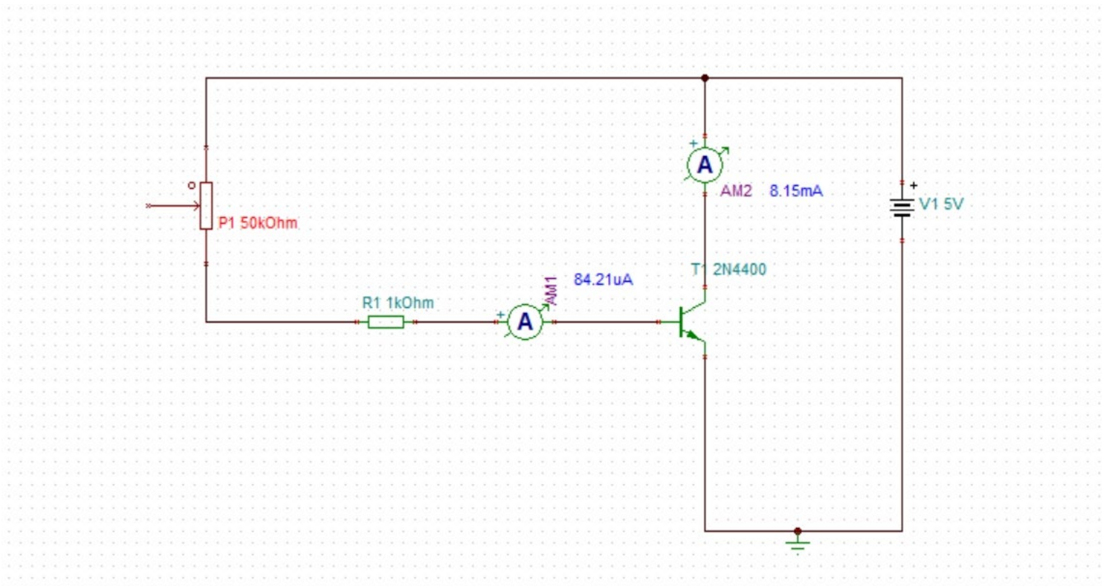
The measured gain is $41.06mA / 384.99\mu A \approx 106.65$.

(2) 20K ohm



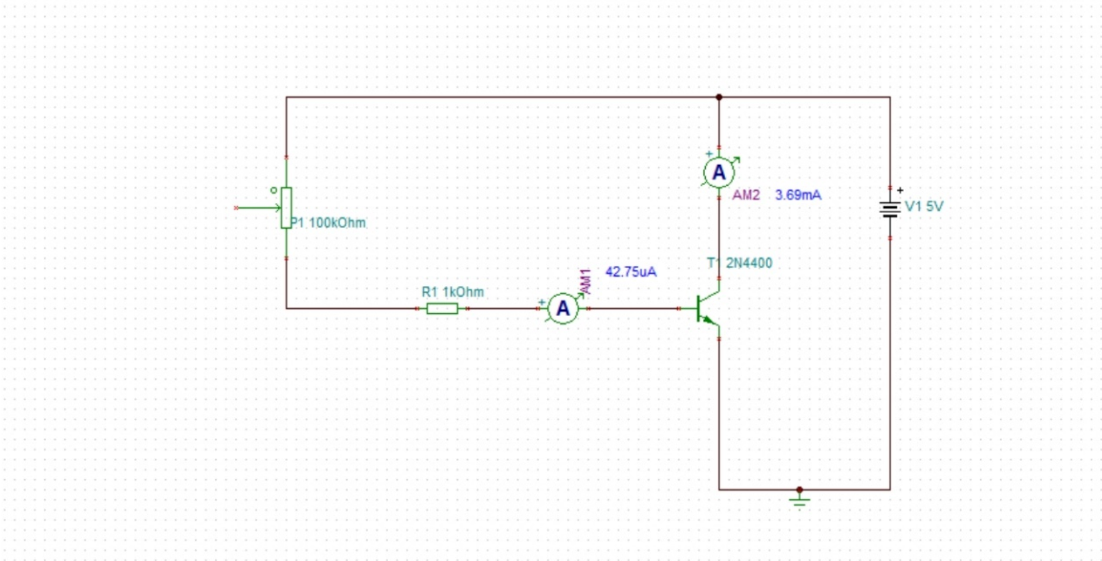
The measured gain is $41.06mA / 384.99\mu A \approx 105.73$.

(3) 50K ohm



The measured gain is $8.15mA / 84.21\mu A \approx 96.78$.

(4) 100K ohm

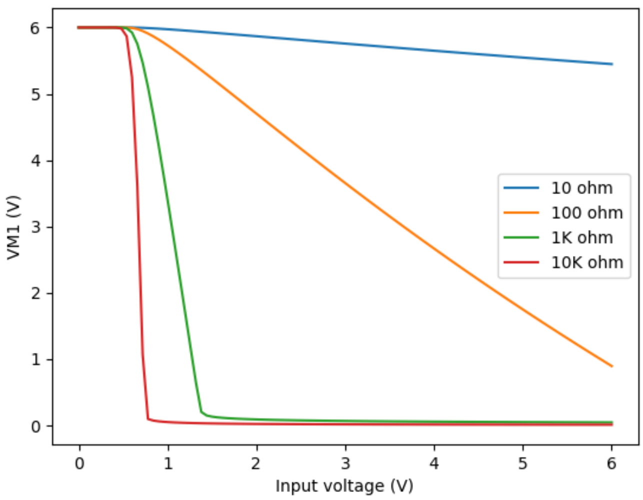


The measured gain is $3.69mA / 42.75\mu A \approx 86.32$.

It is quite obvious that the current amplification of the model decreases as the resistance of P1 increases.

Exercise 20

The curves of switching action of different resistors are plotted as below.



It can be observed that the larger the resistor is, the more rapid switching action can be.

Exercise 21

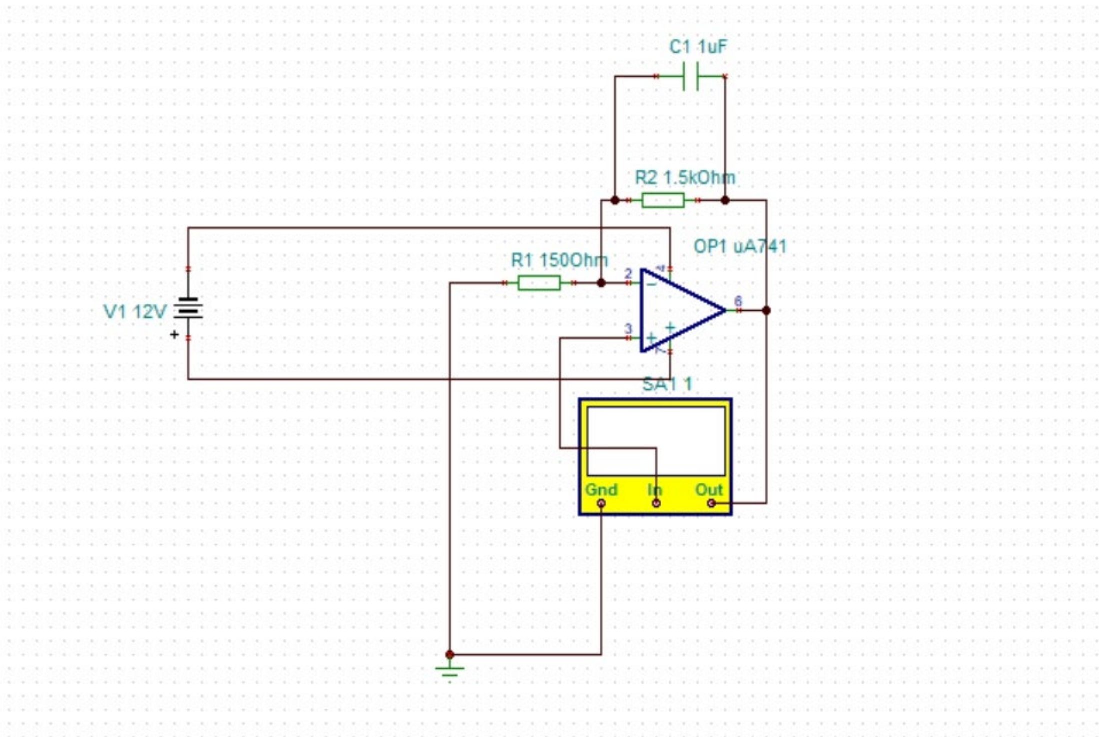
The values for components include:

R = 100K ohm, Rb = 1K ohm and Rload = 470 ohm.

The reason for our choice is that balabala.

Exercise 25

The circuit we design for simulation is shown as below.



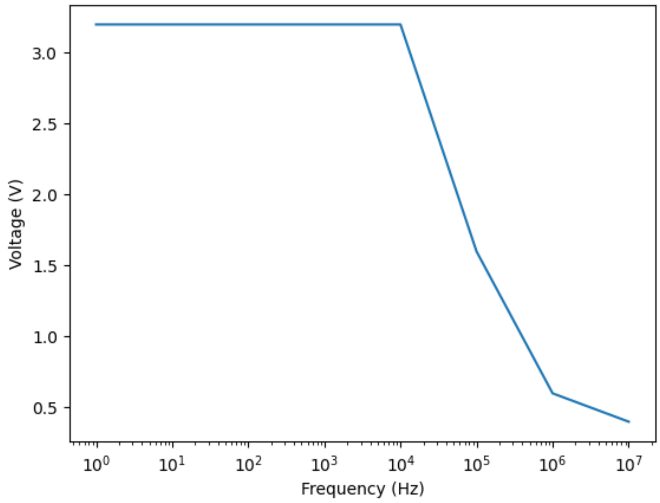
Before inserting the capacitor, the data of input & output with accordance to different frequencies is shown as below.

Input voltage = 300mV.

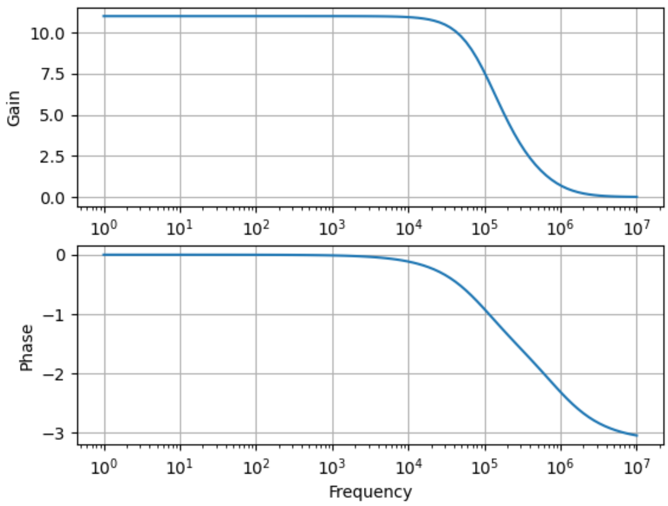
Frequency (Hz)	Output (V)
1	3.2
10	3.2

100	3.2
1000	3.2
10K	3.2
100K	1.6
1M	0.6
10M	0.4

They can be plotted as below



Also, we have frequency response plotted as below.

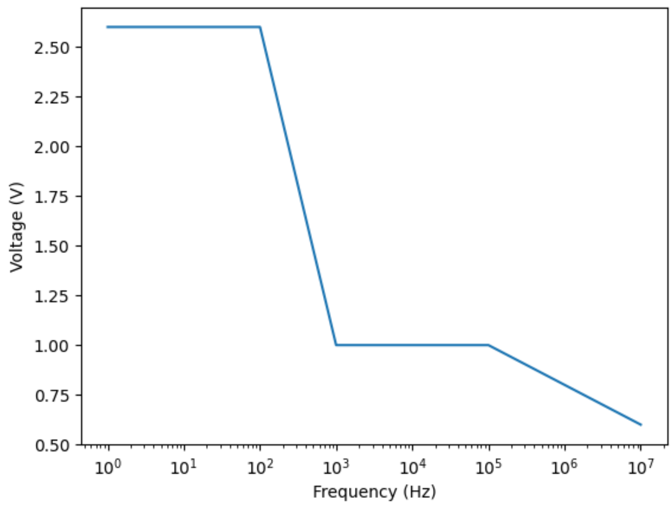


After inserting the capacitor, the data of input & output with accordance to different frequencies is shown as below.

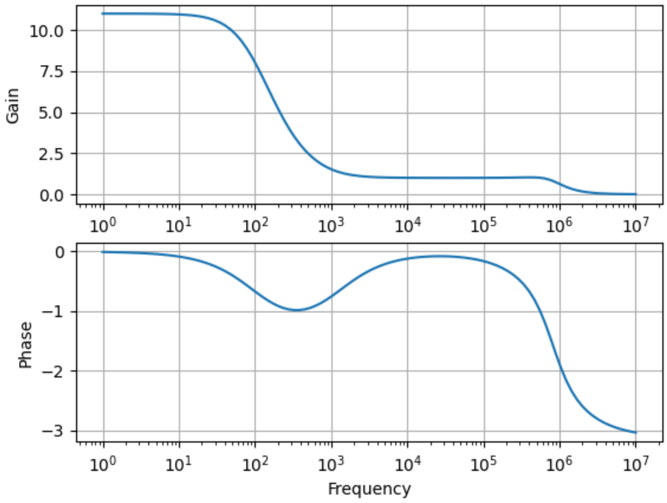
Input voltage = 300mV.

Frequency (Hz)	Output (V)
1	2.6
10	2.6
100	2.6
1000	1
10K	1
100K	1
1M	0.8
10M	0.6

They can be plotted as below



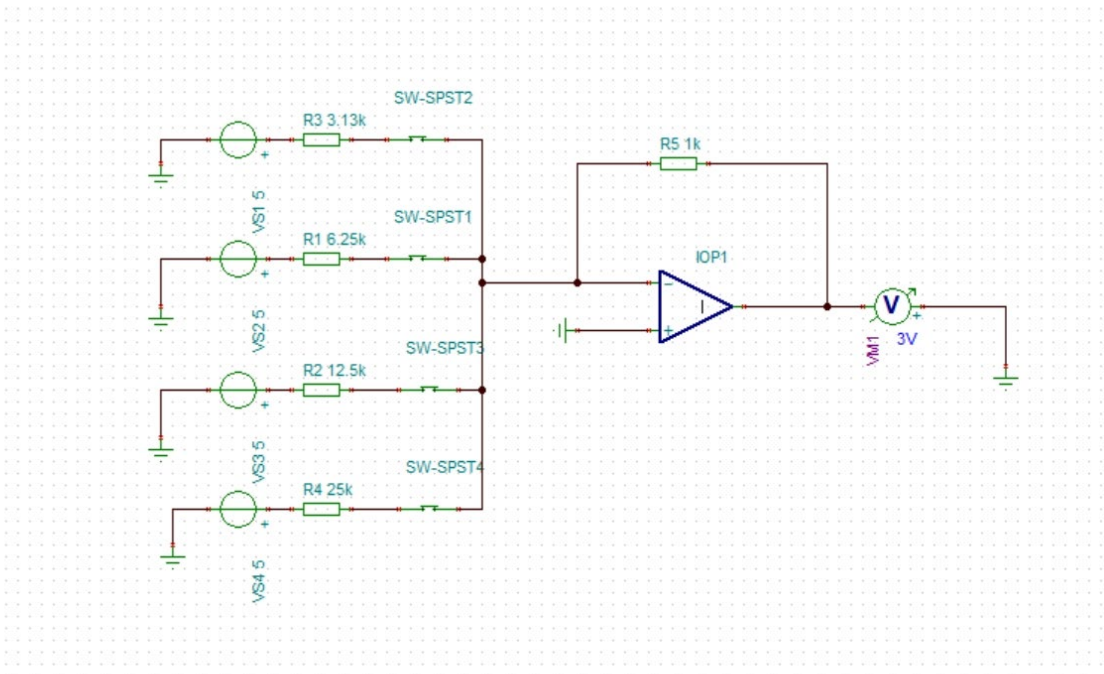
Also, we have frequency response plotted as below.



It can be observed that the capacitor effectively decreases the bandwidth.

Exercise 27

The circuit we design is shown as below, the values of components are labeled in the figure.



Firstly we set R5 = 1K ohm, to simplify the design, we let R4 = 2R3 = 4R2 = 8R1, then

$$V_{out} = -R_f\left(\frac{V_1}{R_1}+\frac{V_2}{R_2}+\frac{V_3}{R_3}+\frac{V_4}{R_4}\right) = -R_f\left(\frac{V_1}{R_1}+\frac{V_2}{2R_1}+\frac{V_3}{4R_1}+\frac{V_4}{8R_1}\right)$$

For V_i, $i=1,2,3,4$, there are only two values 0 V and 5 V, as all four are 5 V, V_{out} is supposed to reach -3 V, that is

$$-R_f\left(\frac{5}{R_1}+\frac{5}{2R_1}+\frac{5}{4R_1}+\frac{5}{8R_1}\right) = -5\frac{15R_f}{8R_1} = -3$$

Then $R_1 = \frac{25R_f}{8} = \frac{25}{8}\Omega = 3.125\Omega$, hence we have $R_2 = 6.25\Omega$, $R_3 = 12.5\Omega$ and $R_4 = 25\Omega$.