EE230: Homework-1
Familiarization with NGSPICE Circuit Simulator and Lab Equipment

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1 Overview of the experiment

1.1 Aim of the experiment

Ngspice is a mixed-signal circuit Simulator. This experiment aims to implement some basic circuits namely :

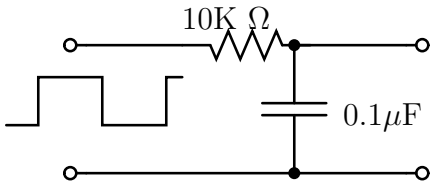
- RC Integrator
- RC Differentiator
- RC Lowpass Filter
- RC Highpass Filter
- RC Bandpass Filter
- RLC Bandpass Filter

in Ngspice and plot their characteristics.

1.2 Methods

We start by creating a netlist for each circuit, simulating on Ngspice and exporting the values to a python script to plot them using Matplotlib.

2 Design



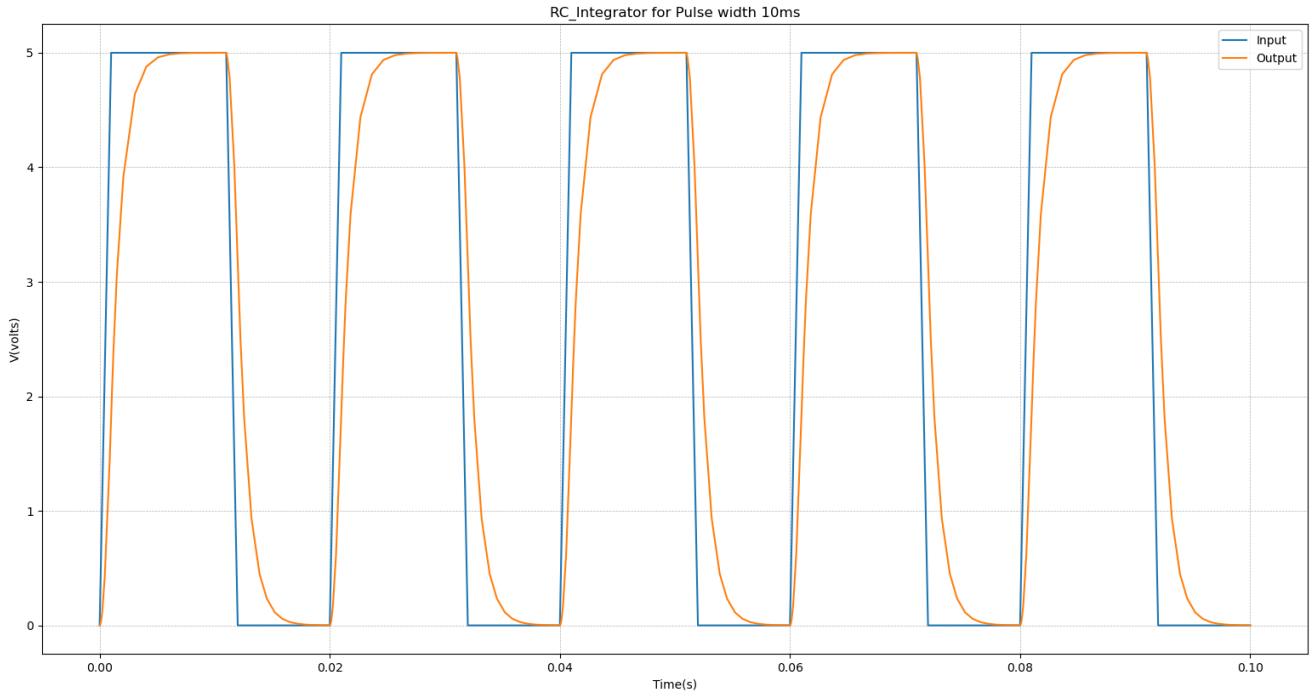
3 Simulation results

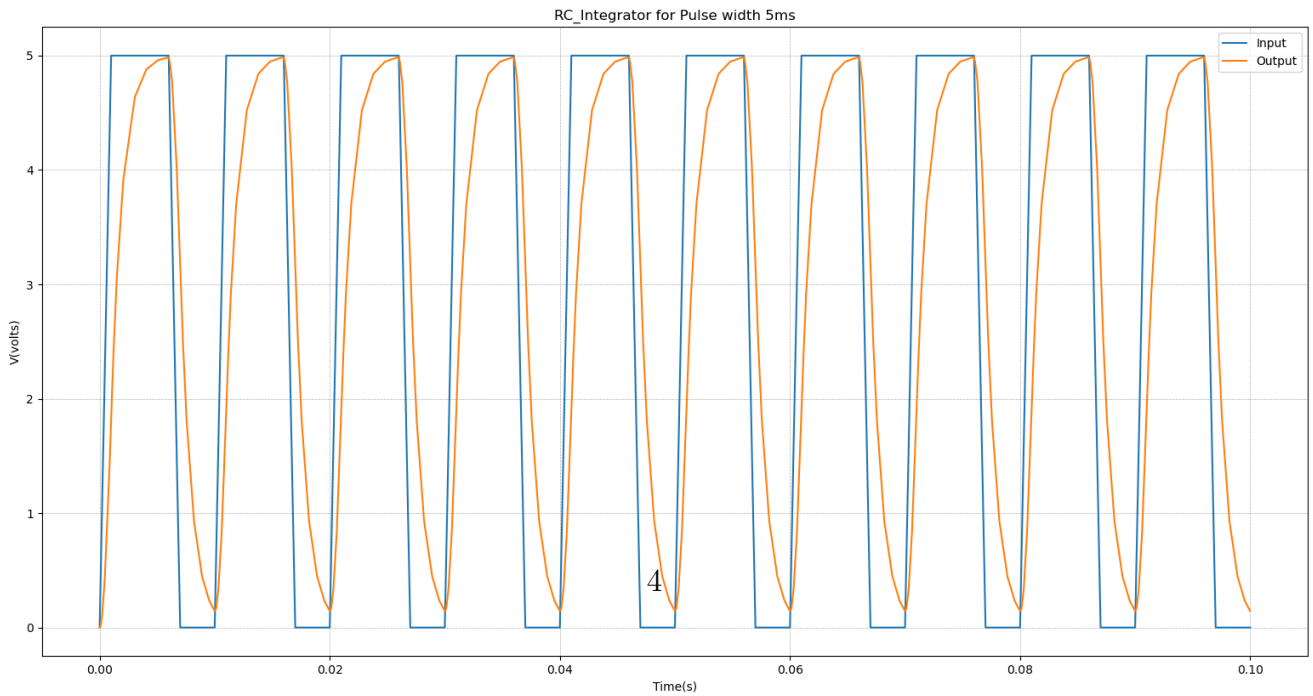
3.1 RC Integrator

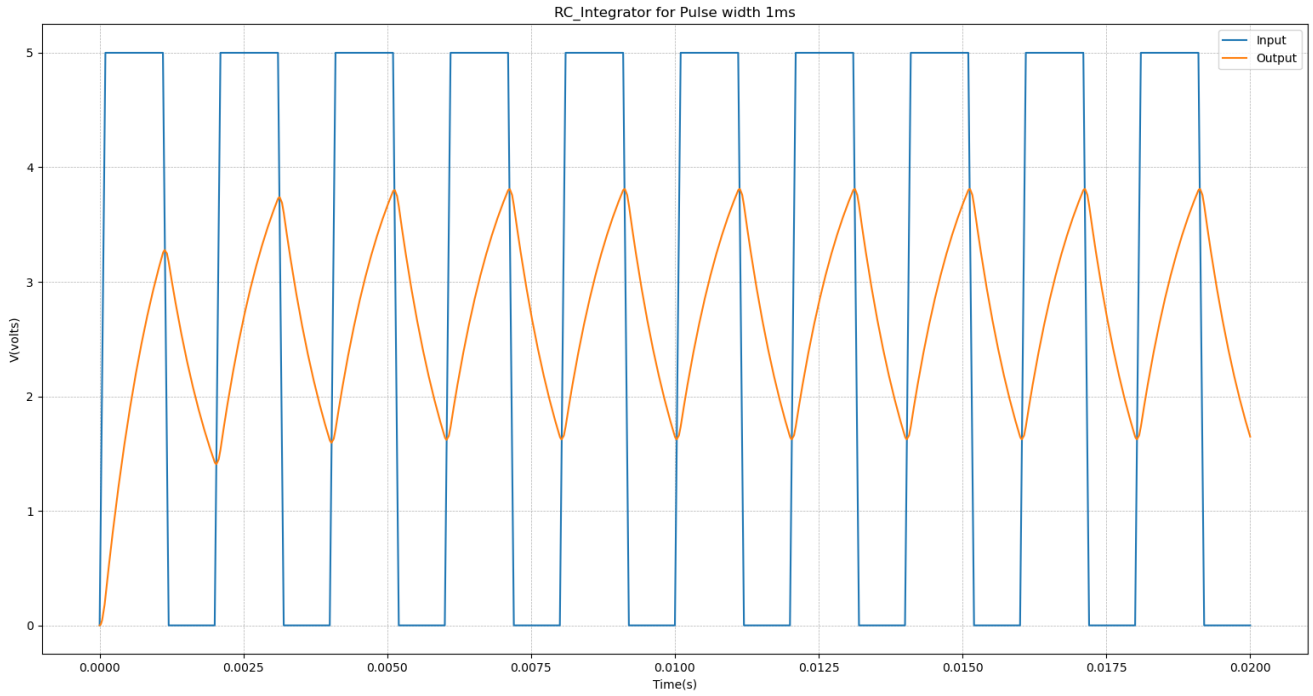
3.1.1 Code snippet

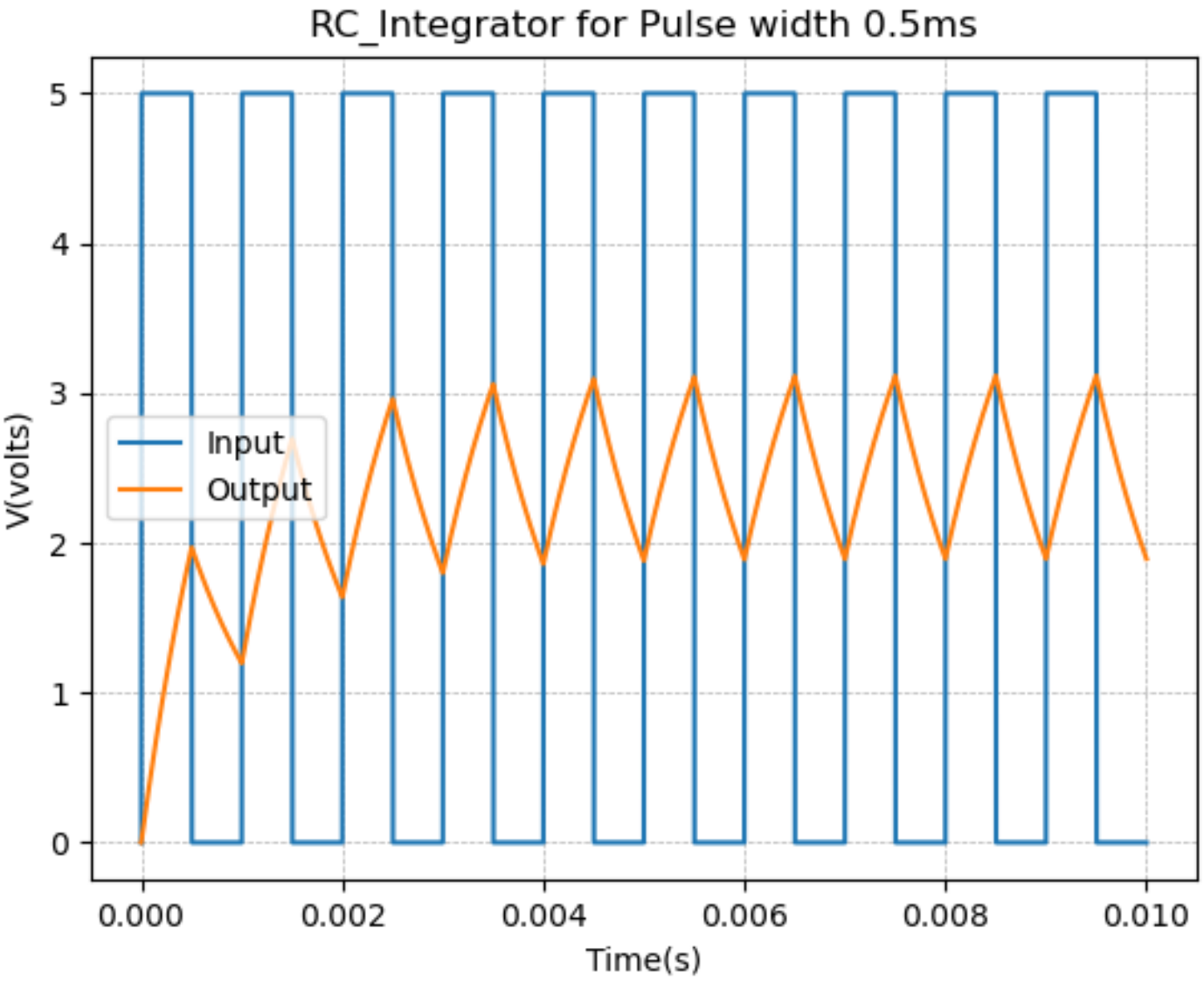
```
RC Integrator circuit transient analysis
*tau =1m #Time Period

*describe circuit
* <element-name> <nodes> <value/nodel>
r 1 2 10k
c 2 0 0.1u
*v 1 0 pulse(0 5 0 0 0 10m 20m) $10*tau
*v 1 0 pulse(0 5 0 0 0 10m 20m) $5*tau
*v 1 0 pulse(0 5 0 0 0 10m 20m) $1*tau
*v 1 0 pulse(0 5 0 0 0 10m 20m) $0.5*tau
*v 1 0 pulse(0 5 0 0 0 10m 20m) $0.1*tau
v 1 0 pulse(0 5 0 0 0 0.05m 0.1m) $0.05*tau
*analysis command
.tran 0.011m 10m

.control
run

*display cmd
plot v(1) v(2)
print v(1) v(2)
*end control mode
.endc

*end netlist
.end
```

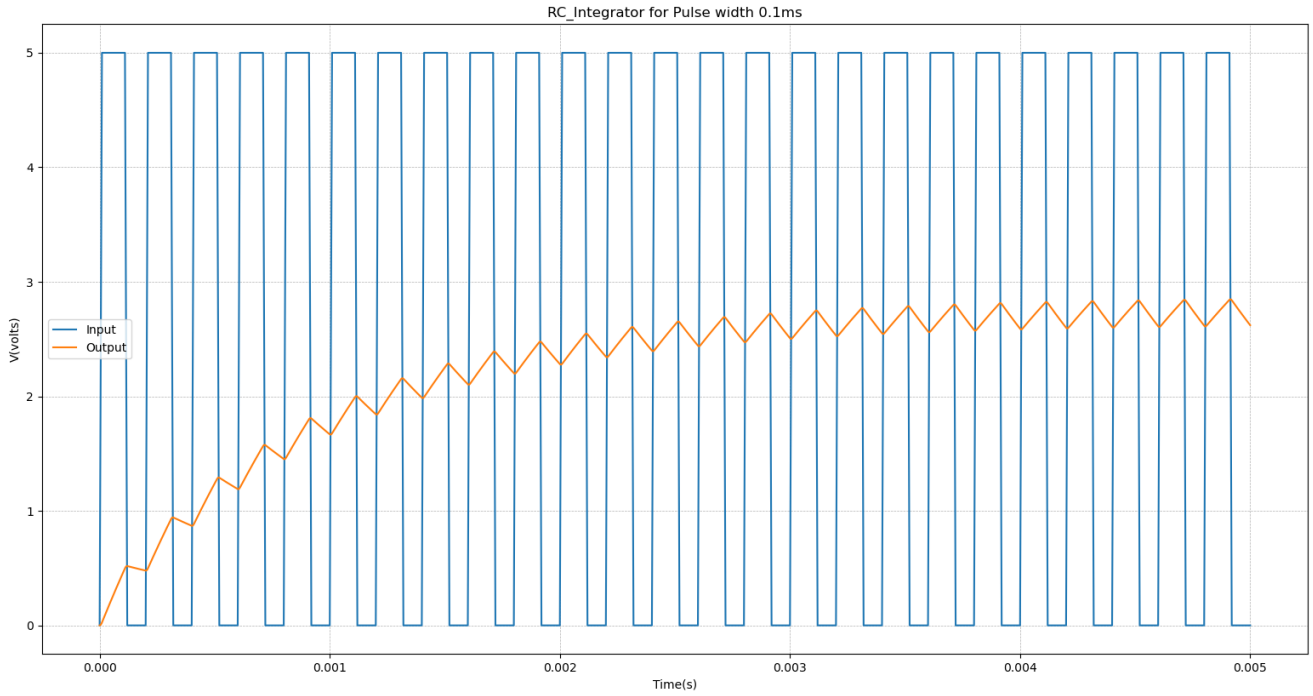
3.1.2 Simulation results

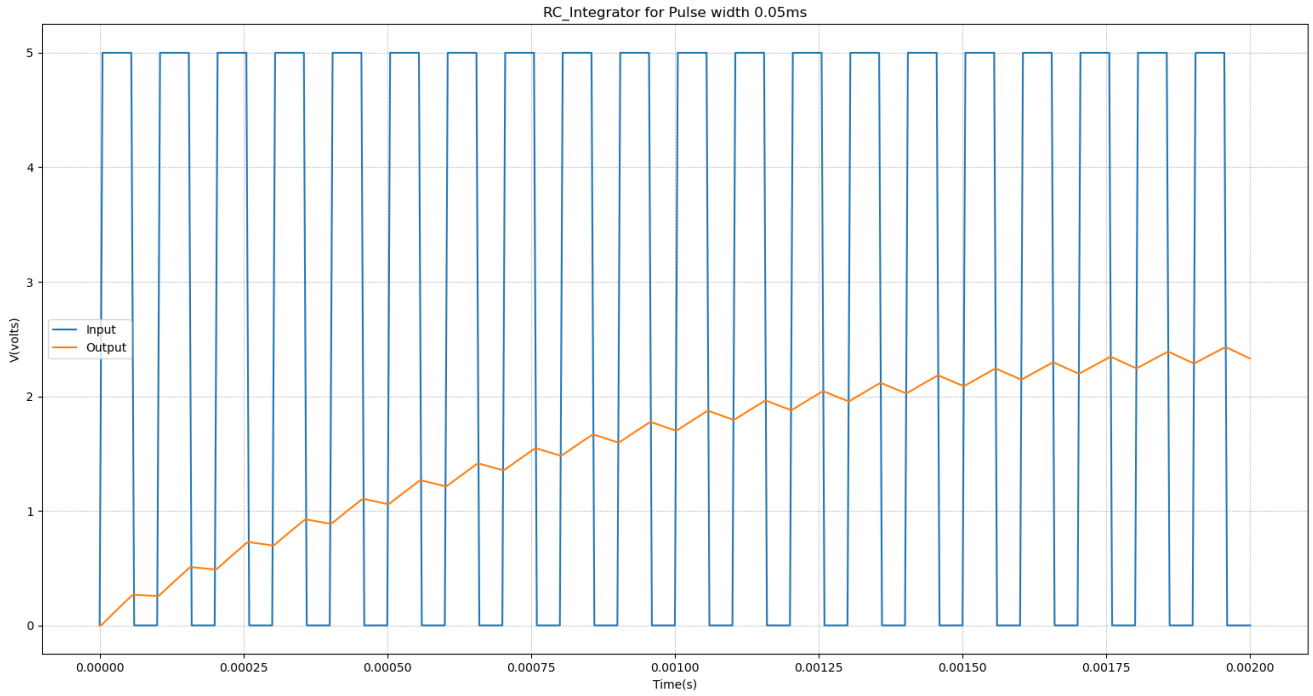





RC_Integrator for Pulse width 1ms
Input
Output
V(volts)
Time(s)
0
1
2
3
4
5
0.0000
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200


RC_Integrator for Pulse width 0.5ms
V(volts)
Time(s)
Input
Output
0
1
2
3
4
5
0.000
0.002
0.004
0.006
0.008
0.010


RC_Integrator for Pulse width 0.1ms
Input
Output
V(volts)
Time(s)
0
1
2
3
4
5
0.000
0.001
0.002
0.003
0.004
0.005



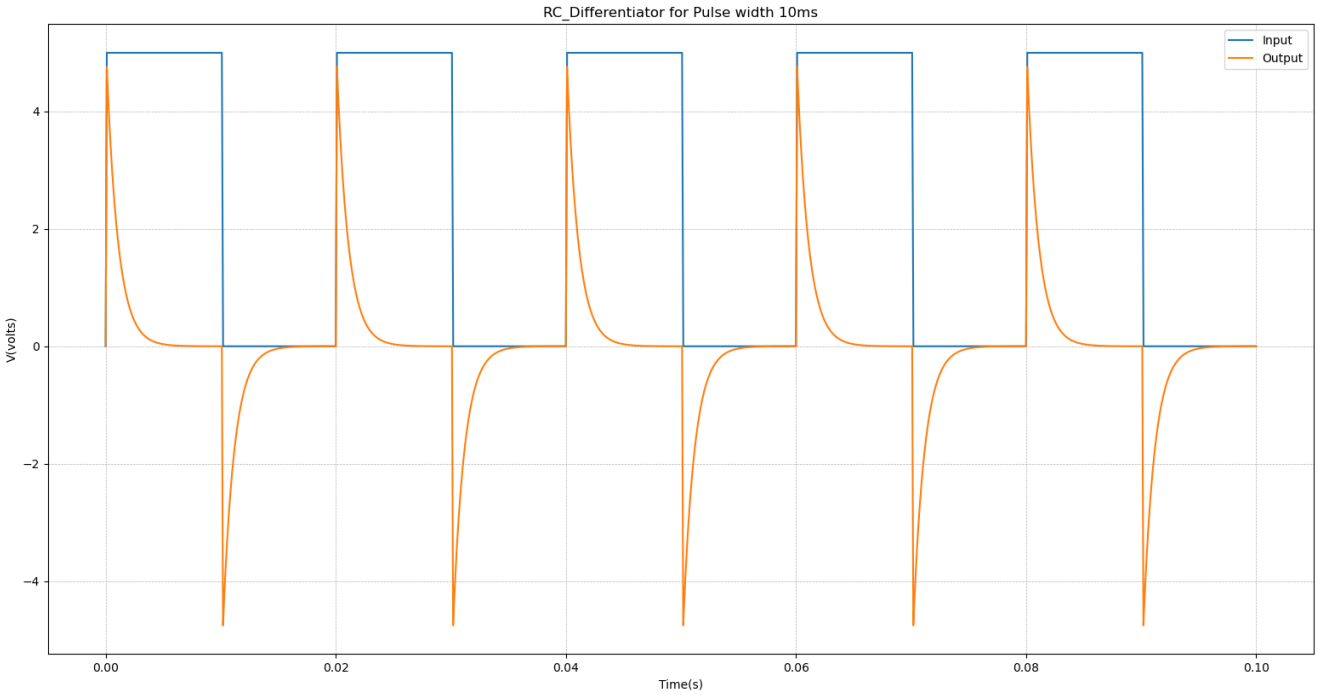
3.2 RC Differentiator

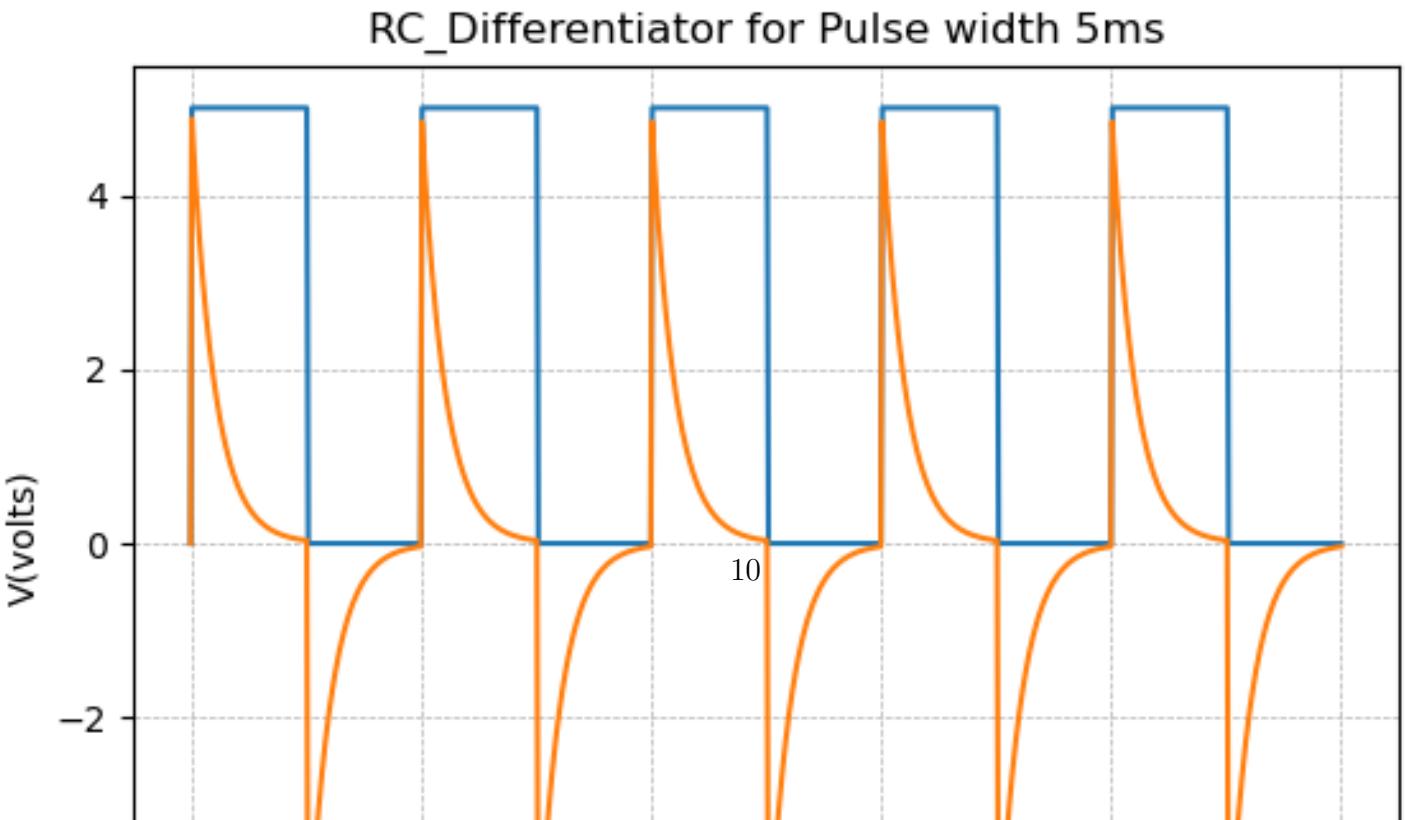
3.2.1 Code snippet

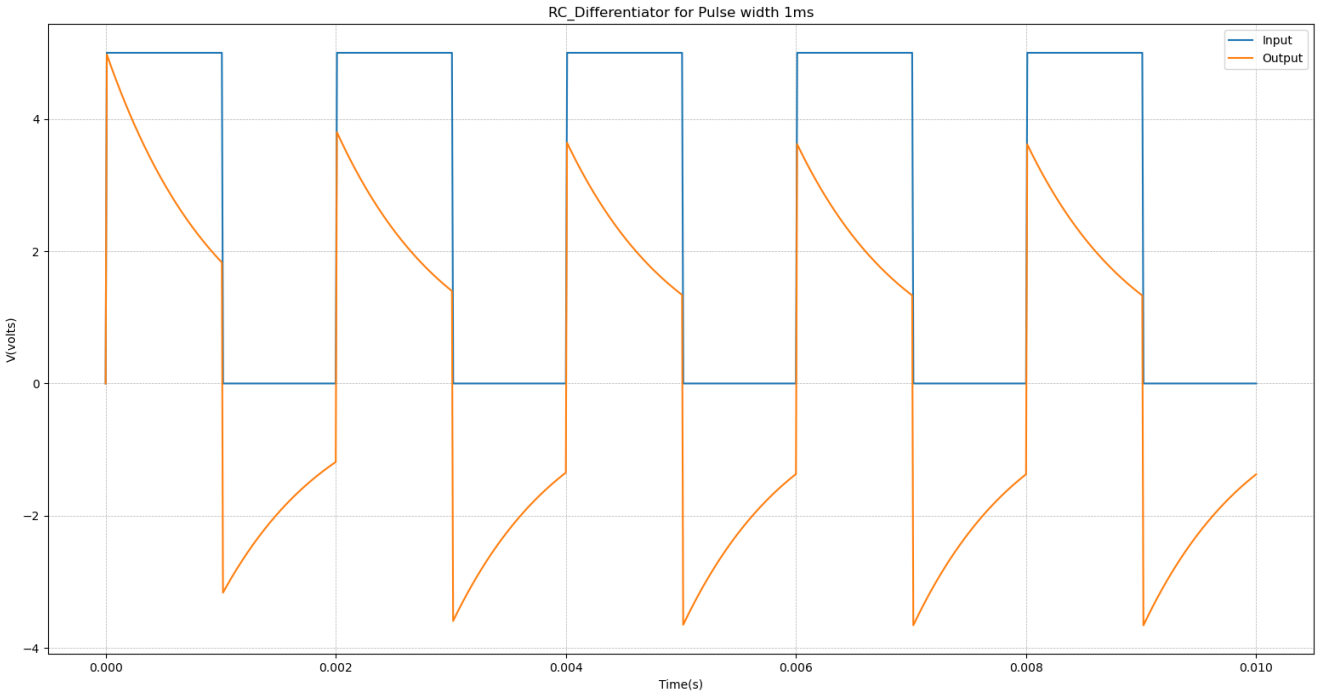
```
RC DIfferentiator circuit transient analysis
*tau =1m #Time Period

*describe circuit
* <element-name> <nodes> <value/nodel>
r 2 0 10k
c 1 2 0.1u
v 1 0 pulse(0 5 0 0 0 10m 20m) $10*tau
*v 1 0 pulse(0 5 0 0 0 10m 20m) $5*tau
*v 1 0 pulse(0 5 0 0 0 10m 20m) $1*tau
*v 1 0 pulse(0 5 0 0 0 10m 20m) $0.5*tau
*v 1 0 pulse(0 5 0 0 0 10m 20m) $0.1*tau
*v 1 0 pulse(0 5 0 0 0 10m 20m) $0.05*tau
*analysis command
```

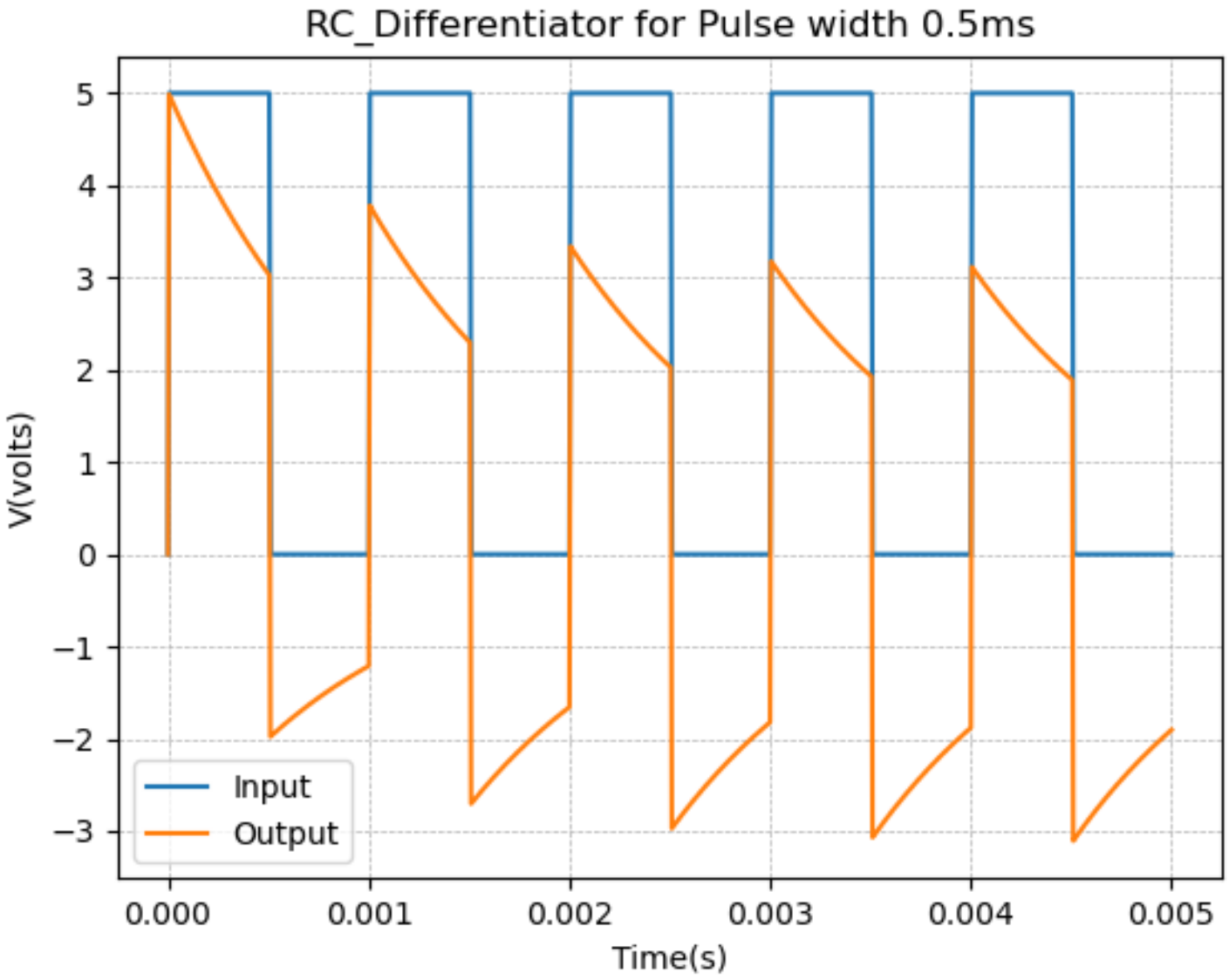
```
.tran 0.1m 100m

.control
run

*display cmd
plot v(2) v(1)
print v(1) v(2)
*end control mode
.endc

*end netlist
.end
```

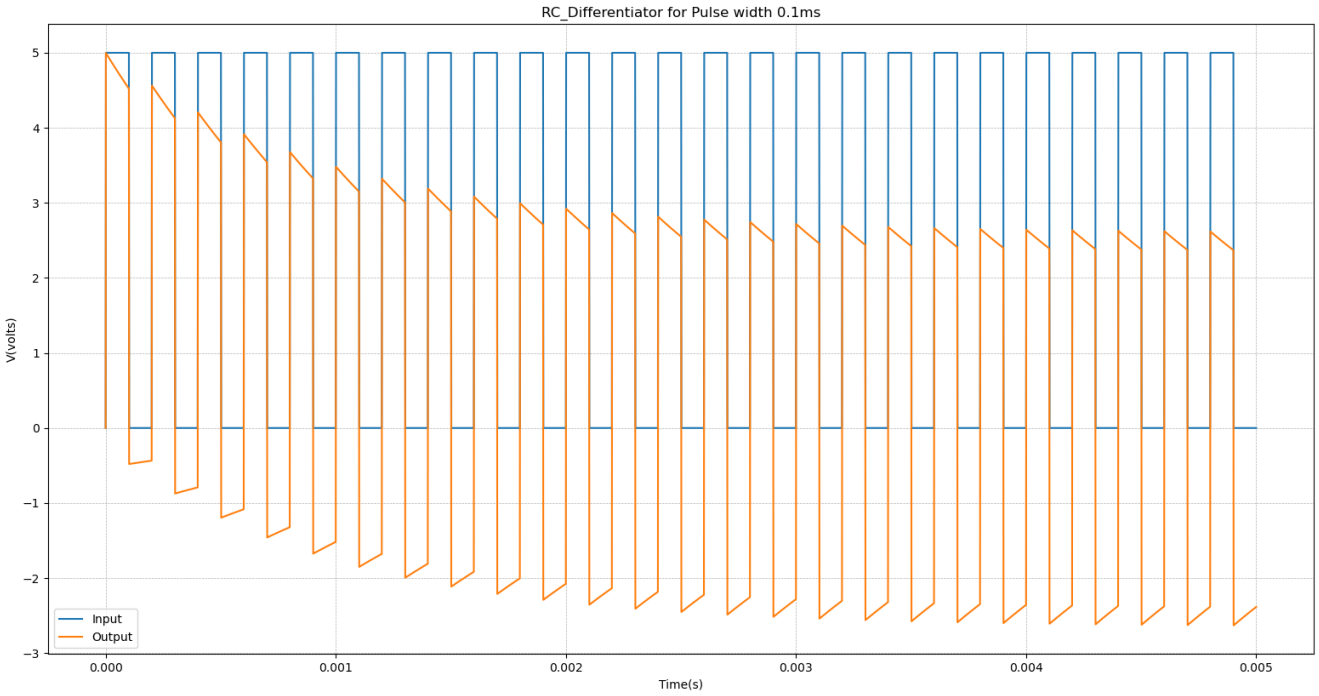
3.2.2 Simulation results

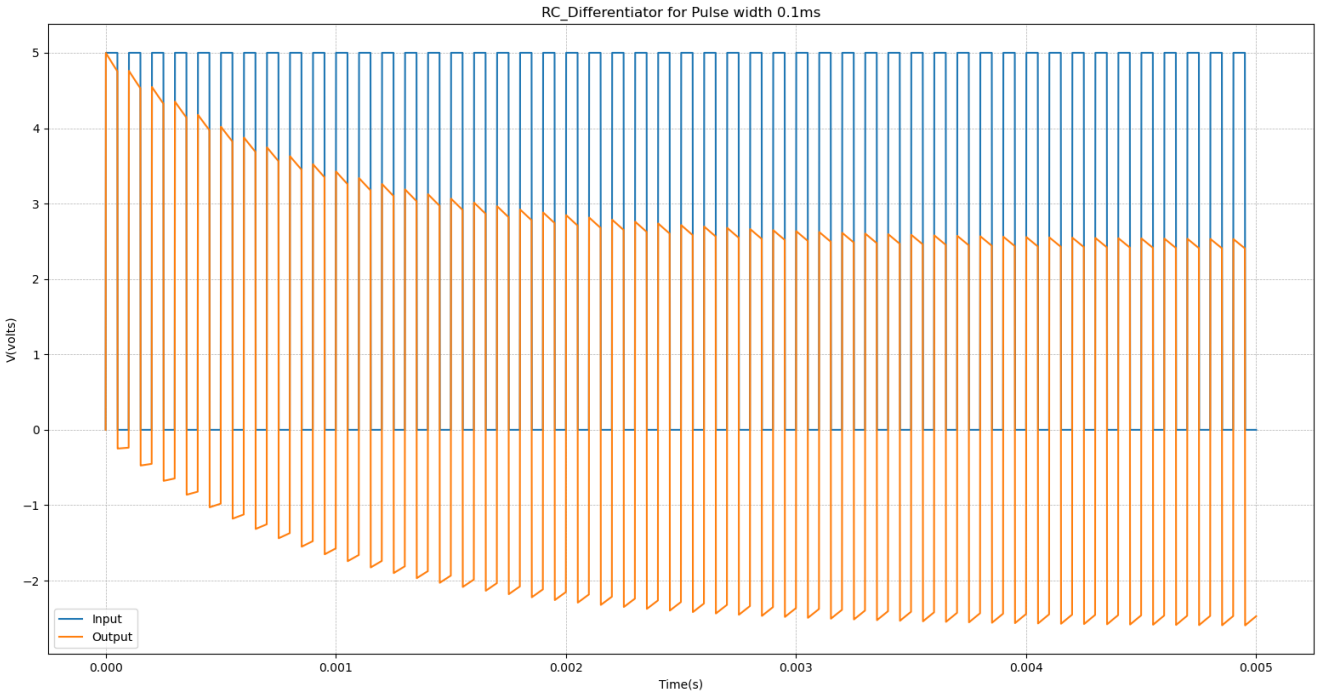





RC_Differentiator for Pulse width 1ms
Input
Output
V(volts)
4
2
0
−2
−4
0.000
0.002
0.004
0.006
0.008
0.010
Time(s)


RC_Differentiator for Pulse width 0.5ms
V(volts)
5
4
3
2
1
0
−1
−2
−3
0.000
0.001
0.002
0.003
0.004
0.005
Time(s)
Input
Output


RC_Differentiator for Pulse width 0.1ms
V(volts)
Time(s)
Input
Output
5
4
3
2
1
0
−1
−2
−3
0.000
0.001
0.002
0.003
0.004
0.005



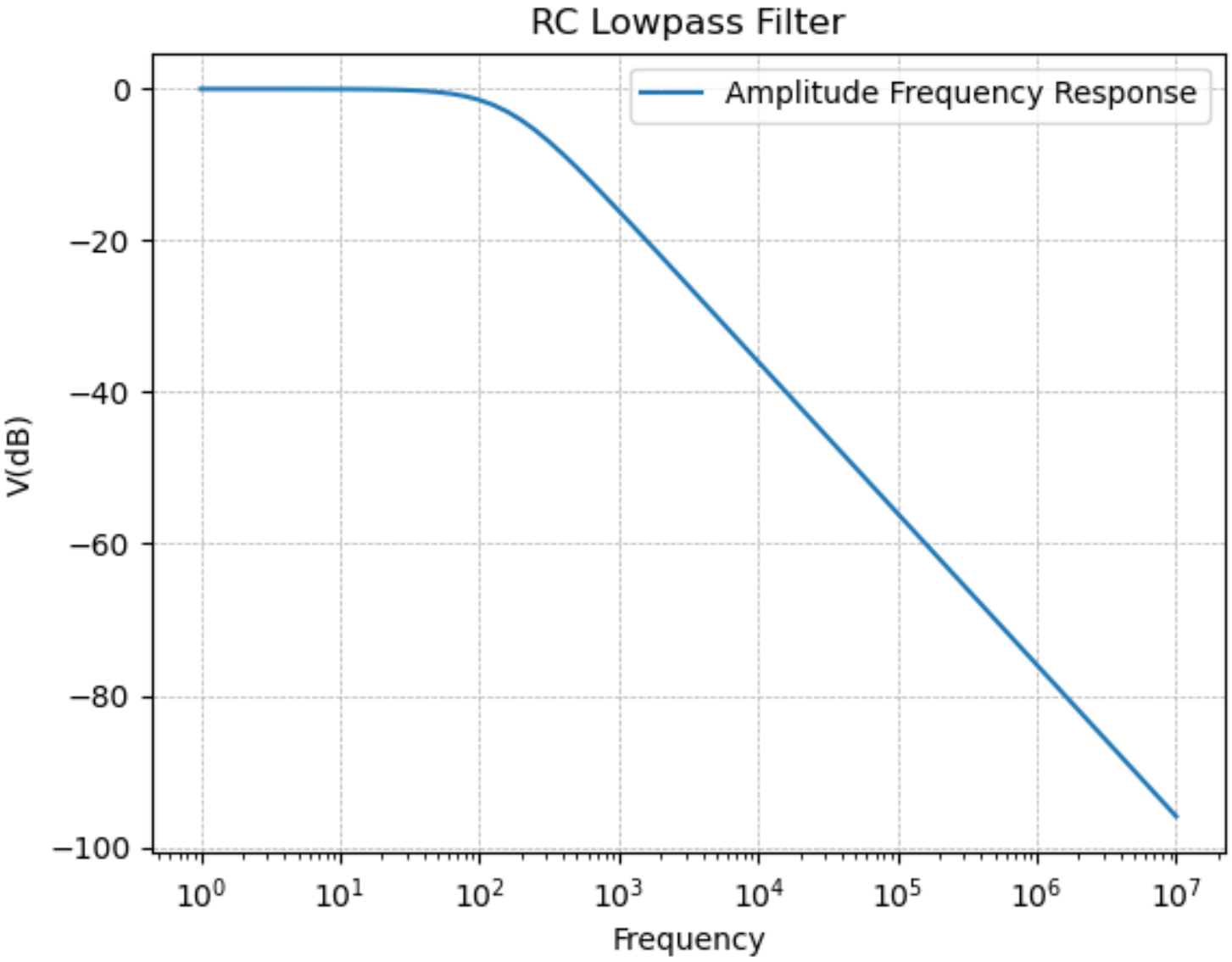
3.3 RC Lowpass Filter

3.3.1 Code snippet

```
RC Lowpass Filter

*describe circuit
* <element-name> <nodes> <value/nodel>
r 1 2 10k
c 2 0 0.1u
vin 1 0 dc 0 ac 1 $ac analysis
*analysis command
.ac dec 10 1 10Meg

.control
run

*display cmd
```

```
plot vdb(2)
print vdb(2)
*end control mode
.endc

*end netlist
.end
```

3.3.2 Simulation results

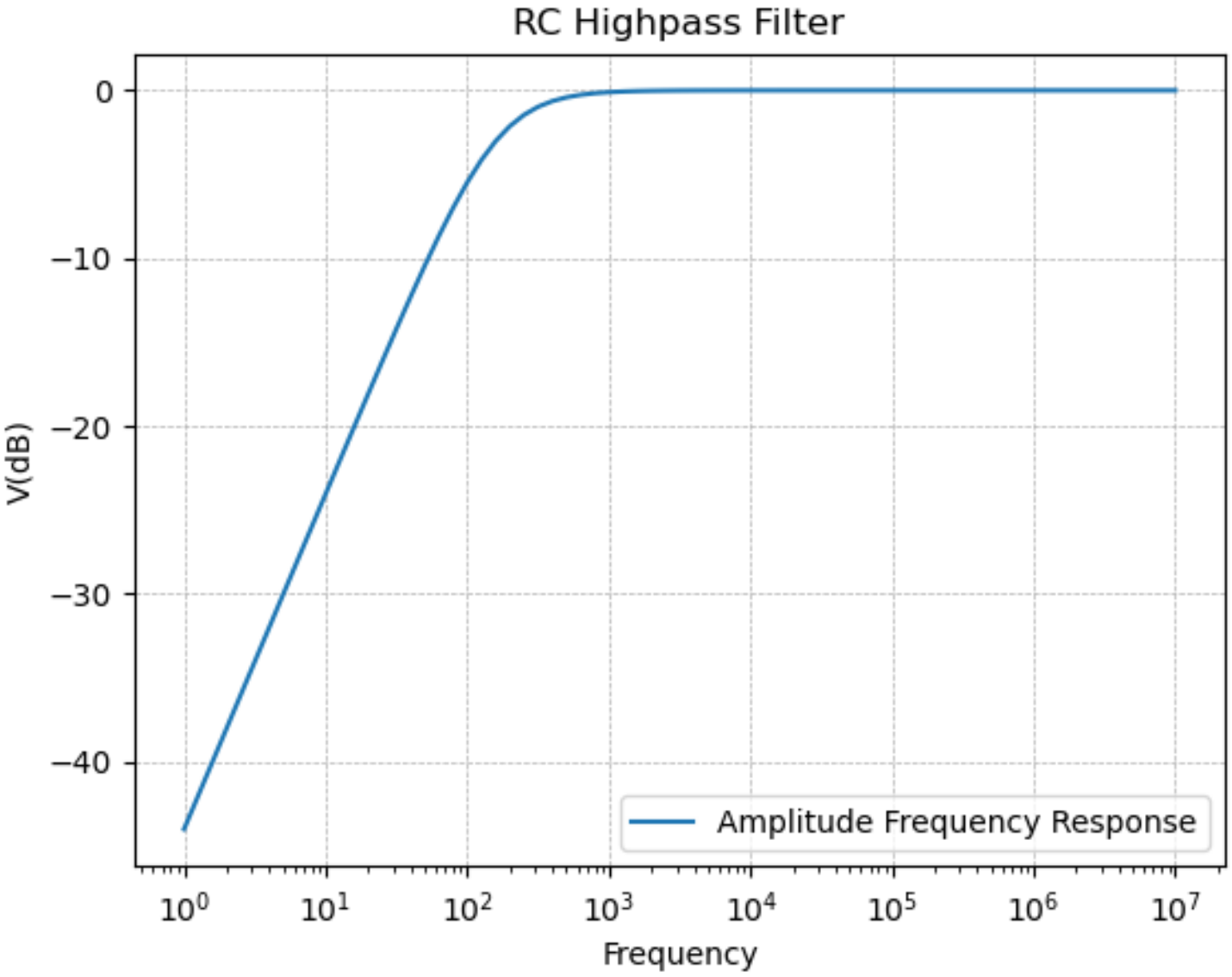


3.4 RC Highpass Filter

3.4.1 Code snippet

```
RC Highpass Filter
*describe circuit
* <element-name> <nodes> <value/nodel>
c 1 2 0.1u
r 2 0 10k
v 1 0 dc 0 ac 1 $ac analysis
*analysis command
.ac dec 10 1 10Meg

.control
run

*display cmd
plot vdb(2)
print vdb(2)
*end control mode
.endc

*end netlist
.end
```

3.4.2 Simulation results

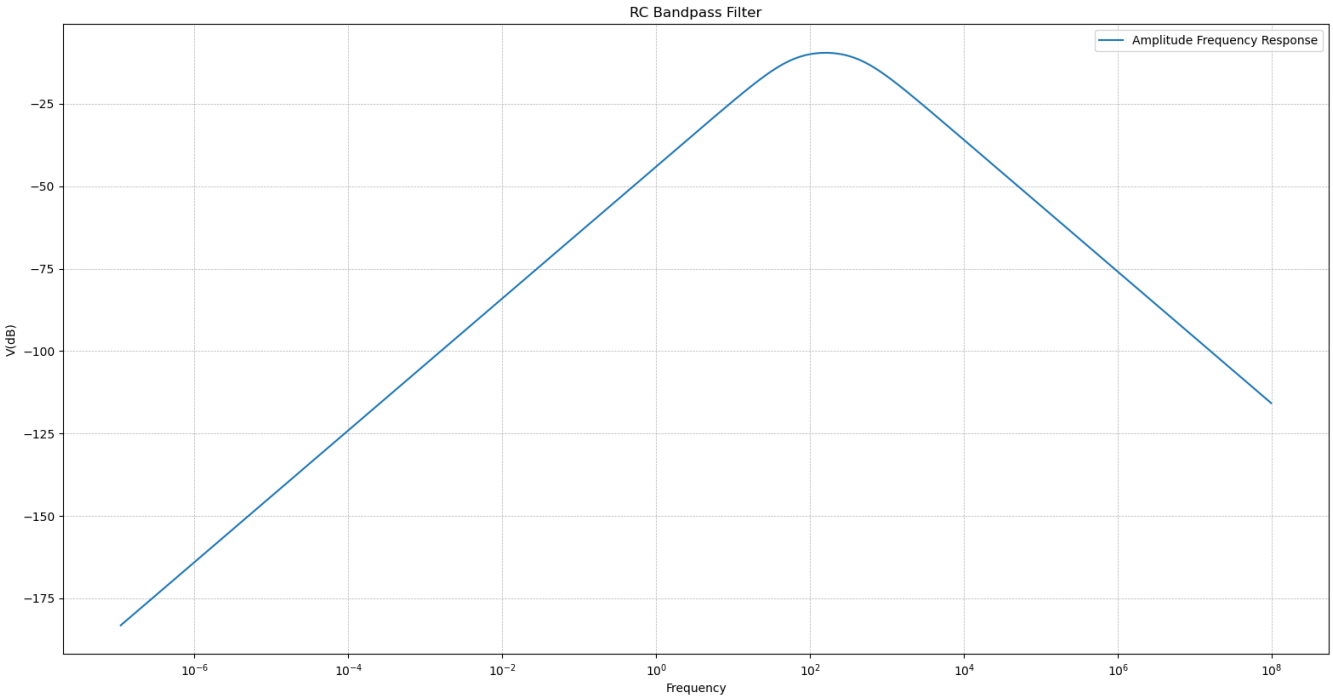


3.5 RC Bandpass Filter

3.5.1 Code snippet

```
RC Bandpass Filter
*describe circuit
* <element-name> <nodes> <value/nodel>
r1 1 2 10k
c1 2 3 0.1u
r2 3 0 10k
c2 3 0 0.1u
v 1 0 dc 0 ac 1 $ac analysis
*analysis command
.ac dec 20 0.1u 100Meg

.control
run

*display cmd
plot vdb(3)
*print vdb(3)
*end control mode
.endc

*end netlist
.end
```

3.5.2 Simulation results



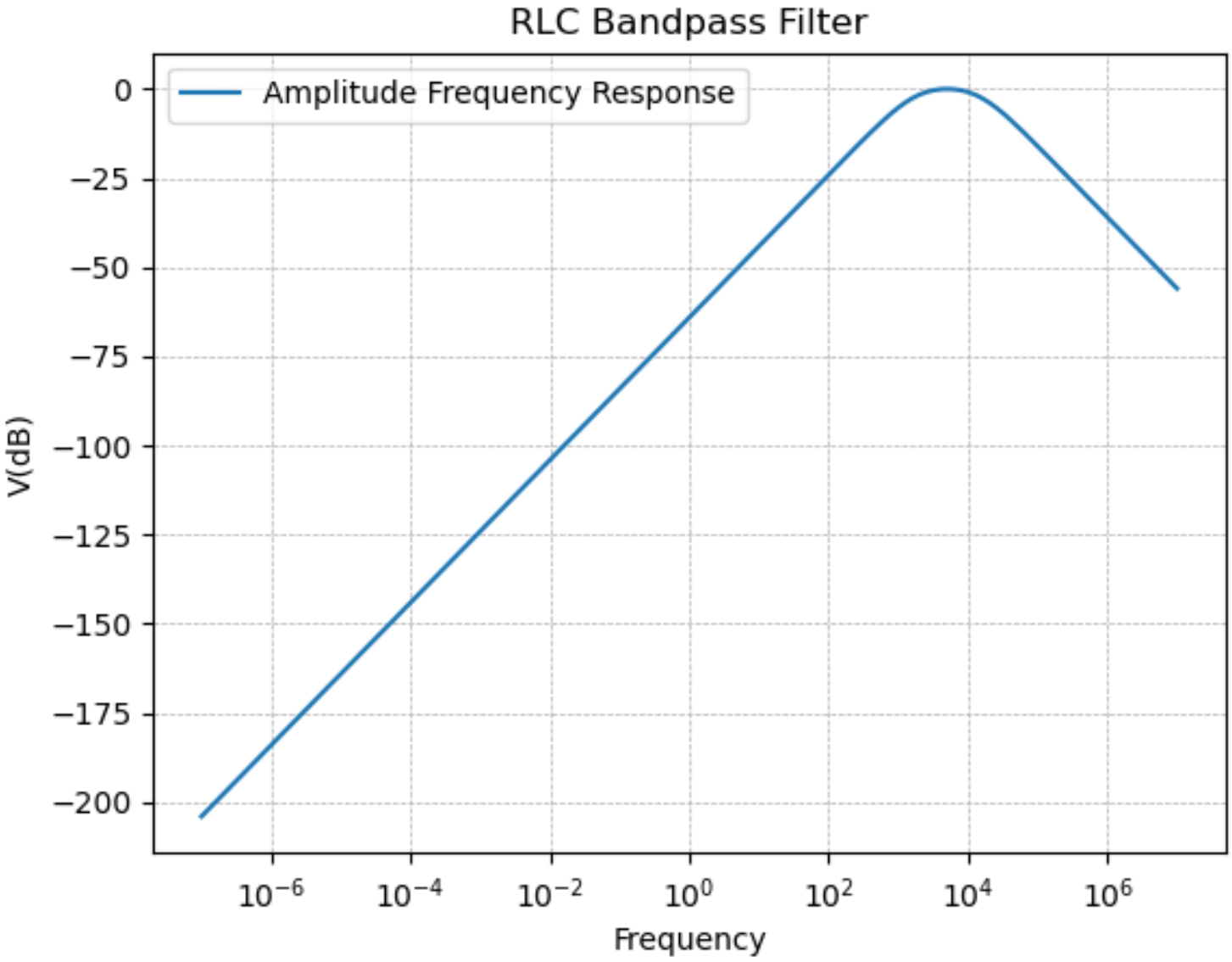
3.6 RLC Bandpass Filter

3.6.1 Code snippet

```
RLC Bandpass Filter
*describe circuit
* <element-name> <nodes> <value/nodel>
l 1 2 10m
c 2 3 0.1u
r 3 0 1k

v 1 0 dc 0 ac 1 $ac analysis
*analysis command
.ac dec 20 0.1u 100Meg

.control
```

```
run

*display cmd
plot vdb(3)
print vdb(3)
*end control mode
.endc

*end netlist
.end
```

3.6.2 Simulation results



4 Experimental results

4.1 RC Integrator

4.2 RC Differentiator

4.3 RC Lowpass Filter

4.4 RC Highpass Filter

4.5 RC Bandpass Filter

4.6 RLC Bandpass Filter

5 Experiment completion status

All the sections were completed