EE 230 Experiment - 1

NGSpice Familiarization

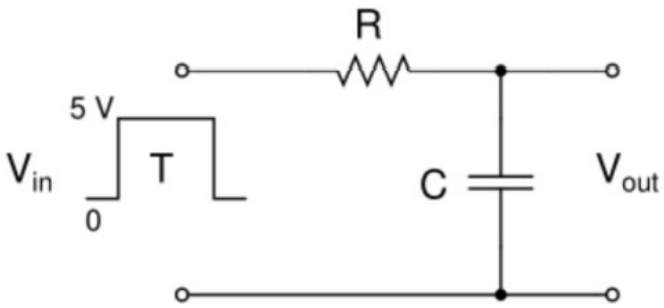
30th July, 2021

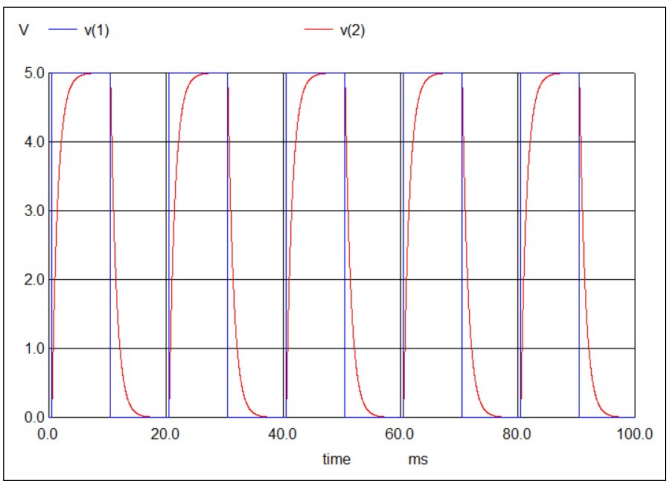
Vinamra Baghel 190010070

1 RC Integrator

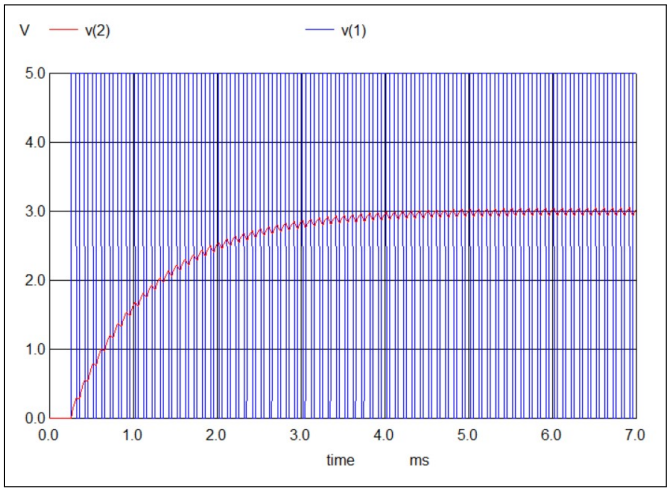
PartB1.cir:

```
B1. RC Integrator Vinamra Baghel 190010070
* <element-name> <nodes> <value/model>
r 1 2 10k
c 2 0 0.1u
v 1 0 pulse(0 5 0.25m 0 0 0.05m 0.1m)
*analysis command
.tran 10u 7m
.control
run
plot v(2) v(1)
.endc
.end
```





(a) $T = 10\tau$



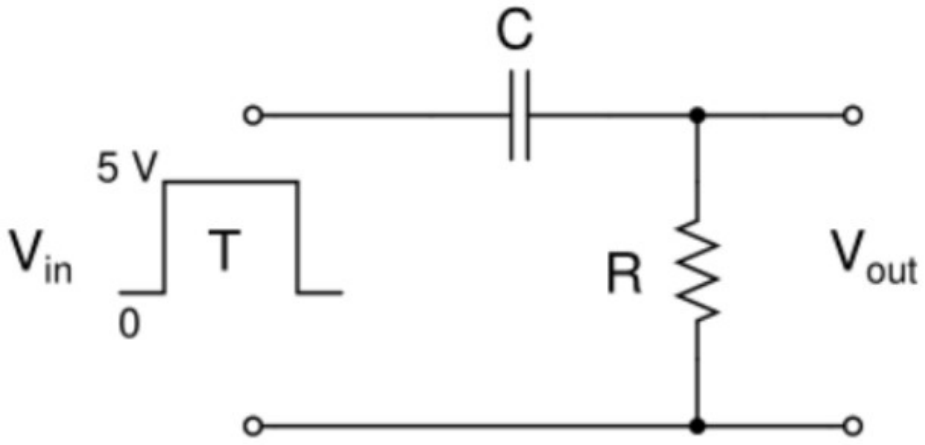
(b) $T = 0.05\tau$

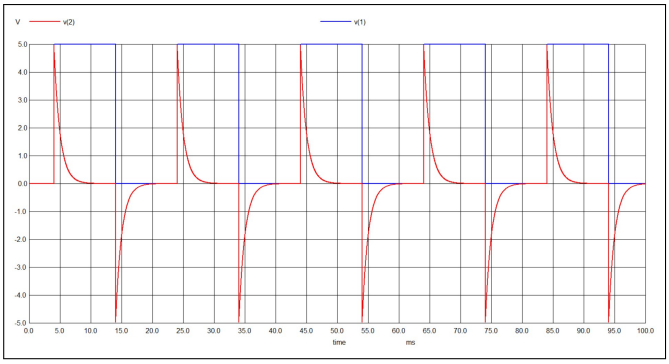
Figure 1: RC Integrator

2 RC Differentiator

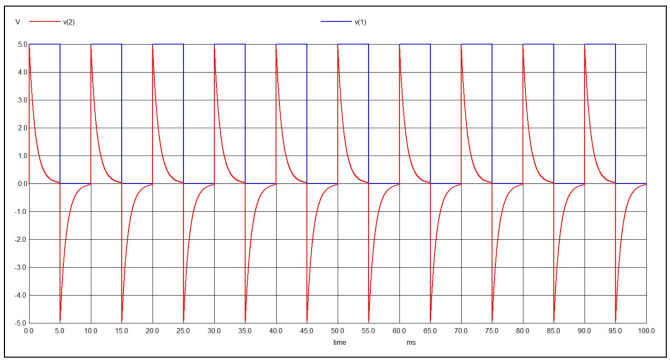
PartB2.cir:

```
B2. RC Differentiator Vinamra Baghel 190010070
* <element-name> <nodes> <value/model>
r 2 0 10k
c 1 2 0.1u
v 1 0 pulse(0 5 4m 0 0 10m 20m)
*analysis command
.tran 10u 40m
.control
run
plot v(2) v(1)
.endc
.end
```





(a) $T = 10\tau$



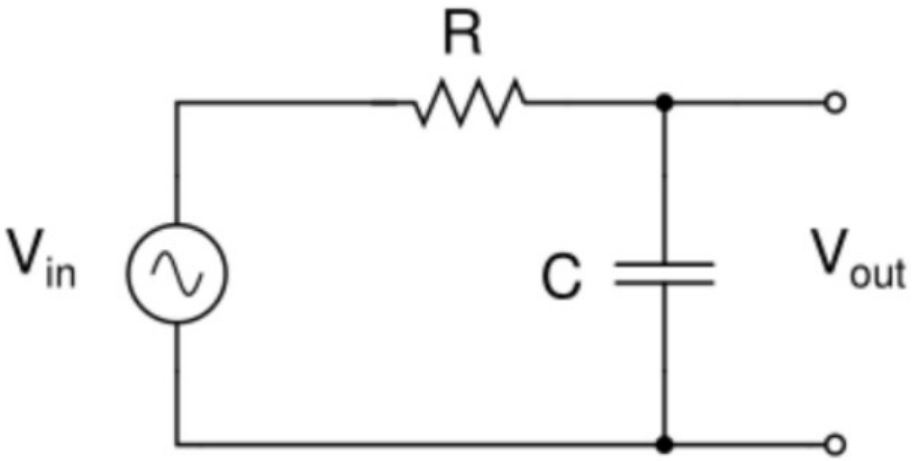
(b) $T = 5\tau$

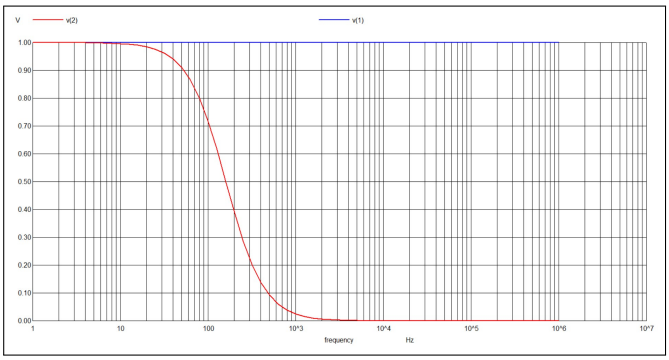
Figure 2: RC Differentiator

3 RC Lowpass Filter

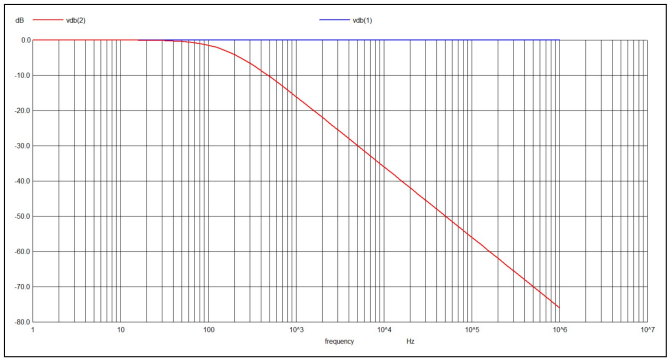
PartB3.cir:

```
B3. RC Lowpass Filter Vinamra Baghel 190010070
* <element-name> <nodes> <value/model>
r 1 2 10k
c 2 0 0.1u
vin 1 0 dc 0 ac 1
*analysis command
.ac dec 10 1 1Meg
.control
run
set color0 = white
set color1 = black
set color2 = red
set color3 = blue
set xbrushwidth = 2
plot vdb(2) vdb(1)
.endc
.end
```





(a) Linear Scale



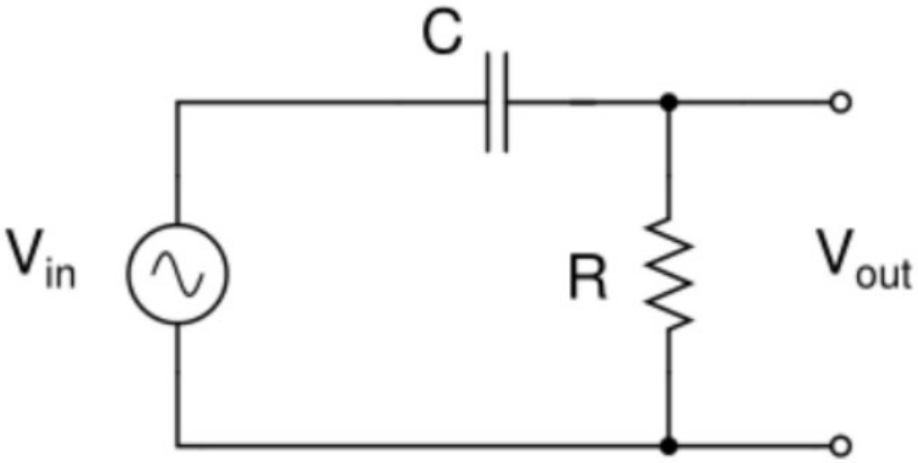
(b) Decibel Scale

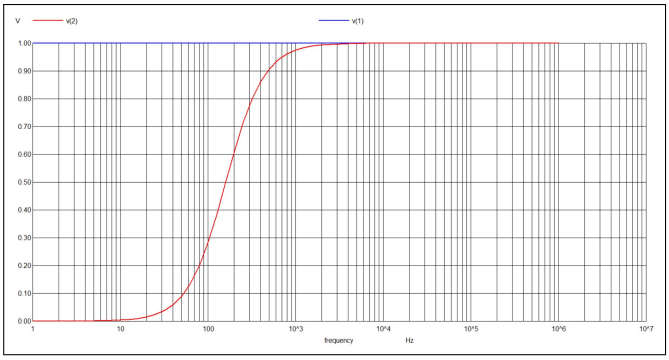
Figure 3: RC Lowpass

4 RC Highpass Filter

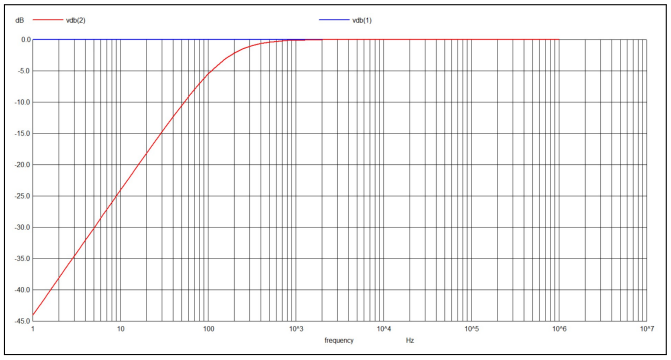
PartB4.cir:

```
B4. RC Highpass Filter Vinamra Baghel 190010070
* <element-name> <nodes> <value/model>
r 2 0 10k
c 1 2 0.1u
vin 1 0 dc 0 ac 1
*analysis command
.ac dec 10 1 1Meg
.control
run
set color0 = white
set color1 = black
set color2 = red
set color3 = blue
set xbrushwidth = 2
plot vdb(2) vdb(1)
.endc
.end
```





(a) Linear Scale



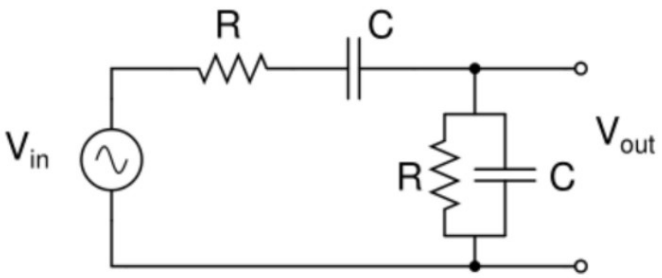
(b) Decibel Scale

Figure 4: RC Highpass

5 RC Bandpass Filter

PartB5.cir:

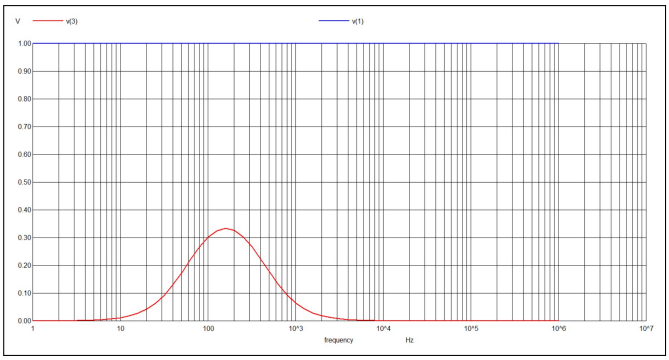
```
B5. RC Bandpass Filter Vinamra Baghel 190010070
* <element-name> <nodes> <value/model>
r 1 2 10k
c 2 3 0.1u
r 3 0 10k
c 3 0 0.1u
vin 1 0 dc 0 ac 1
*analysis command
.ac dec 10 1 1Meg
.control
run
plot vdb(3) vdb(1)
meas ac peak MAX vmag(3)
meas ac fpeak WHEN vmag(3) = peak
let f3db = peak/sqrt(2)
meas ac f1 WHEN vmag(3)=f3db RISE=1
meas ac f2 WHEN vmag(3)=f3db FALL=1
.endc
.end
```



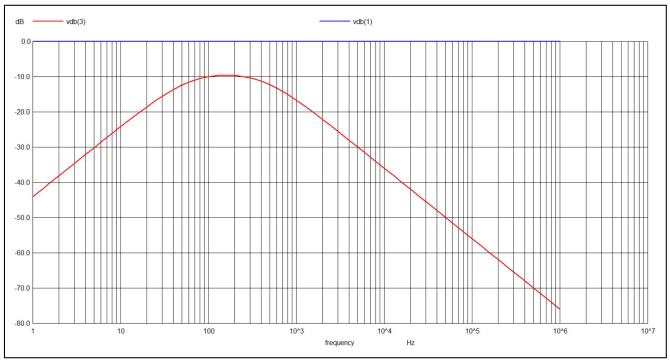
Transfer function = $\frac{1000s}{s^2+3000s+10^6}$. Comparing with $\frac{a_1 s}{s^2+\frac{\omega}{Q}s+\omega}$,

upper and lower -3dB frequencies: ω_1, $\omega_2 = \omega_0\sqrt{1+\frac{1}{4Q^2}} \pm \frac{\omega_0}{2Q}$, and center-frequency gain = $\frac{a_1 Q}{\omega_0}$

Theoretically: Center frequency, f_0 = 159.16 Hz; Lower frequency, f_L = 47.74 Hz; and Upper frequency, f_H = 525.51 Hz
From Simulation: Center frequency, f_0 = 1.584891e+02 Hz; Lower frequency, f_L = 4.838534e+01 Hz; and Upper frequency, f_H = 5.276607e+02 Hz



(a) Linear Scale



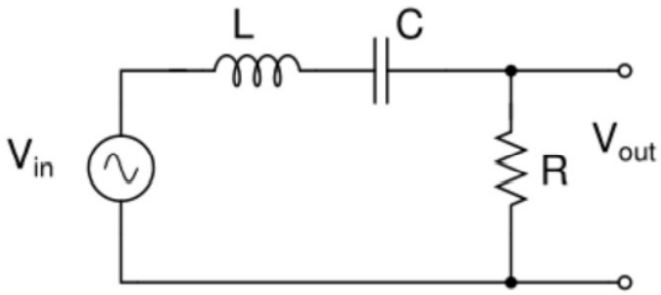
(b) Decibel Scale

Figure 5: RC Bandpass

6 RLC Bandpass Filter

PartB6.cir:

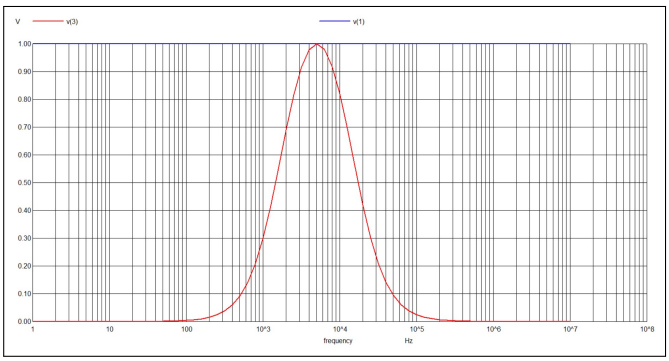
```
B6. RLC Bandpass Filter Vinamra Baghel 190010070
* <element-name> <nodes> <value/model>
l 1 2 10m
c 2 3 0.1u
r 3 0 1k
vin 1 0 dc 0 ac 1
*analysis command
.ac dec 10 1 10Meg
.control
run
plot vdb(3) vdb(1)
meas ac peak MAX vmag(3)
meas ac fpeak WHEN vmag(3) = peak
let f3db = peak/sqrt(2)
meas ac f1 WHEN vmag(3)=f3db RISE=1
meas ac f2 WHEN vmag(3)=f3db FALL=1
.endc
.end
```



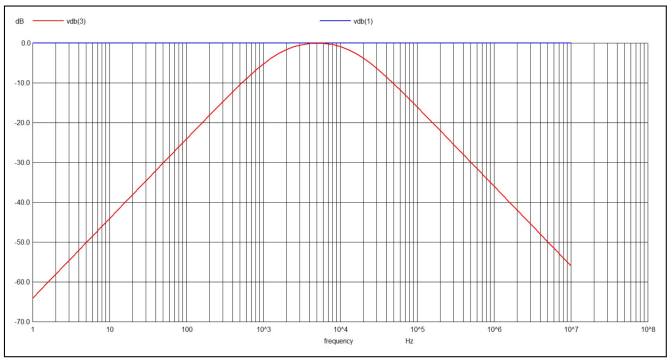
Transfer function $= \frac{1000s}{s^2+3000s+10^6}$. Comparing with $\frac{a_1 s}{s^2+\frac{\omega}{Q}s+\omega}$,

upper and lower -3dB frequencies: ω_1, $\omega_2 = \omega_0\sqrt{1+\frac{1}{4Q^2}} \pm \frac{\omega_0}{2Q}$, and center-frequency gain $= \frac{a_1 Q}{\omega_0}$

Theoretically: Center frequency, $f_0 = 174605.15$ Hz; Lower frequency, $f_L = 1475.98$ Hz; and Upper frequency, $f_H = 17460.64$ Hz
From Simulation: Center frequency, $f_0 = 1.74611e{+}05$ Hz; Lower frequency, $f_L = 1.468642e{+}03$ Hz; and Upper frequency, $f_H = 1.745991e{+}04$ Hz



(a) Linear Scale



(b) Decibel Scale

Figure 6: RLC Bandpass

Learnings from the experiment

- Circuit simulations using NGSpice Software
- Introduction of Lab Equipments
- XCircuit Software for Circuit Drawing
- Various RC and RLC Filter Circuits

Challenges faced

- Unfamilarities with NGSpice Syntax
- Calculation of Center, Upper and Lower -3dB Frequencies

Questions or clarifications: None

Files associated: https://github.com/VNMR-35/EE-230-Lab