LAPORAN PRAKTIKUM
SISTEM INSTRUMENTASI ELEKTRONIKA
MODUL IV

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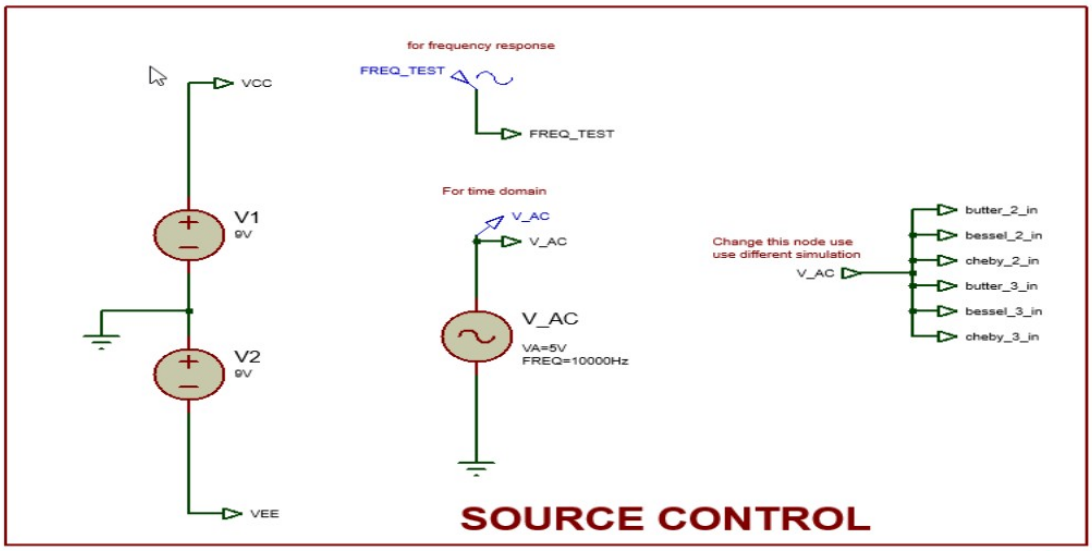
Hari & jam Prakt.: Rabu, 8 September 2021

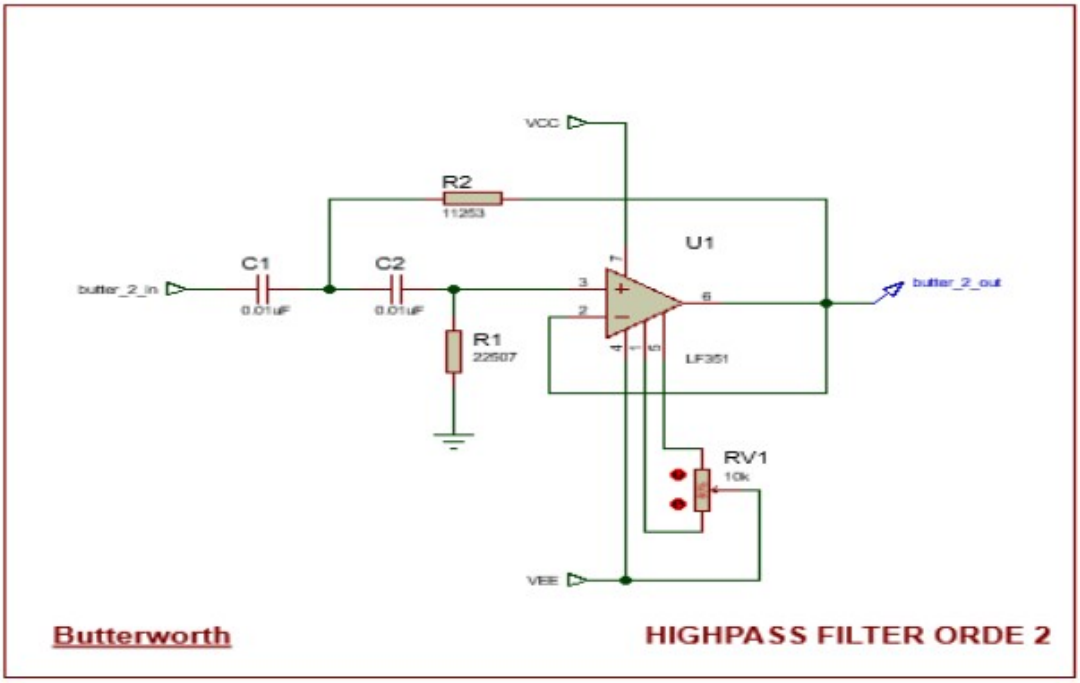
Dosen / Asisten: Lanny Augustine **Paraf:**

<u>Tugas awal (jawaban diletakkan di Lampiran II):</u>
Jika amplitudo input adalah 5Vpeak, hitunglah Amplitudo output pada Gain -3dB, -40dB, -60dB!

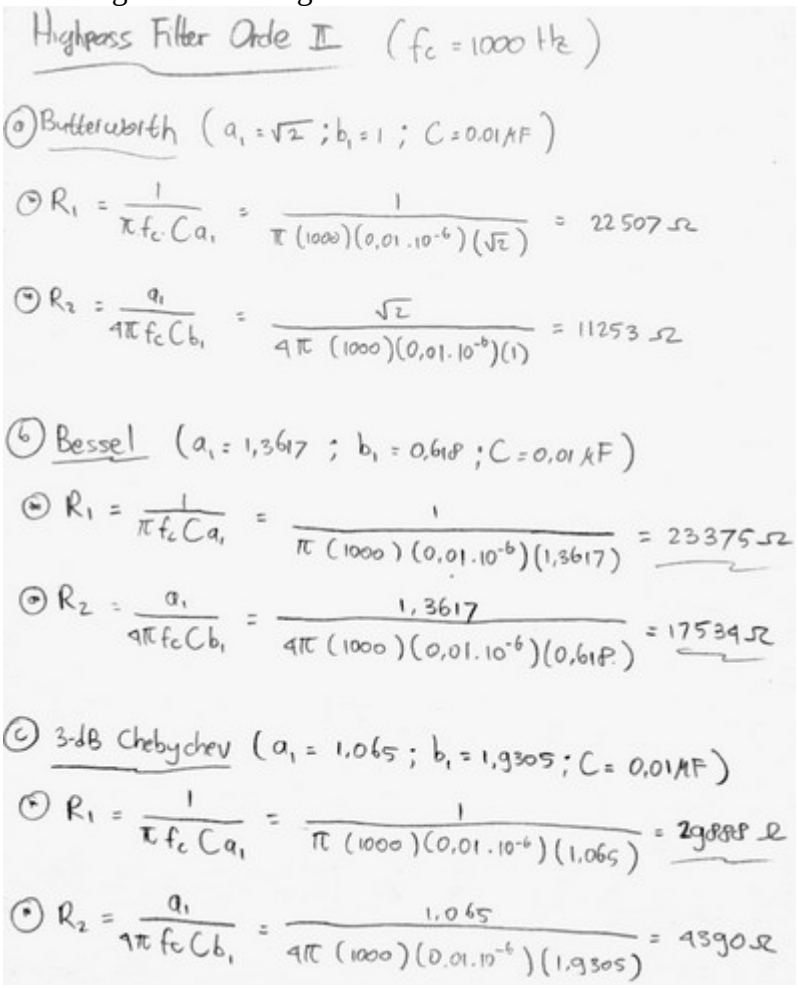
A. *Highpass Filter* Orde 2

Screenshoot rangkaian (3 rangkaian filter identik, hanya berbeda nilai komponen)





Perhitungan desain rangkaian:



Hasil percobaan:

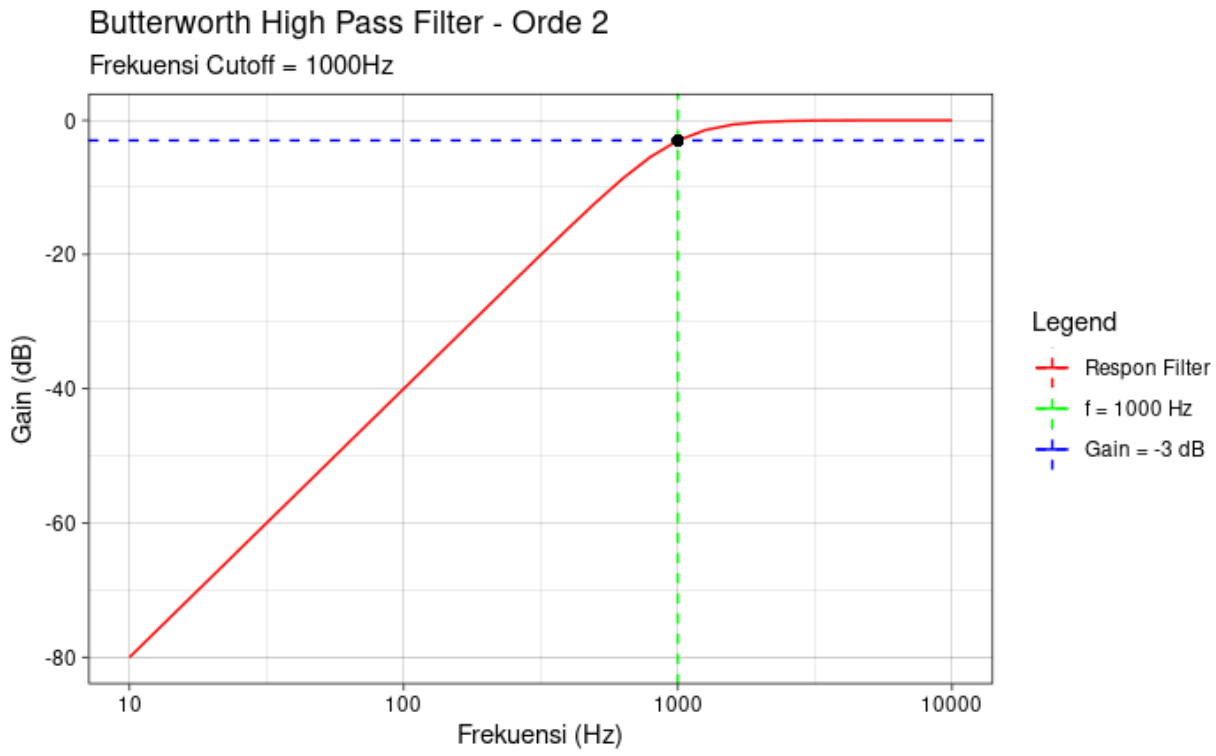
Vcc = 9 volt; f_{cutoff} = 1000 Hz; C1 = C2 = C = 0,01µF

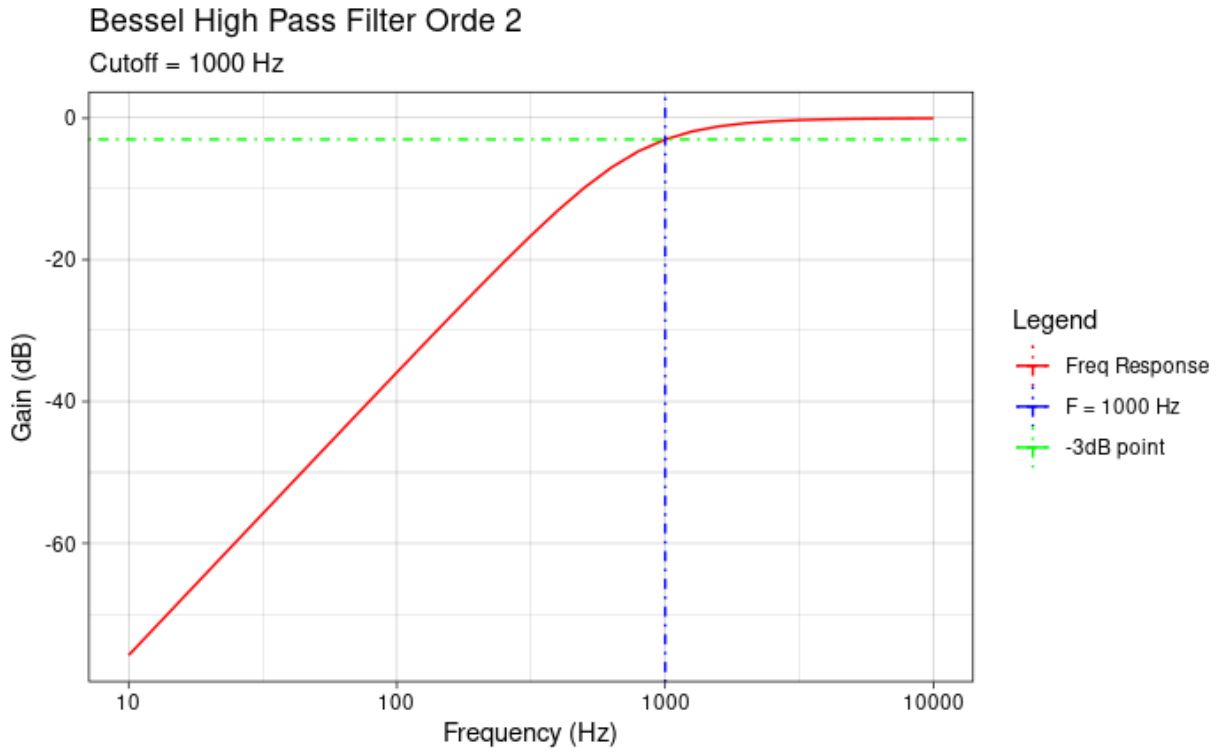
Tabel 4.1

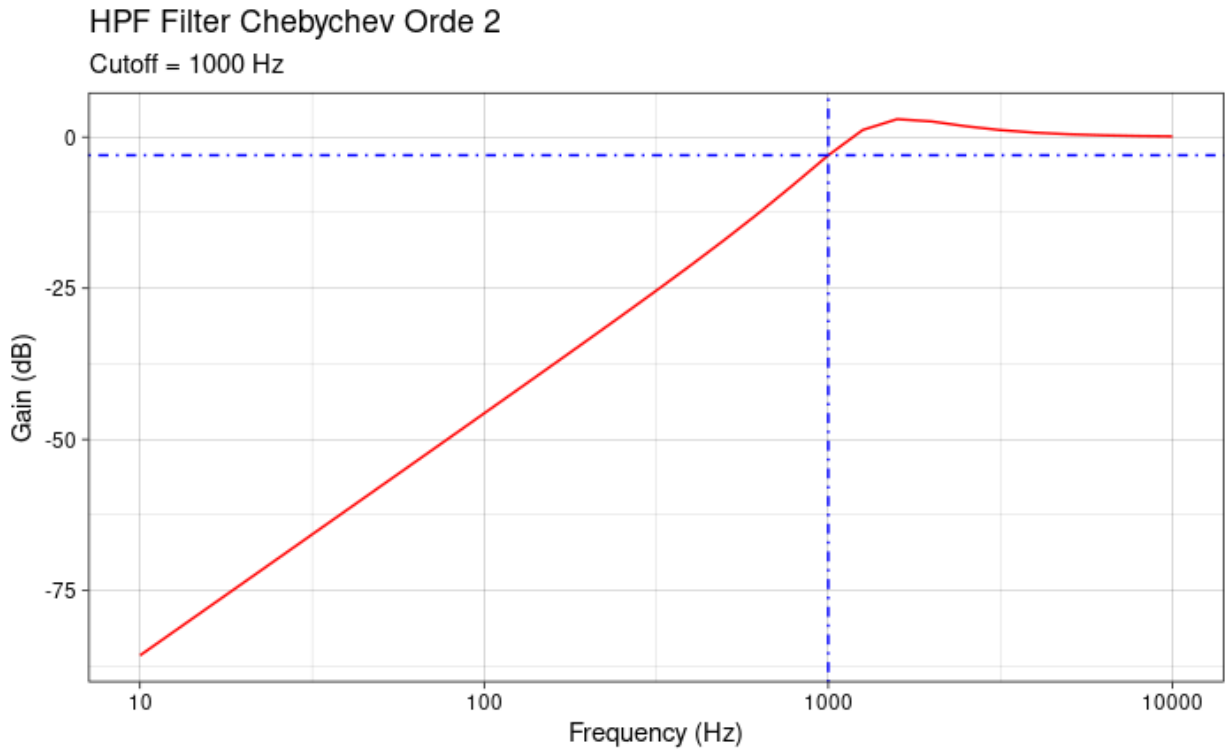
Vin (Vpeak)	Fin (Hz)	Fout (Hz)	Vout (Vpeak)		
			Butterworth R_1= 22507 Ω R_2= 11253 Ω	**Bessel** R_1= 23375 Ω R_2= 17534 Ω	**Chebychev** R_1= 29888 Ω R_2= 4390 Ω
5 V	10	10	-0.00449706	-0.00418491	-0.00474113
	100	100	0.0463392	0.772873	0.0217318
	1000	1000	3.55269	3.55056	3.65289
	10000	10000	5.01627	4.99587	5.06595

Catatan: Sama seperti modul 3, saya akan export hasil simulasi dahulu agar gambar sinyalnya lebih baik. Plotting dilakukan dengan Python & R, untuk dokumen source plot & file hasil export akan disertakan di google drive: https://drive.google.com/drive/folders/1VPh25QU0d0TTBIjMc40O82AMlhxL1AsK?usp=sharing

- Grafik respon frekuensi terhadap gain dalam skala logaritmik (diagram Bode) HPF orde 2:







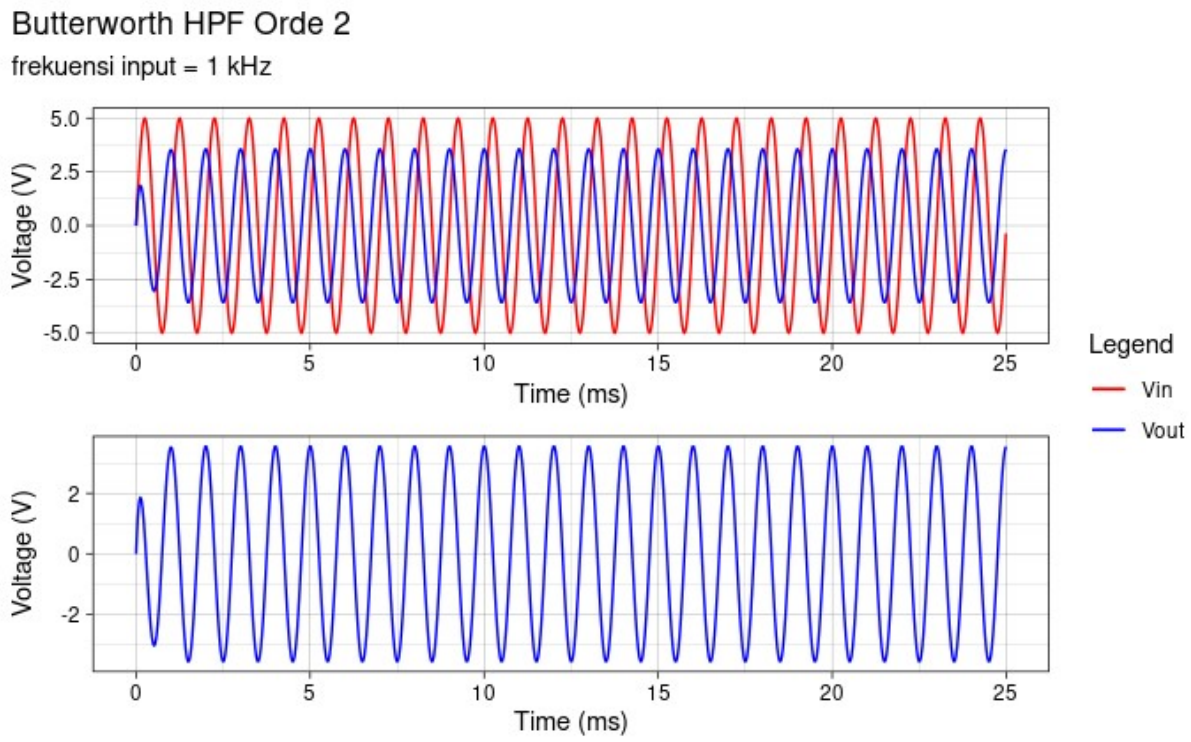
- Puncak *ripple* HPF Chebychev pada frekuensi input = 1584.893 Hz, amplitudo output HPF:

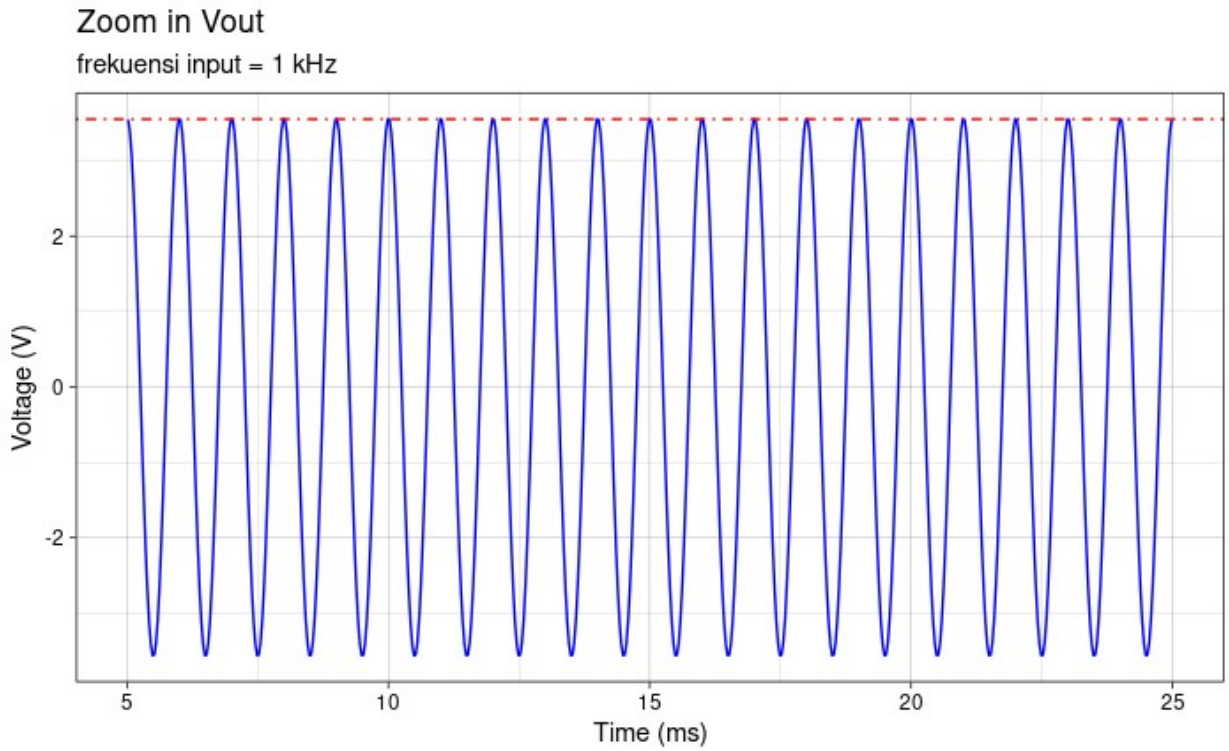
  $Gain = 2.96181\,dB = 1.406340552\ \ kali$

  $V_{out} = 5 * 1.406340552 = 7.031702762\ \ V$

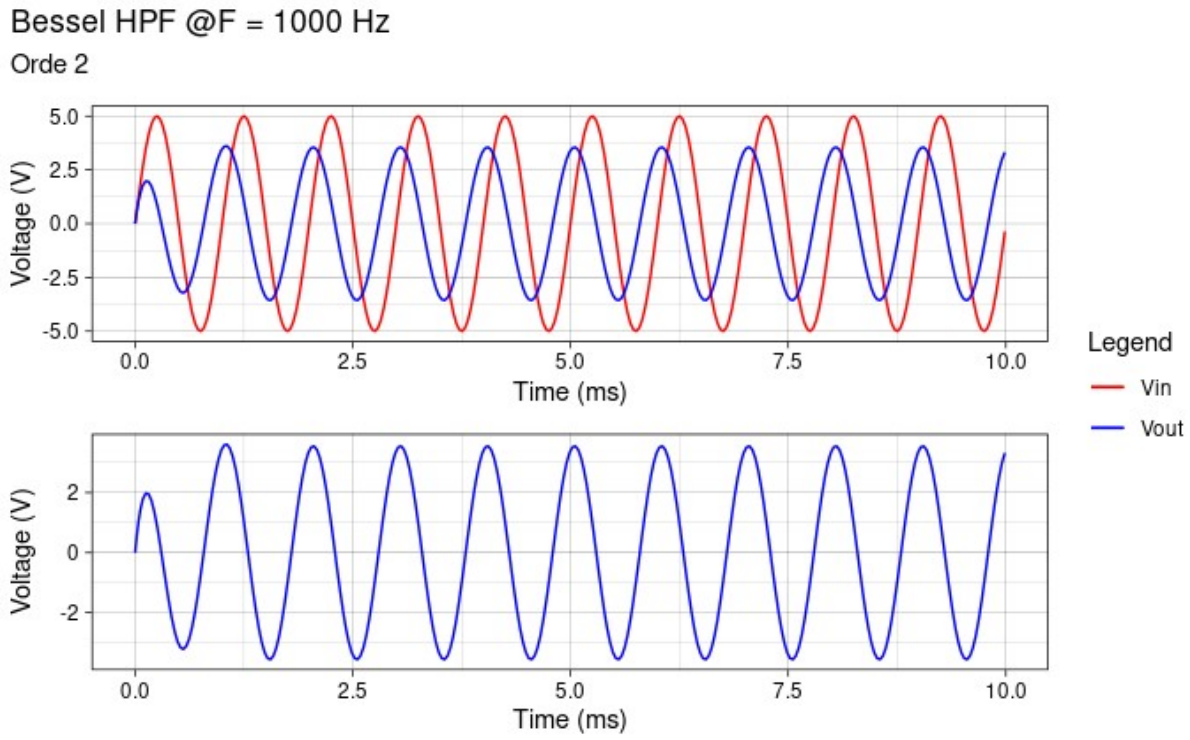
- Gambarkan bentuk gelombang input dan output (time domain) HPF saat frekuensi cutoff :

  Butterworth



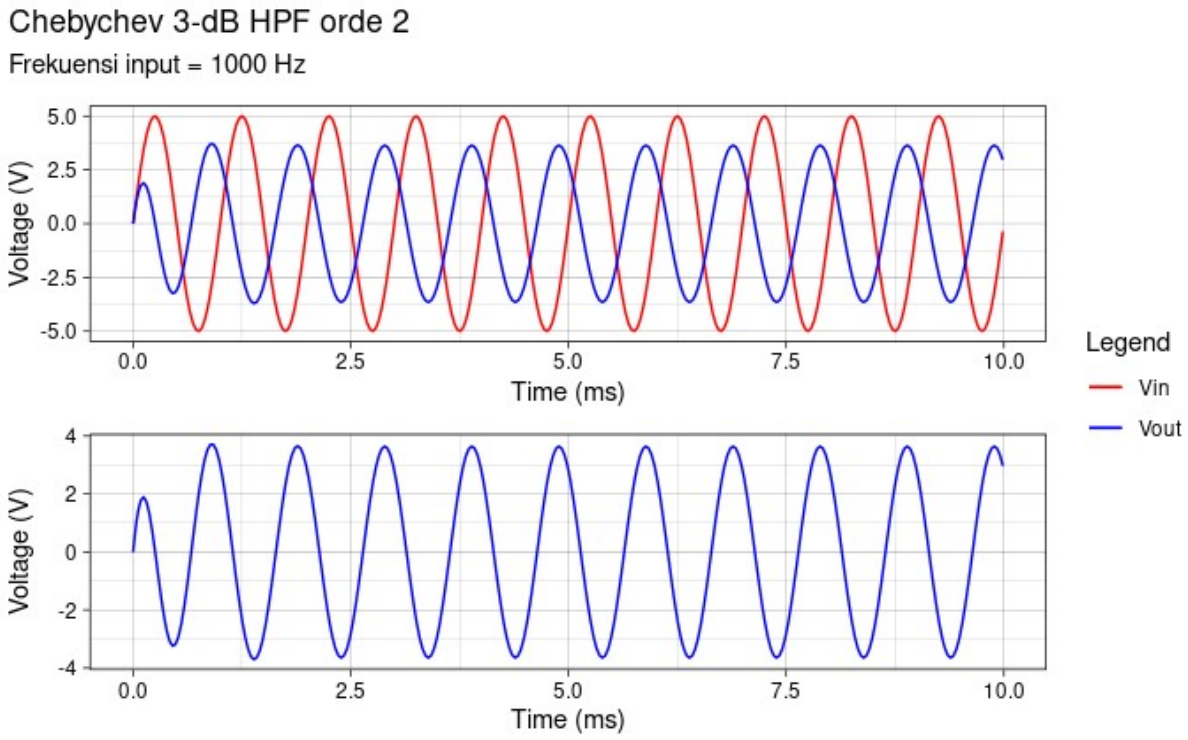

Zoom in Vout
frekuensi input = 1 kHz
Voltage (V)
2
0
-2
5
10
15
20
25
Time (ms)

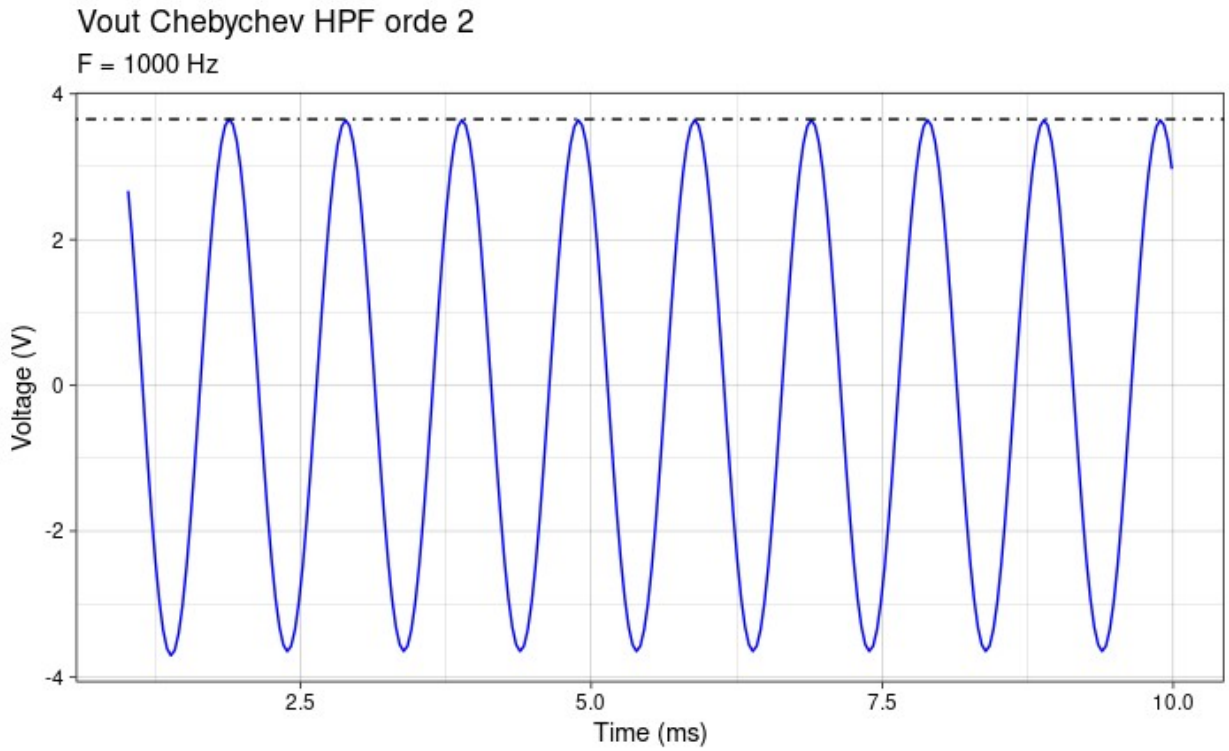
Bessel


Bessel HPF @F = 1000 Hz
Orde 2
Voltage (V)
5.0
2.5
0.0
-2.5
-5.0
0.0
2.5
5.0
7.5
10.0
Time (ms)
Legend
Vin
Vout
Voltage (V)
2
0
-2
0.0
2.5
5.0
7.5
10.0
Time (ms)


Zoom In Vout Bessel HPF Orde 2
F = 1000 Hz
Voltage (V)
2
0
-2
4
6
8
10
Time (ms)

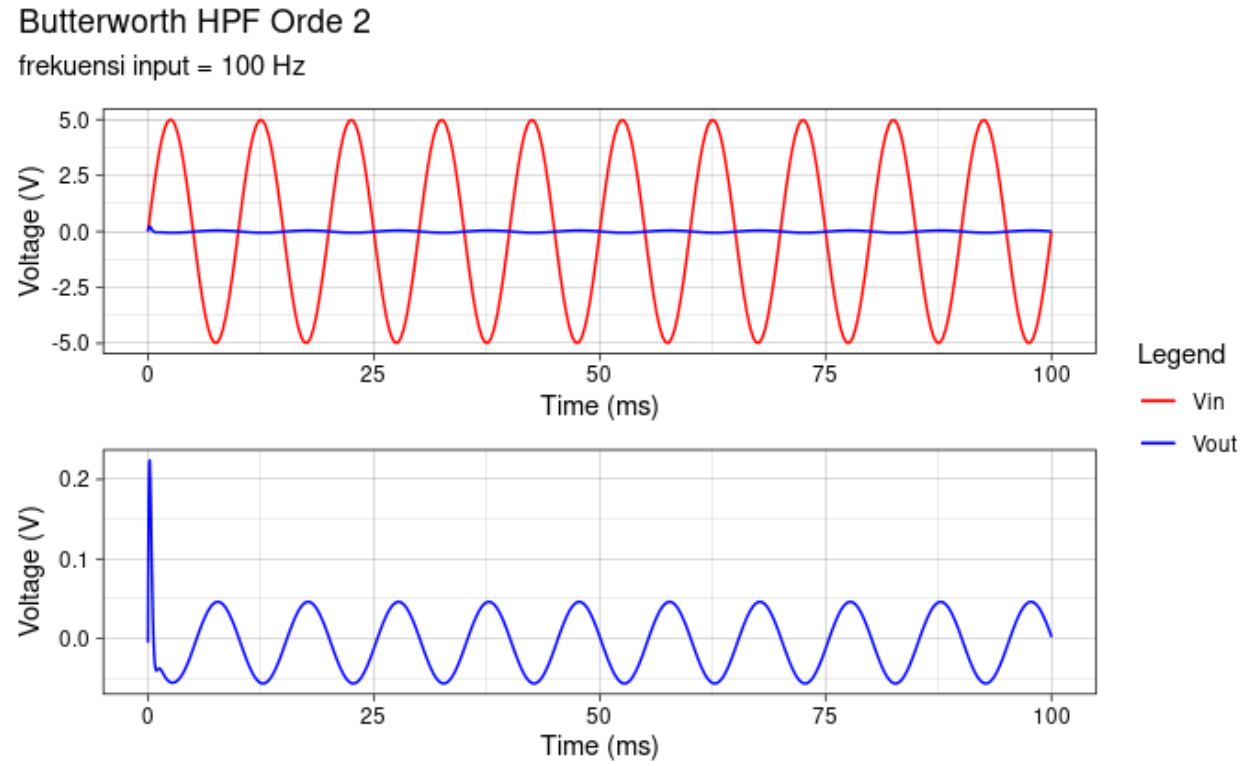
Chebychev

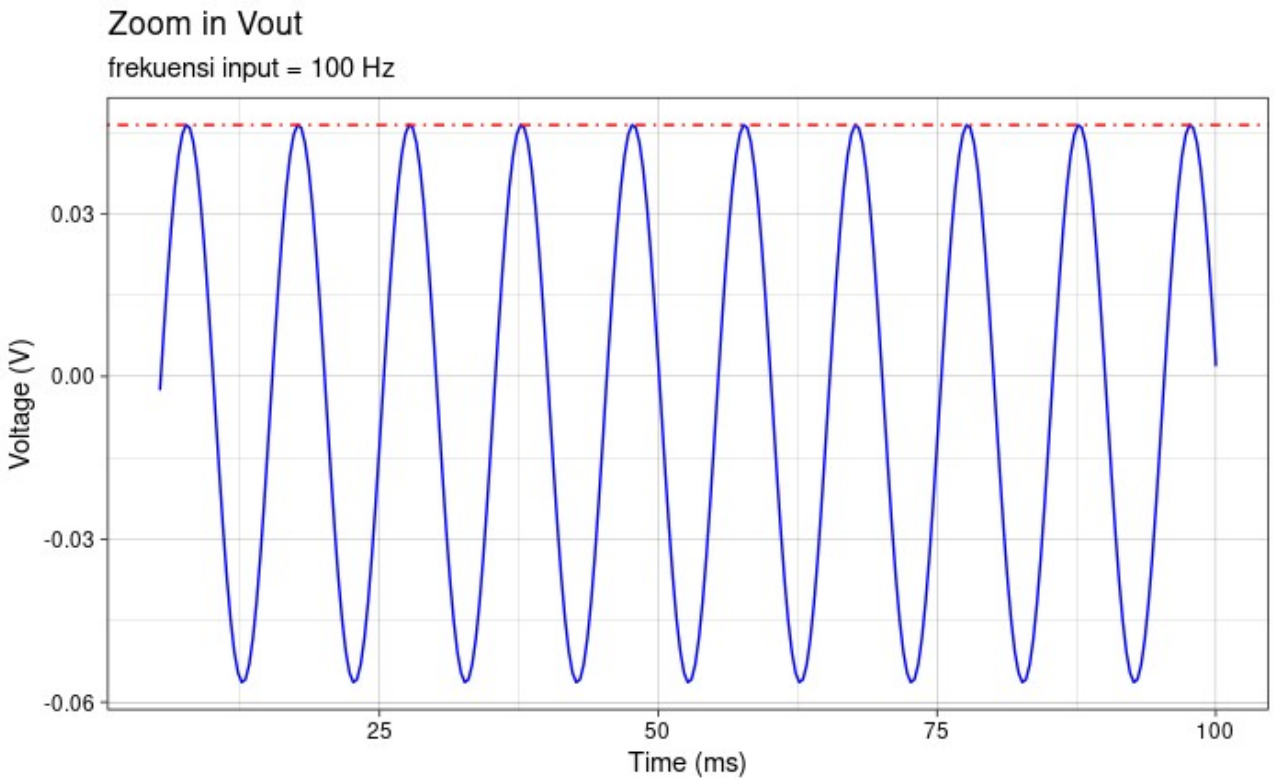

Chebychev 3-dB HPF orde 2
Frekuensi input = 1000 Hz
Voltage (V)
5.0
2.5
0.0
-2.5
-5.0
0.0
2.5
5.0
7.5
10.0
Time (ms)
Legend
Vin
Vout
Voltage (V)
4
2
0
-2
-4
0.0
2.5
5.0
7.5
10.0
Time (ms)


Vout Chebychev HPF orde 2
F = 1000 Hz
Voltage (V)
4
2
0
-2
-4
2.5
5.0
7.5
10.0
Time (ms)

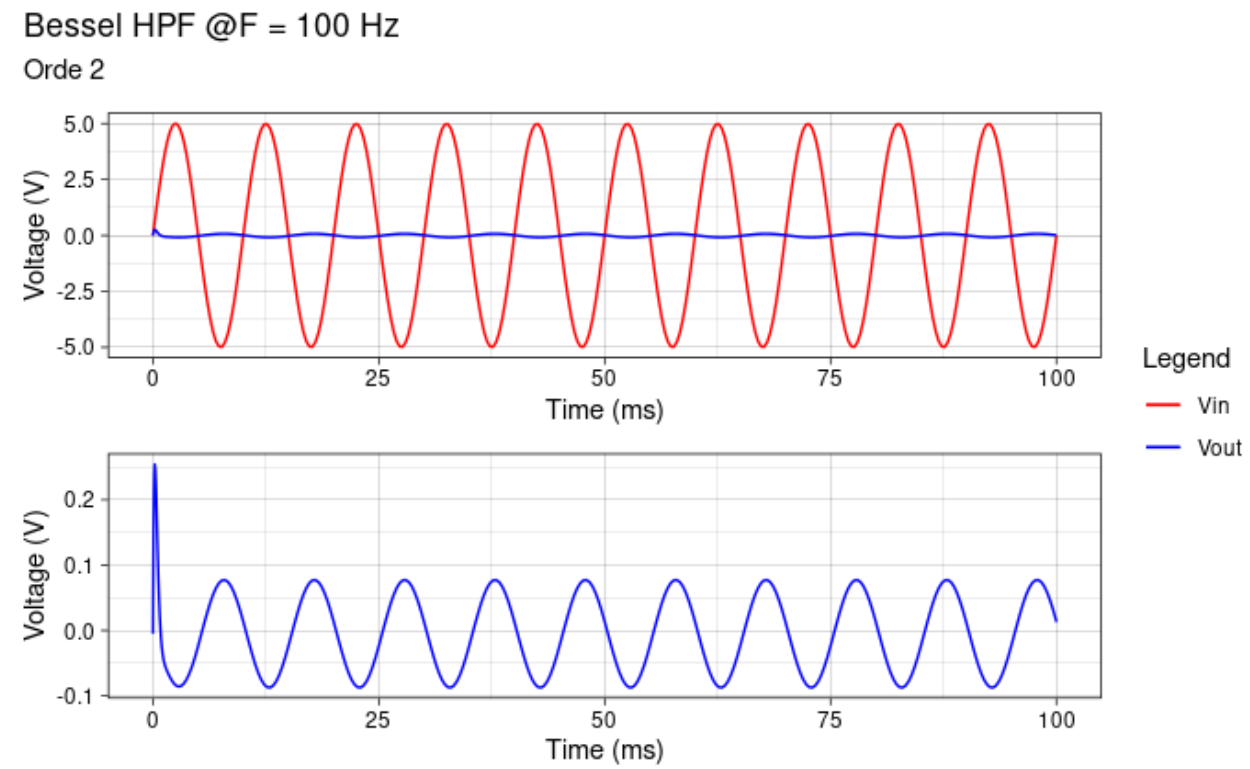
- Gambarkan bentuk gelombang input dan output (time domain) HPF saat Gain = -40dB:

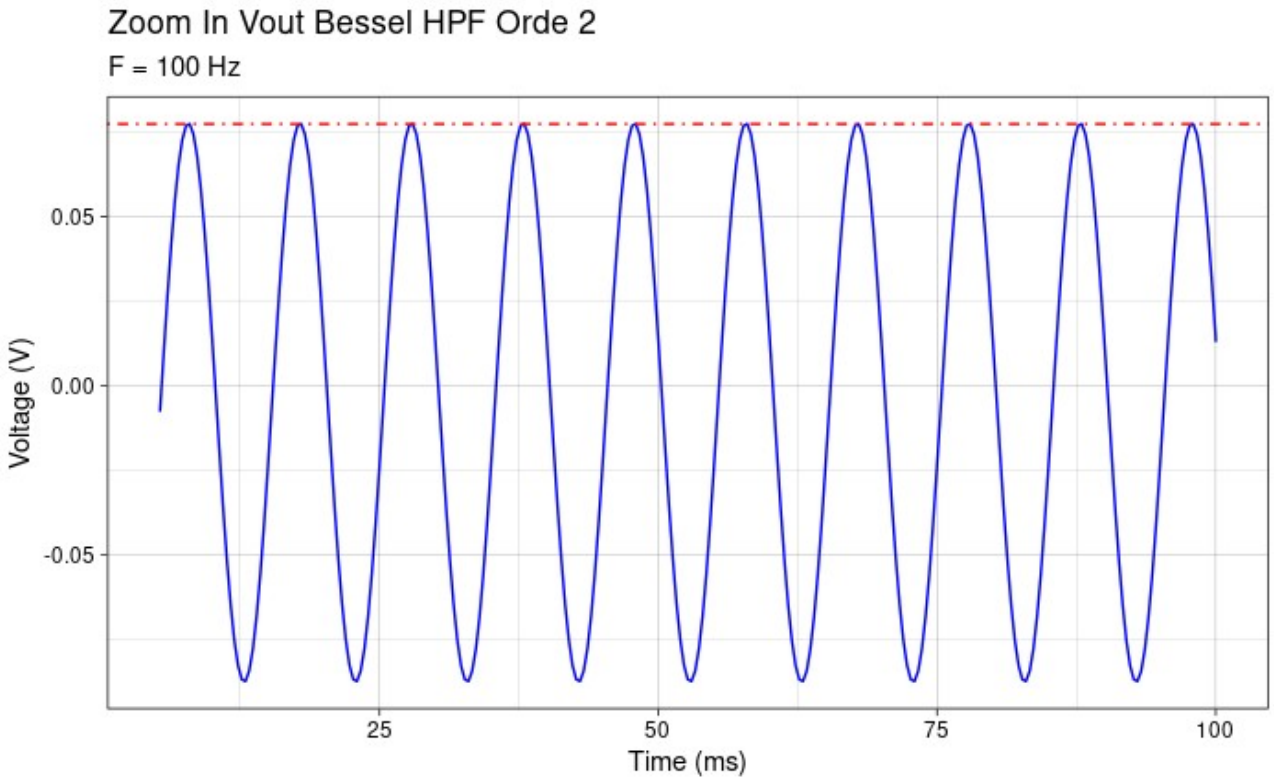
Butterworth



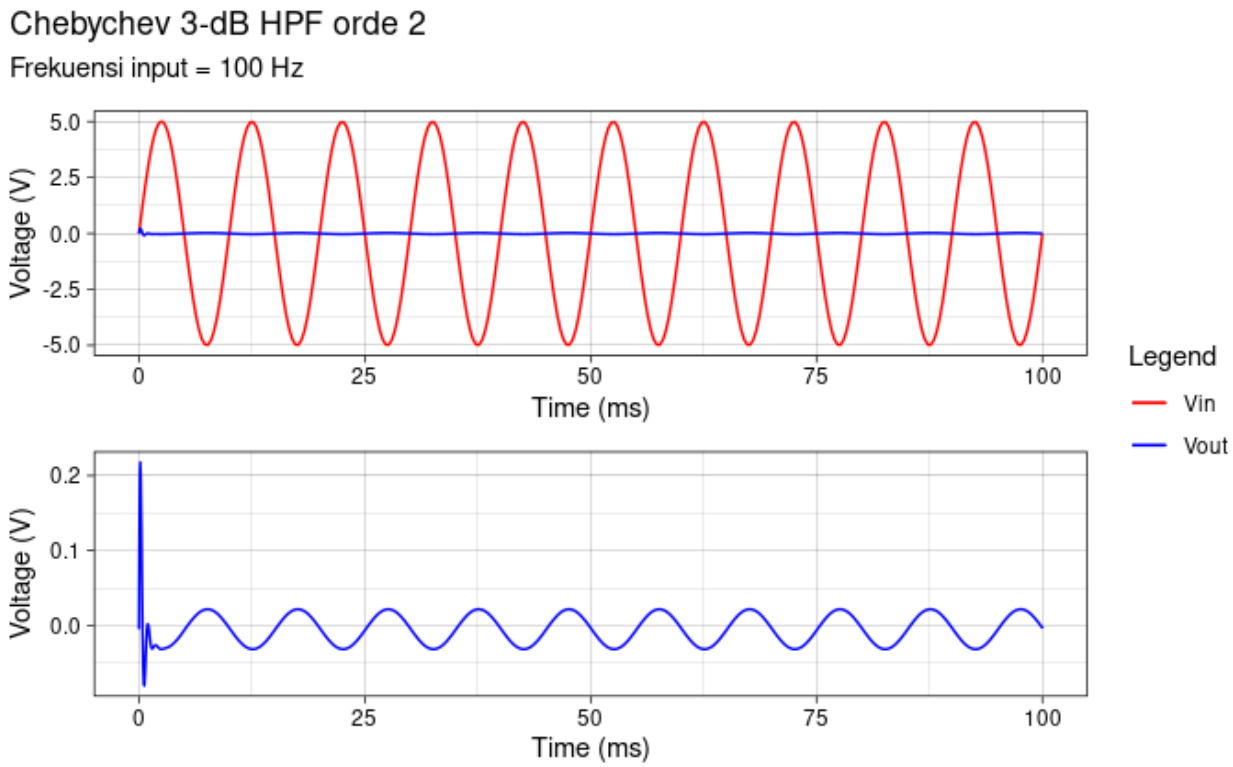


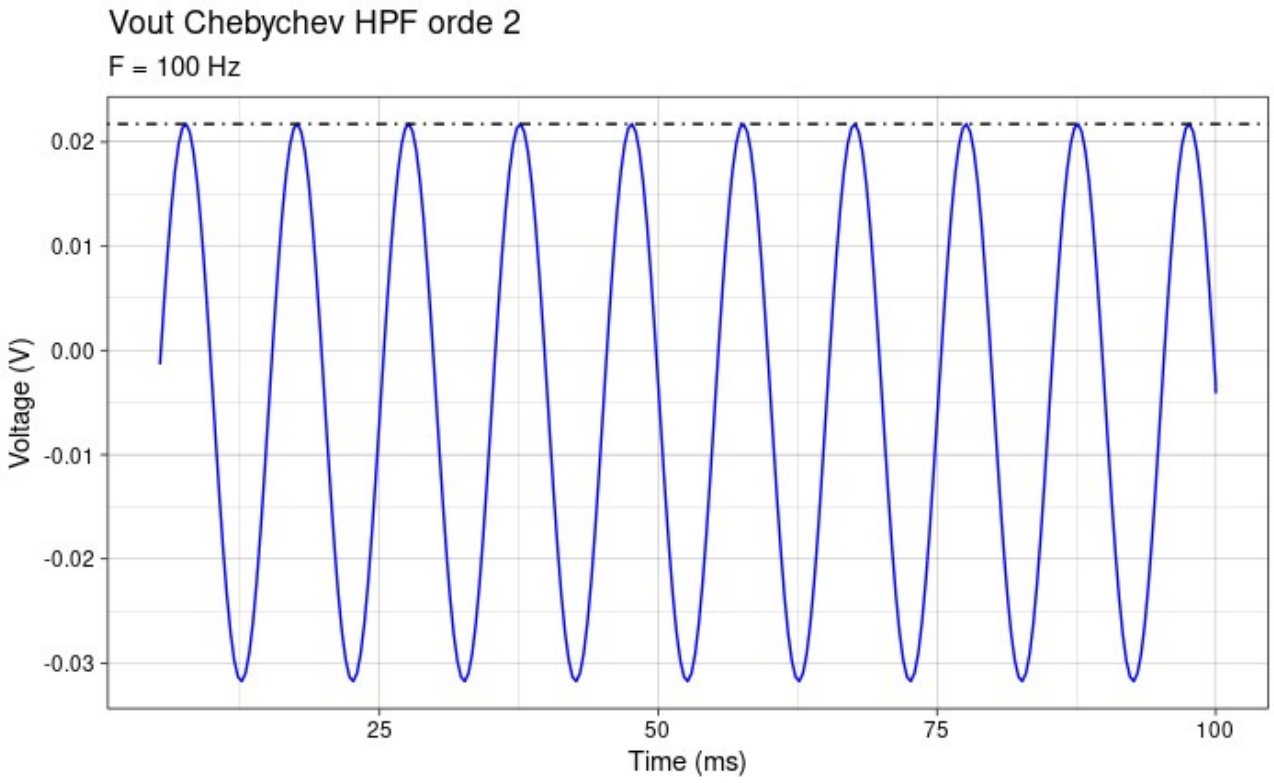
Bessel


Bessel HPF @F = 100 Hz
Orde 2
Voltage (V)
5.0
2.5
0.0
-2.5
-5.0
0
25
50
75
100
Time (ms)
Legend
Vin
Vout
Voltage (V)
0.2
0.1
0.0
-0.1
0
25
50
75
100
Time (ms)


Zoom In Vout Bessel HPF Orde 2
F = 100 Hz
Voltage (V)
0.05
0.00
-0.05
25
50
75
100
Time (ms)

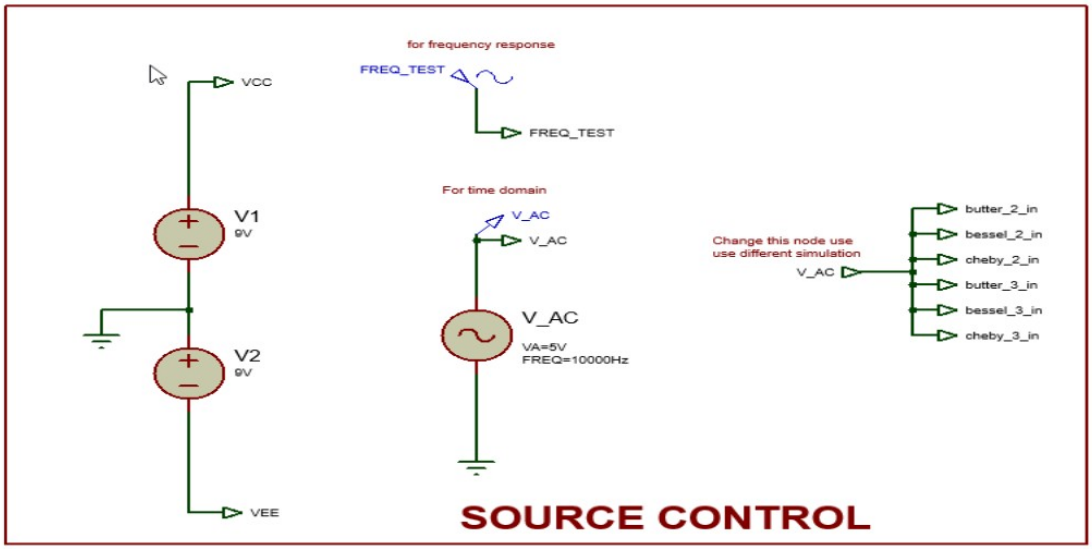
Chebychev 3-dB

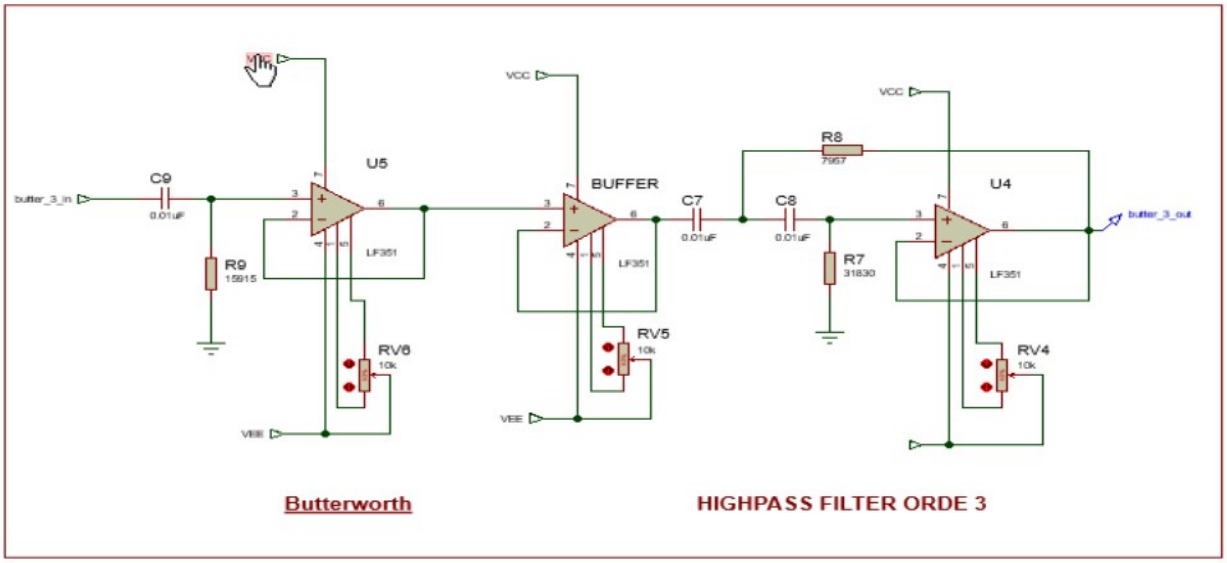




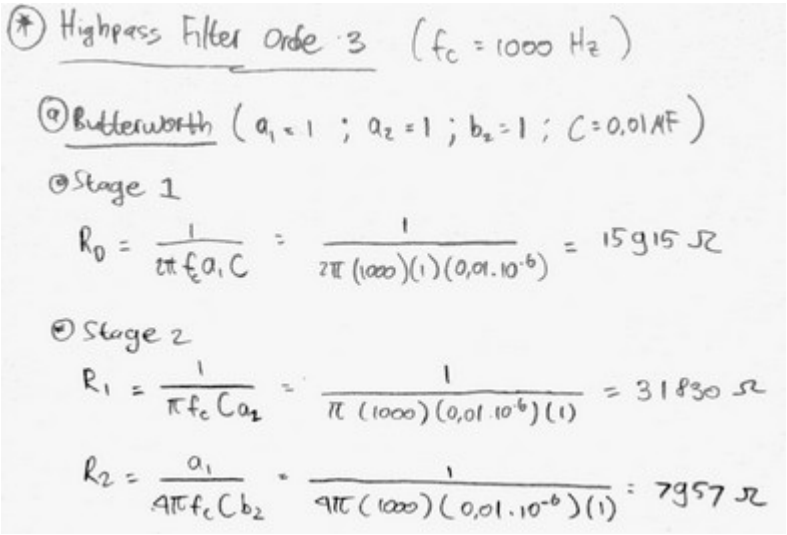
B. *Highpass Filter* Orde 3

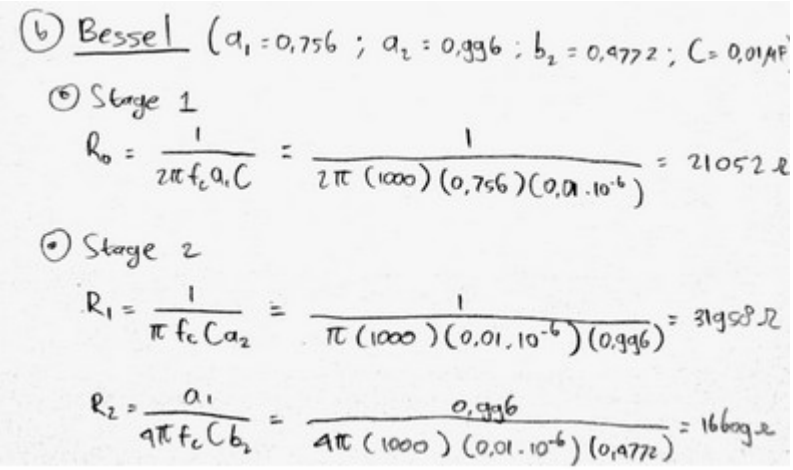
Screenshoot rangkaian (3 rangkaian filter identik, hanya berbeda di nilai komponen)

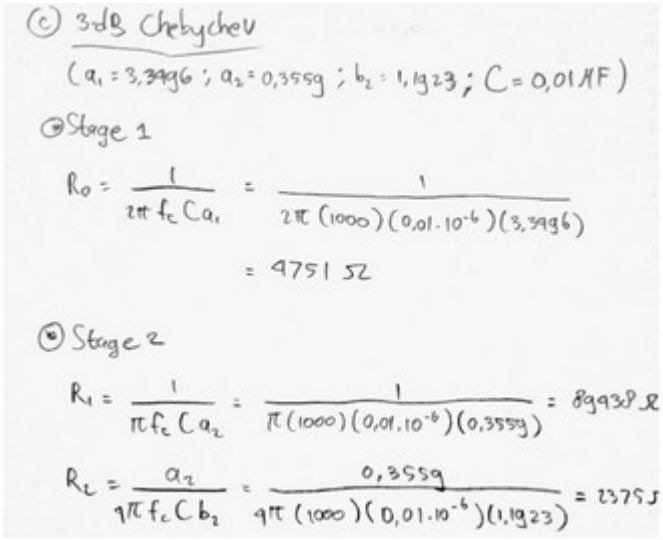




Perhitungan desain rangkaian:







Hasil percobaan:

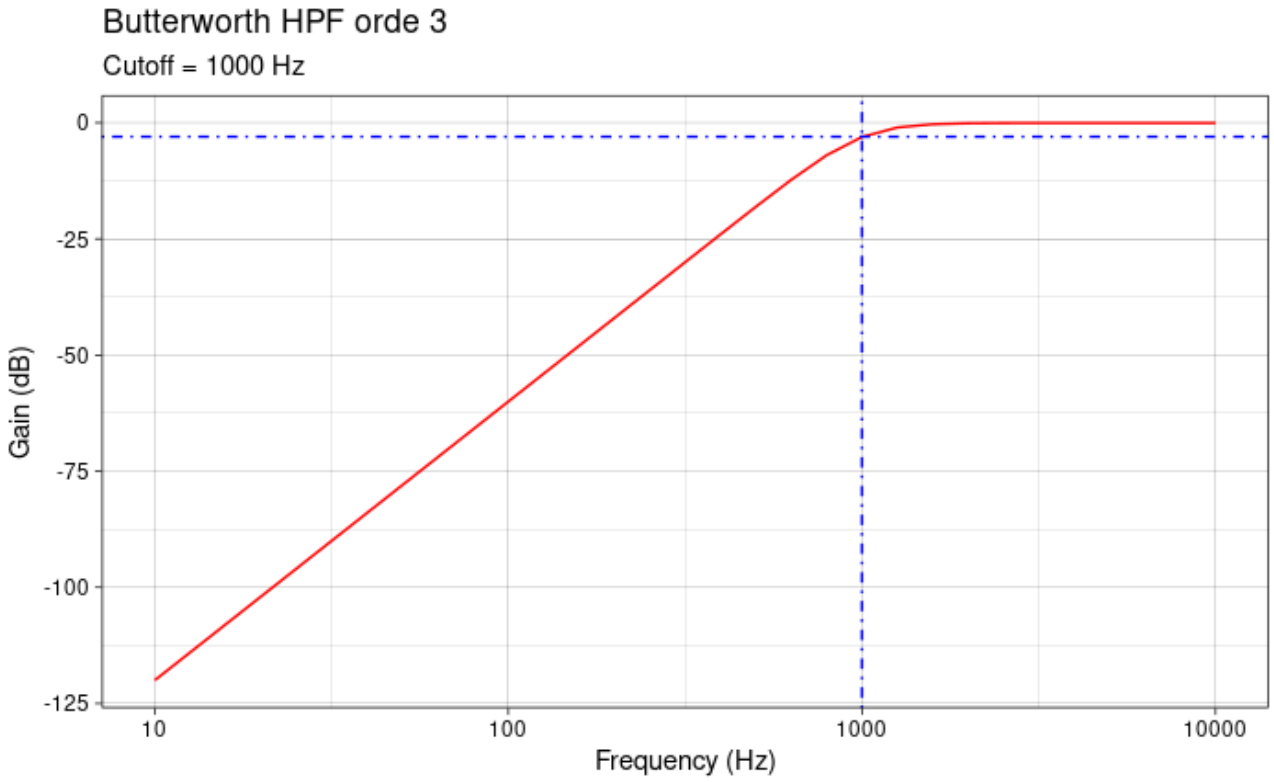
Vcc = 9 volt; f_{cutoff} = 1000 Hz; C0 = C1 = C2 = C = 0,01μF

Tabel 4.2

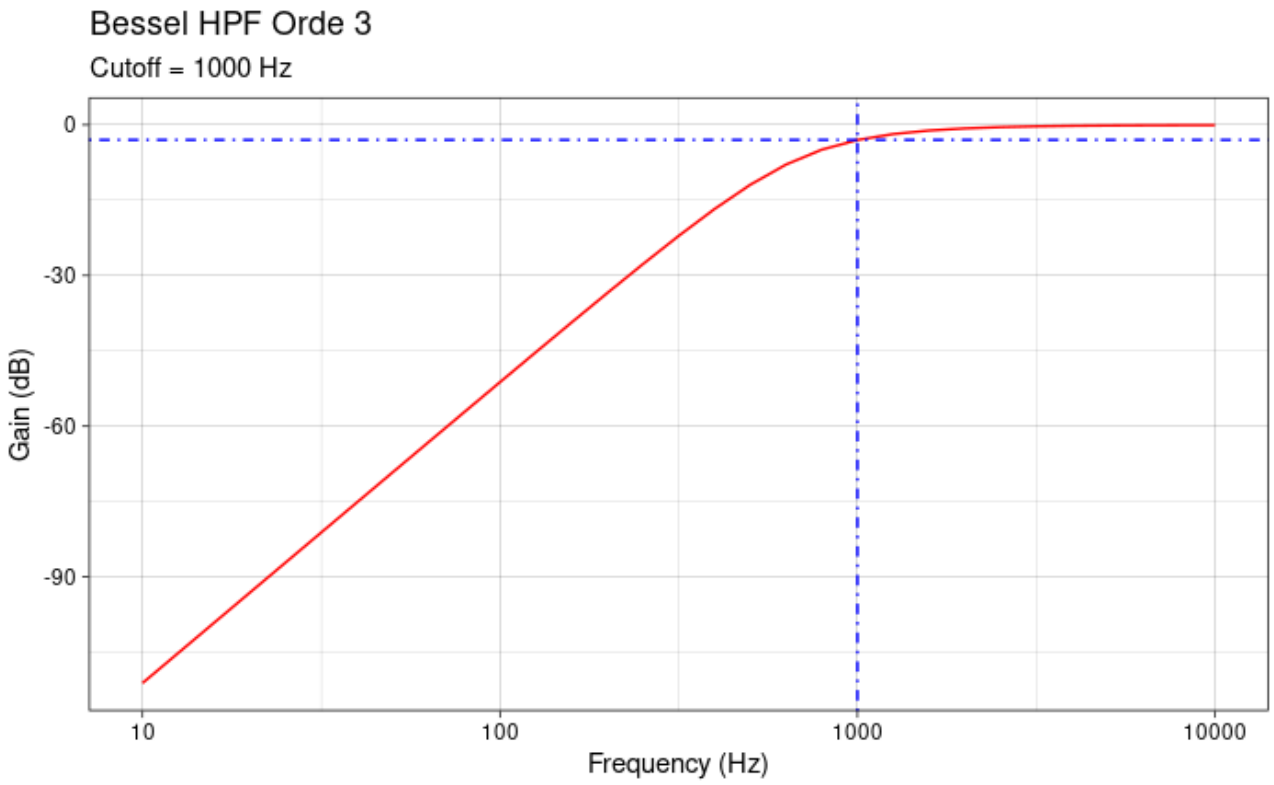
Vin (Vpeak)	Fin (Hz)	Fout (Hz)	Vout (Vpeak)		
			Butterworth	**Bessel**	**Chebychev**
			R_0= 15915 Ω R_1= 31830 Ω R_2= 7957 Ω	R_0= 21052 Ω R_1= 31958 Ω R_2= 16609 Ω	R_0= 4751 Ω R_1= 89438 Ω R_2= 2375 Ω
5 V	10	10	0.1523273	0.153918	0.439579
	100	100	0.157482	0.168192	0.440882
	1000	1000	3.72844	3.70712	4.09061
	10000	10000	5.11806	5.17626	5.26553

- Grafik respon frekuensi terhadap gain dalam skala logaritmik (diagram Bode) HPF orde 3:

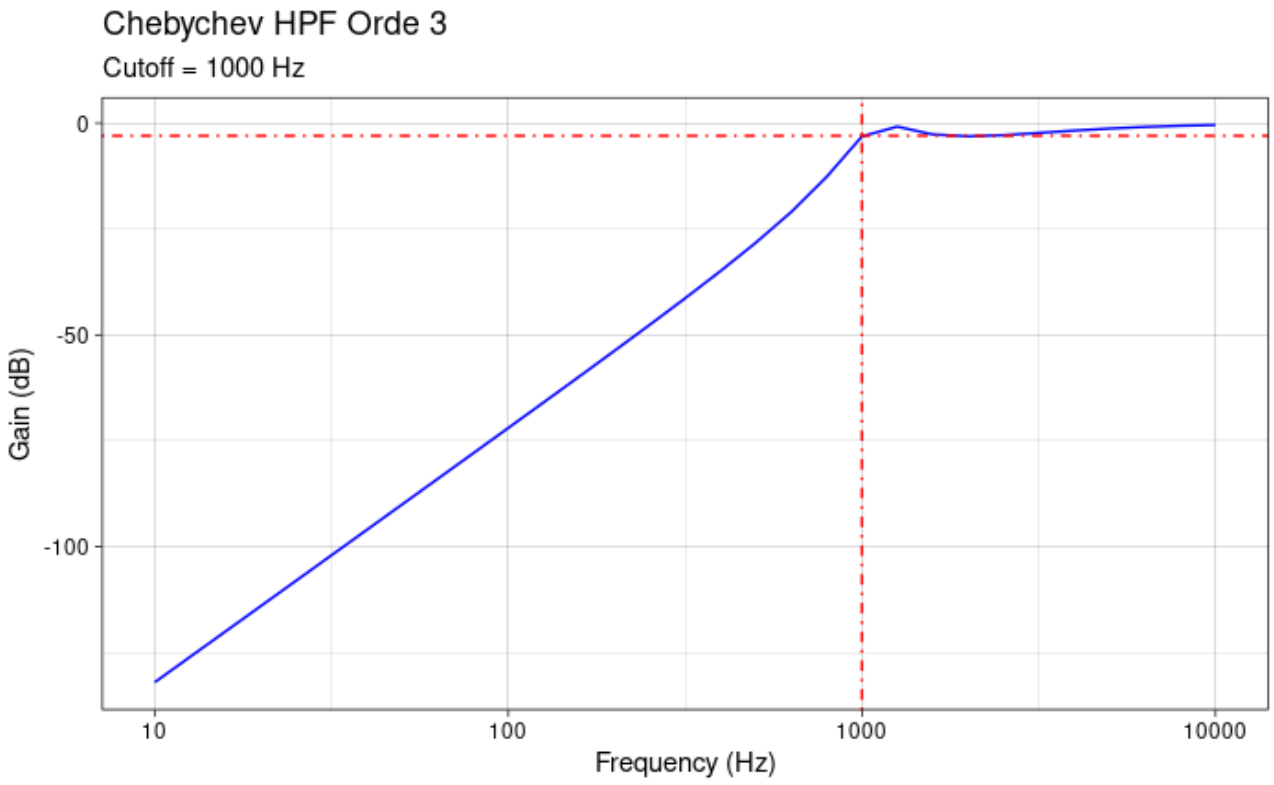
Butterworth



Bessel



Chebychev 3-dB

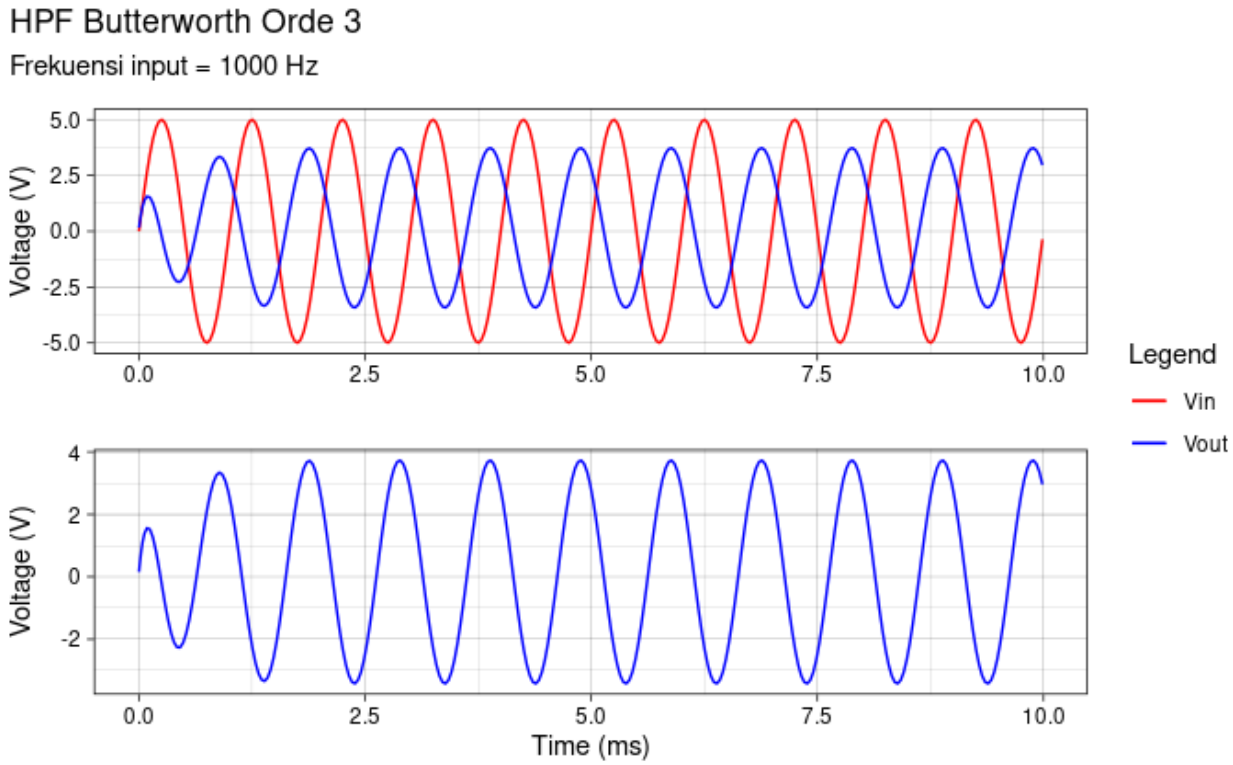


- Puncak *ripple* HPF Chebychev pada frekuensi input = 1995.262 Hz, amplitudo output HPF:

$$Gain = -3.10983 = 0.699050418 \ kali$$

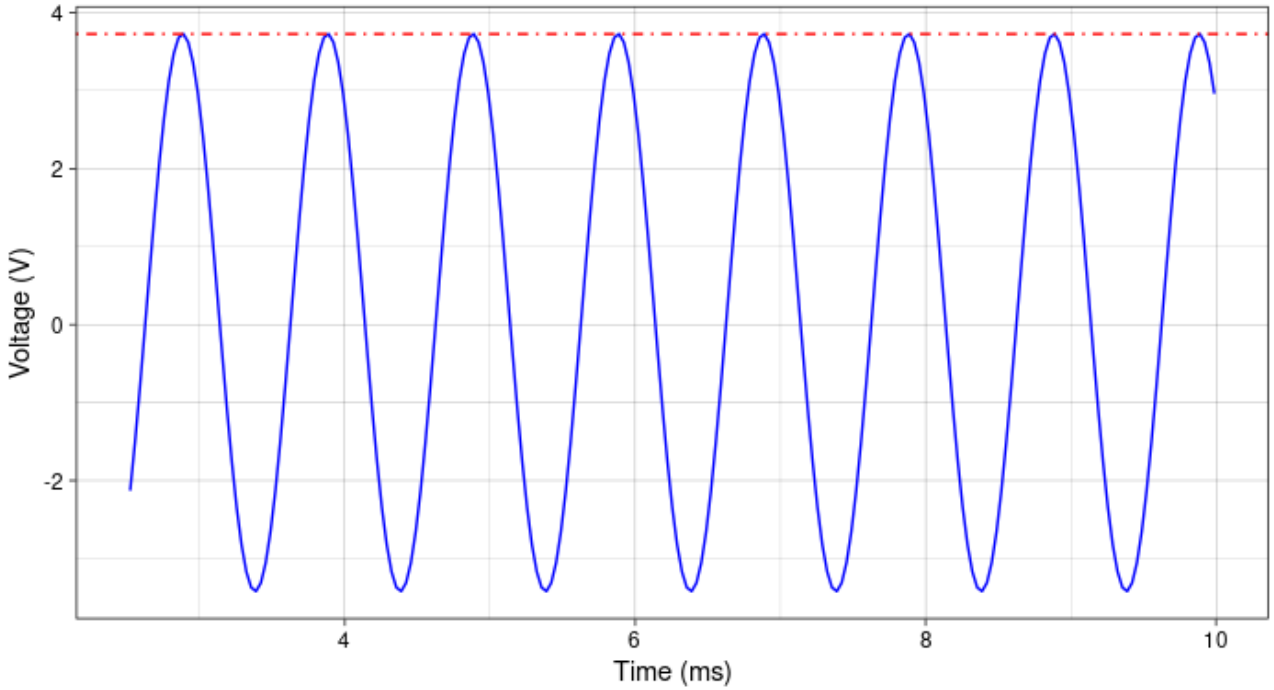
$$V_{out} = 5V \times 0.699050418 = 3.495252092V$$

- Gambarkan bentuk gelombang input dan output (time domain) HPF saat frekuensi cutoff :



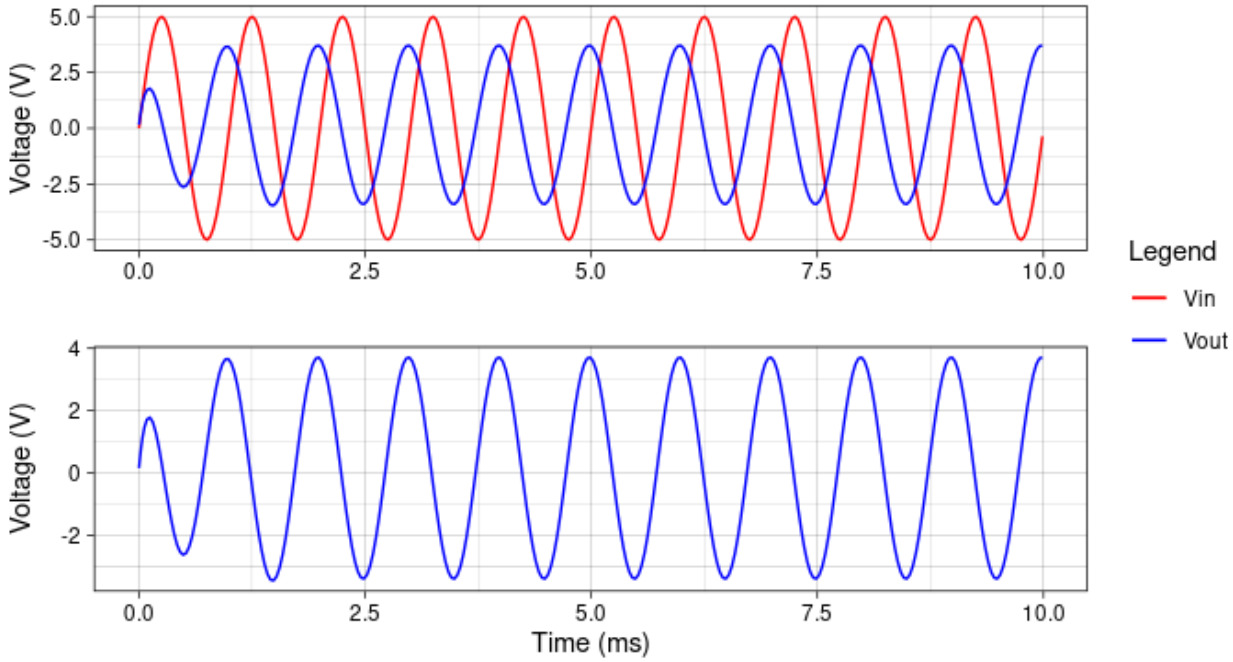
Zoom in Vout Butterworth HPF Orde 3

Frekuensi input = 1000 Hz



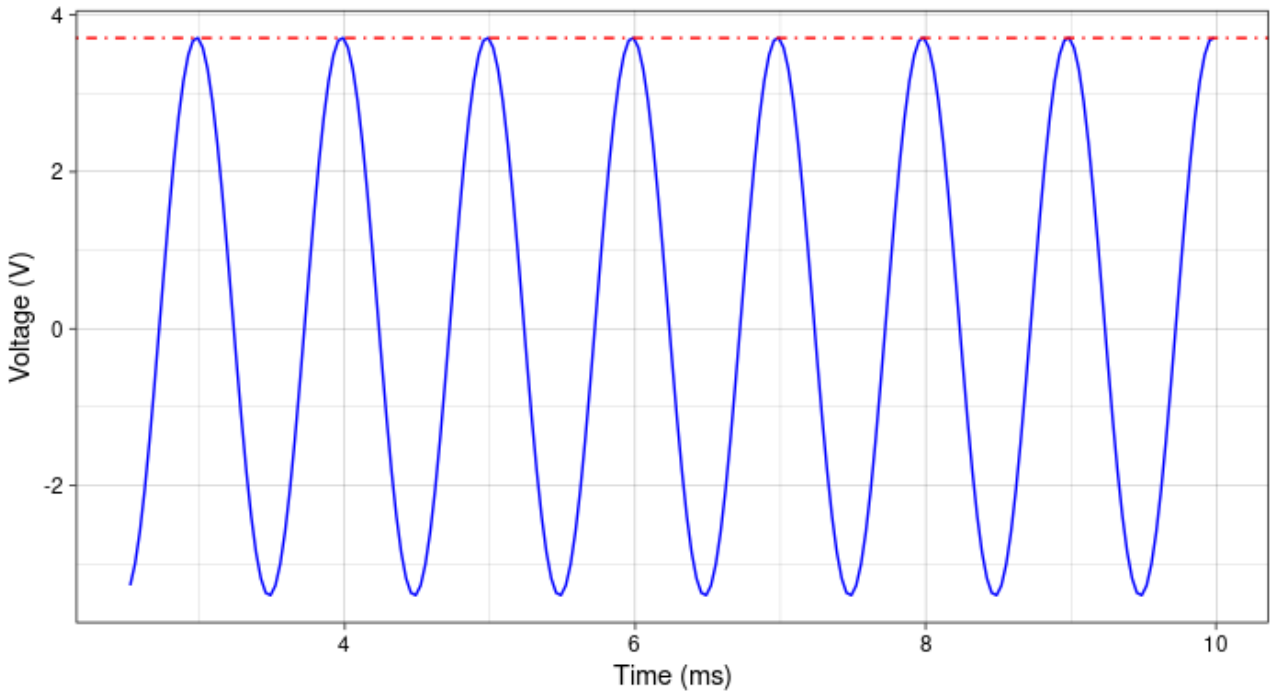
HPF Bessel Orde 3

Frekuensi input = 1000 Hz



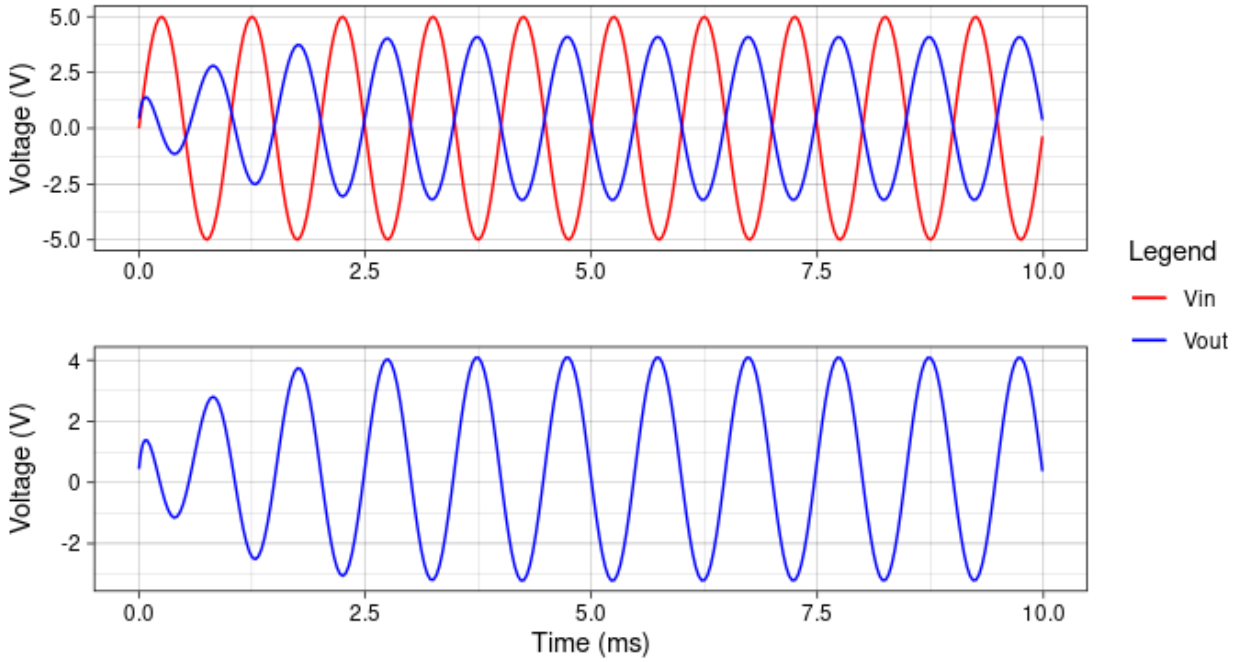
Zoom in Vout Bessel HPF Orde 3

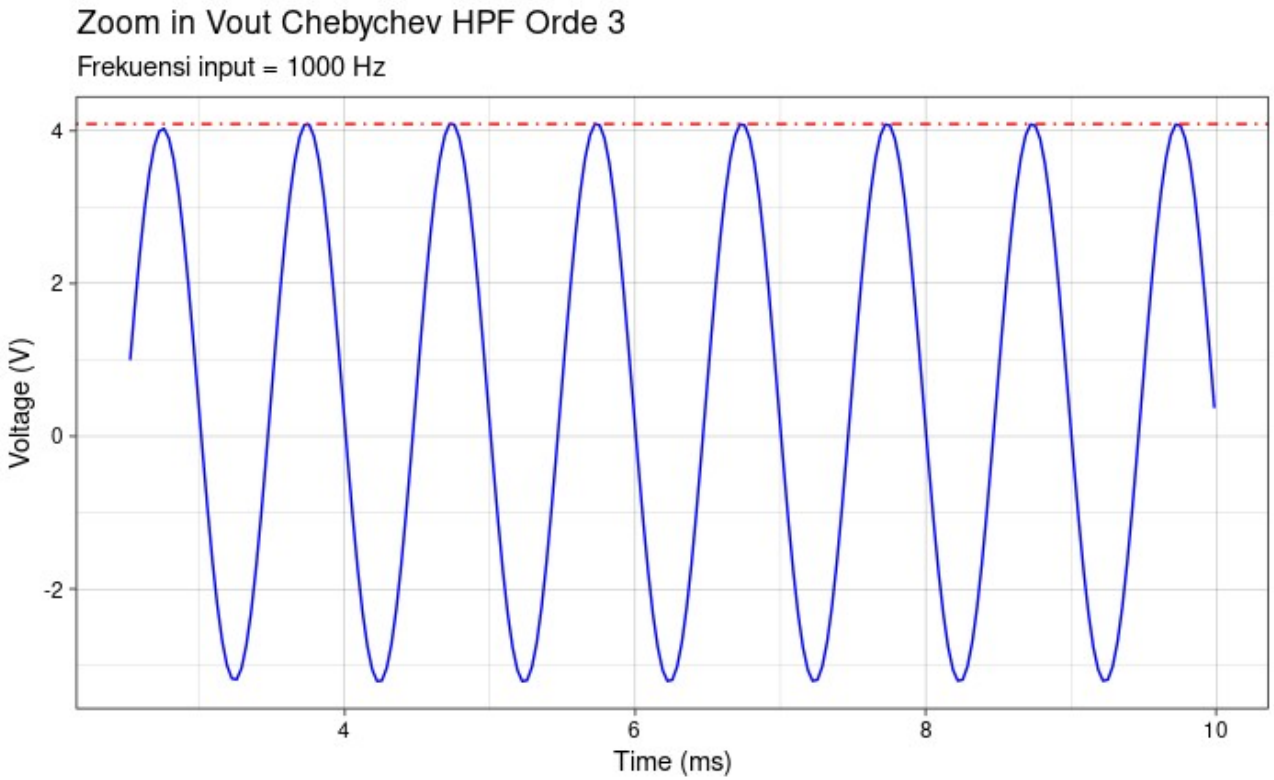
Frekuensi input = 1000 Hz



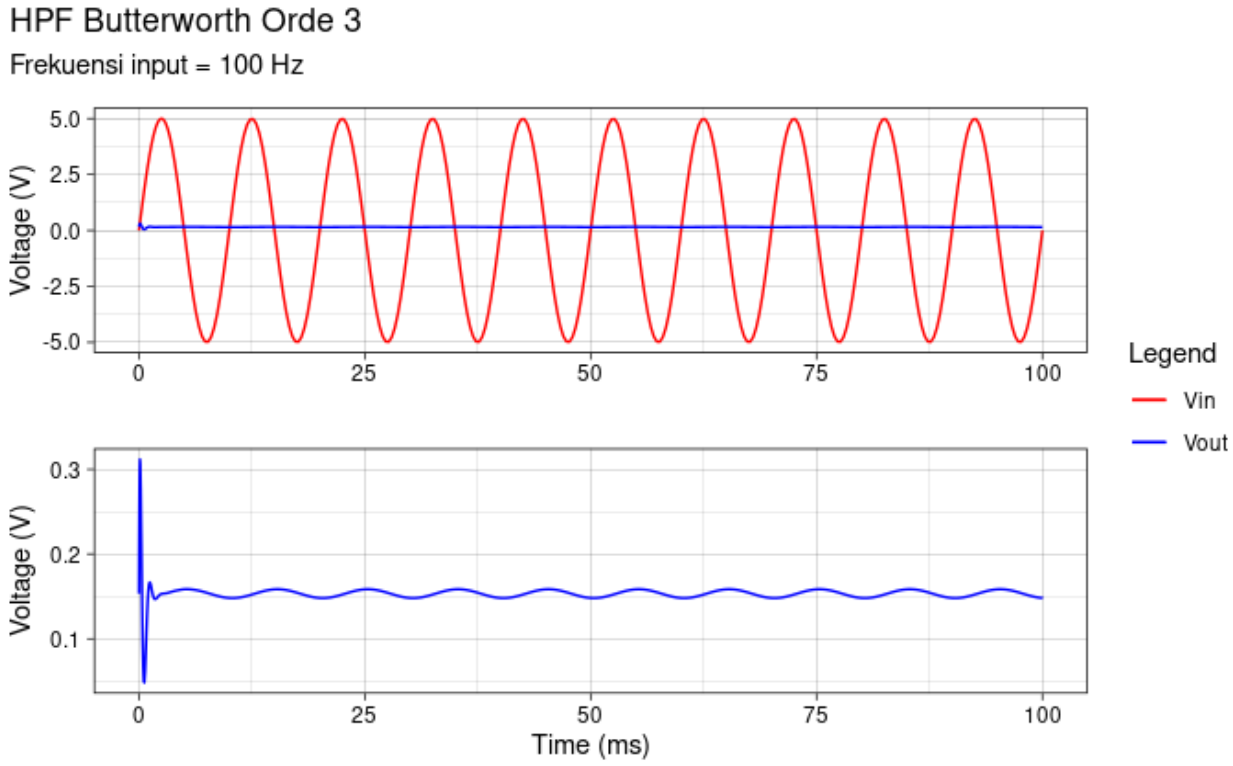
Chebychev HPF Orde 3

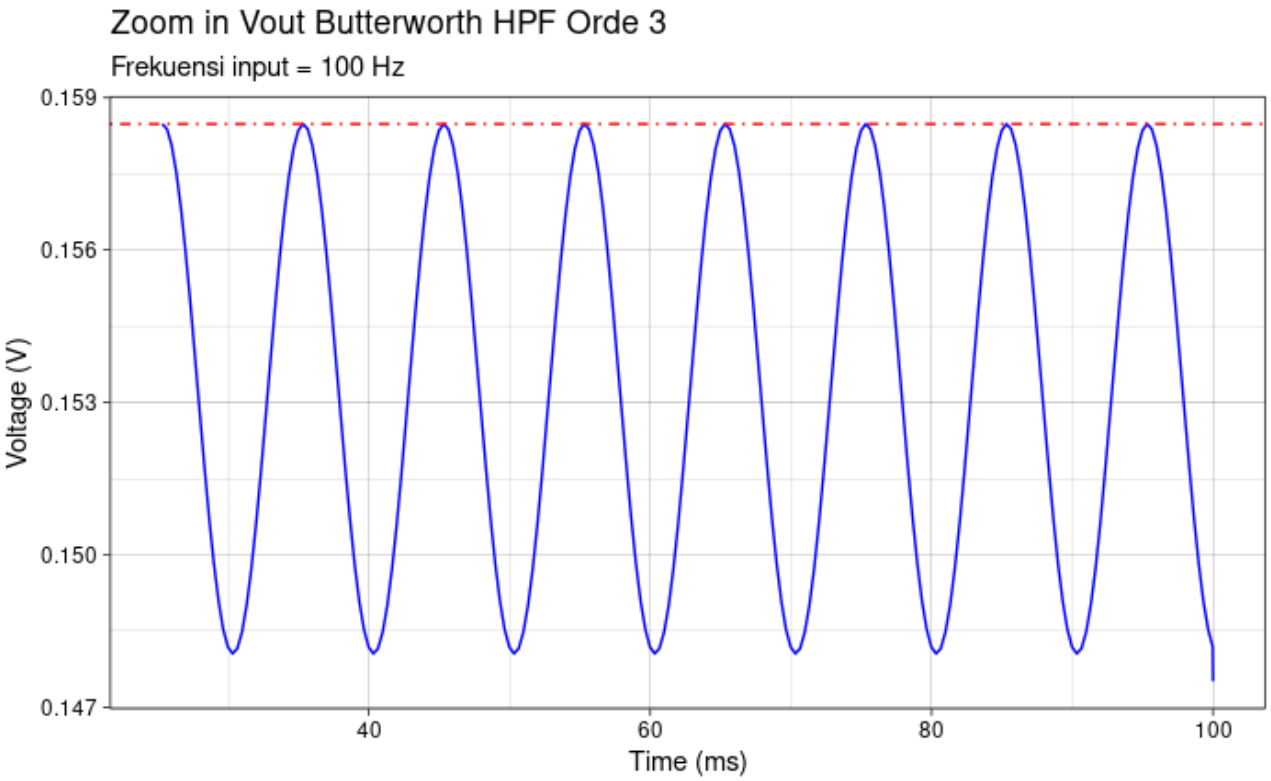
Frekuensi input = 1000 Hz

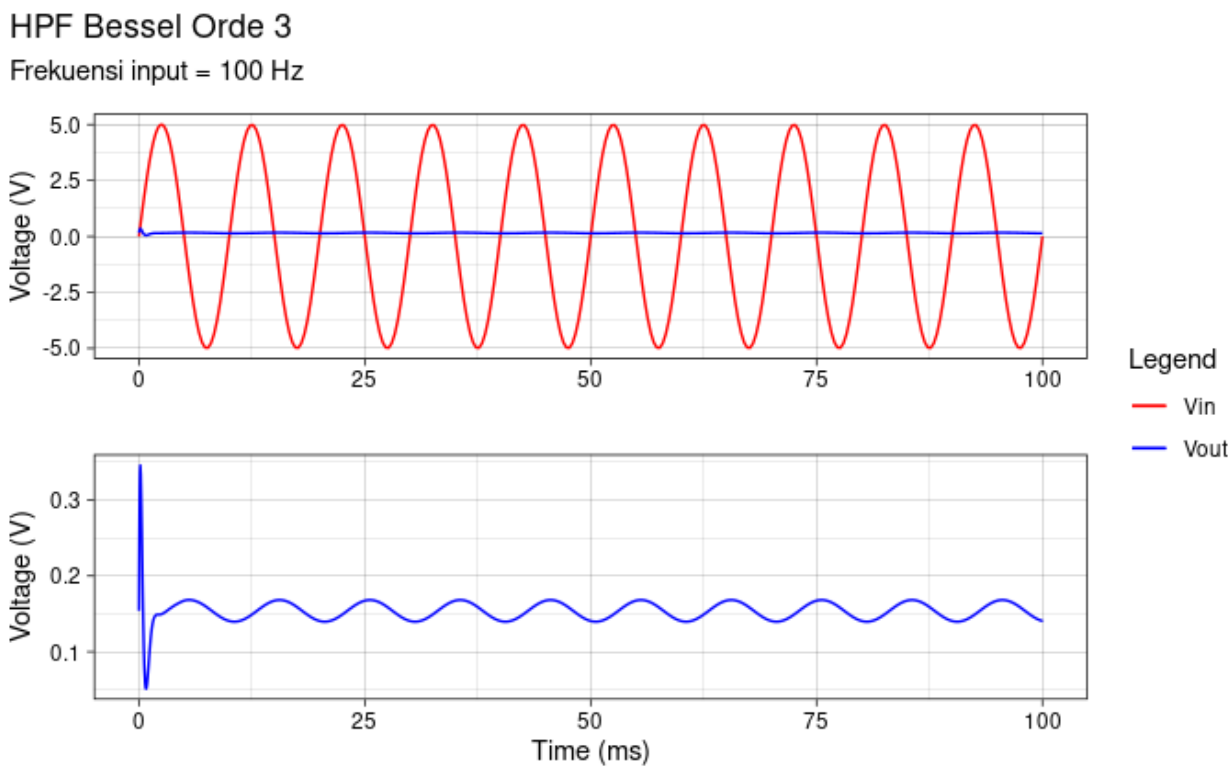




- Gambarkan bentuk gelombang input dan output (time domain) HPF saat Gain = -60dB:

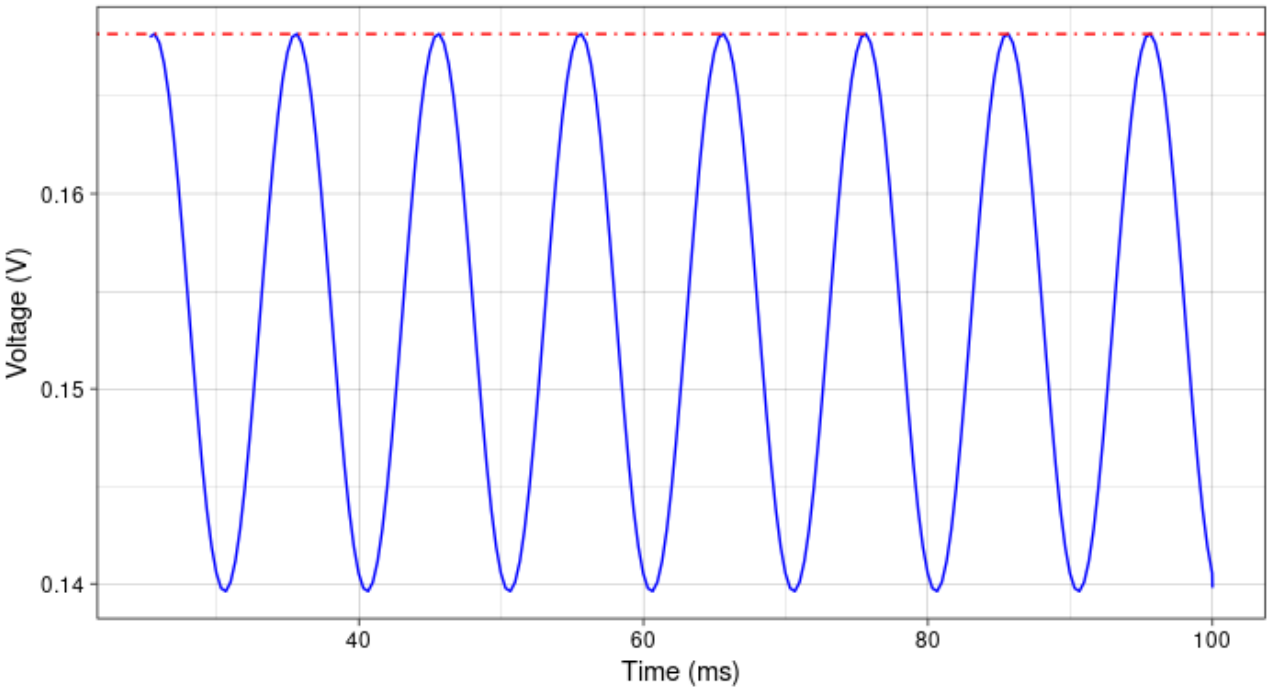



Zoom in Vout Butterworth HPF Orde 3
Frekuensi input = 100 Hz
0.159
0.156
0.153
0.150
0.147
Voltage (V)
40
60
80
100
Time (ms)


HPF Bessel Orde 3
Frekuensi input = 100 Hz
5.0
2.5
0.0
-2.5
-5.0
Voltage (V)
0
25
50
75
100
0.3
0.2
0.1
Voltage (V)
Time (ms)
Legend
Vin
Vout

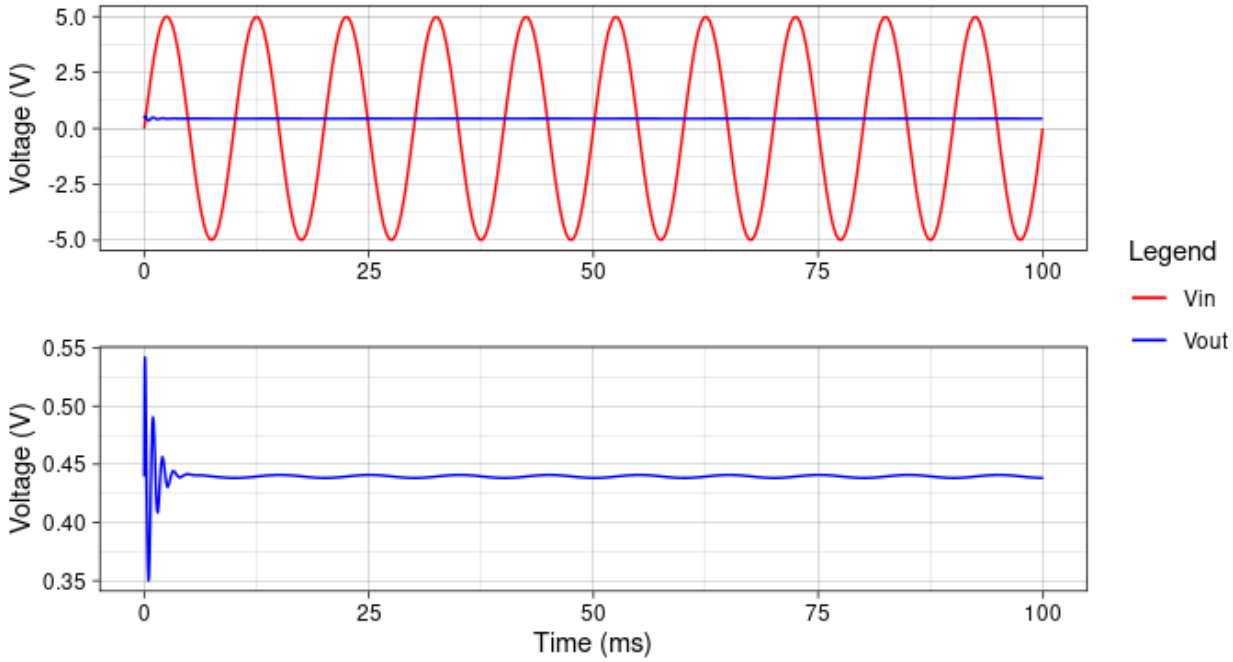
Zoom in Vout Bessel HPF Orde 3

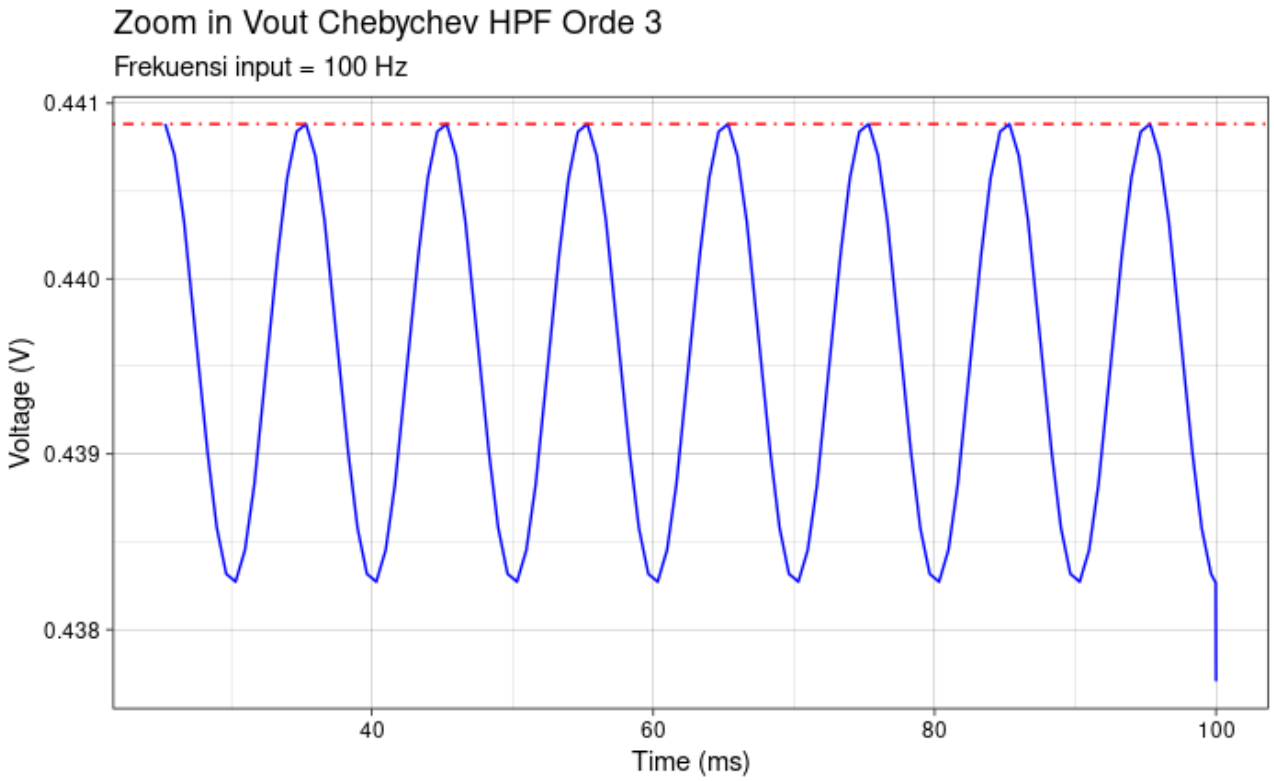
Frekuensi input = 100 Hz



Chebychev HPF Orde 3

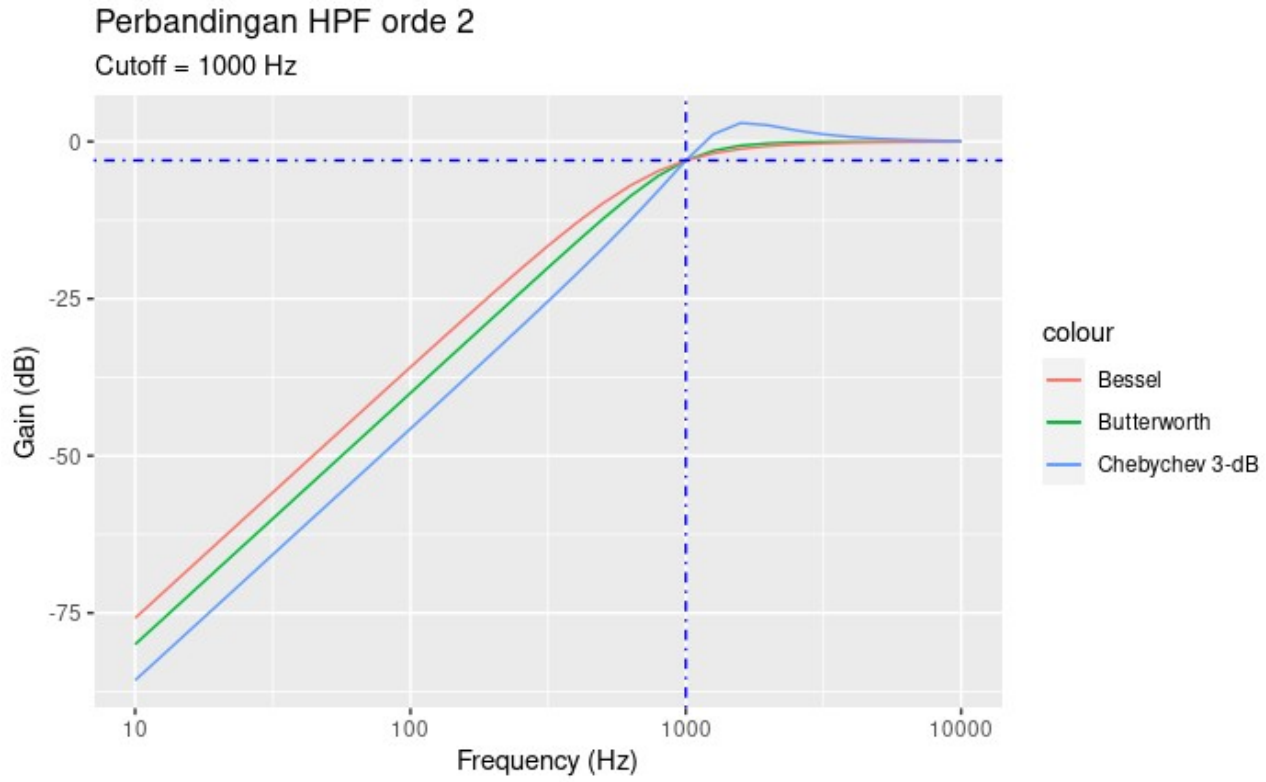
Frekuensi input = 100 Hz




Zoom in Vout Chebychev HPF Orde 3
Frekuensi input = 100 Hz
0.441
0.440
0.439
0.438
Voltage (V)
40
60
80
100
Time (ms)

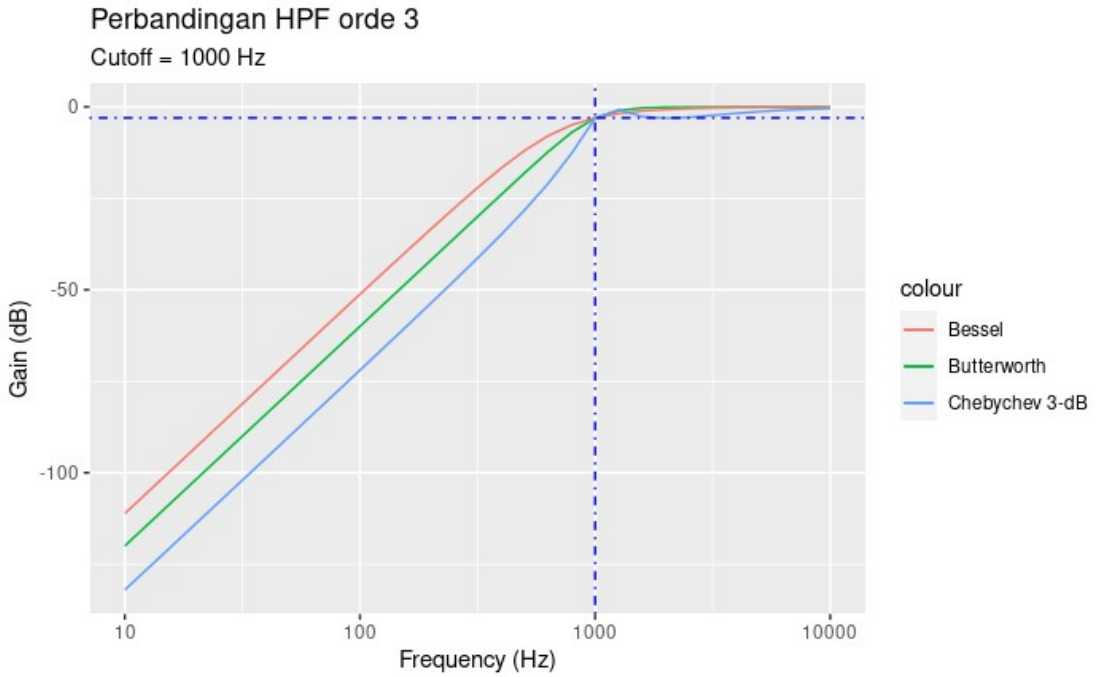
Analisa

dari grafik perbandingan filter berikut:



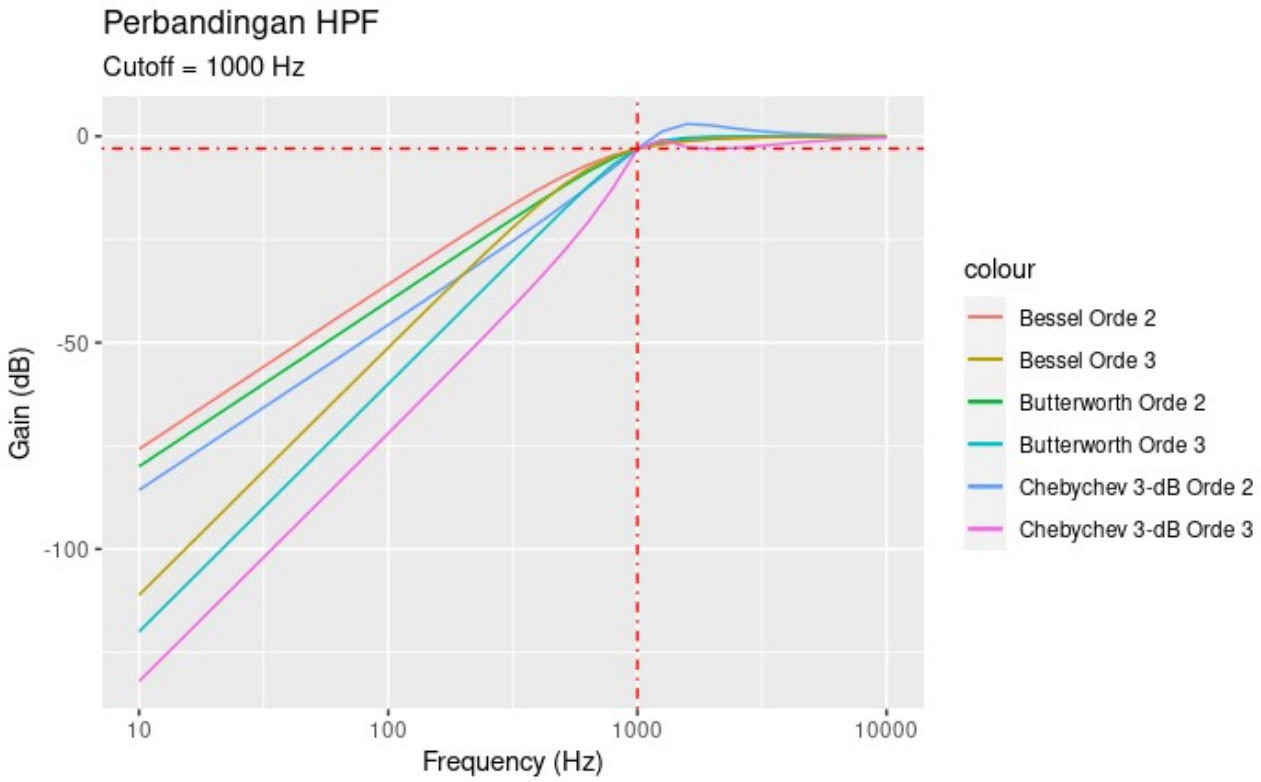
Maka dapat terlihat bahwa Chebychev memberikan roll-off dB yang lebih cepat, sedangkan Bessel yang paling lambat

Demikian juga berlaku untuk filter orde 3. Namun pada filter orde 3, roll-off dB/decade adalah sebesar -60dB / decade, sedangkan pada filter orde 2, roll-off adalah -40 dB/decade.
Dengan kata lain, setiap penurunan frekuensi-bagi-10 (misalnya 1000 Hz ke 100 Hz), peredamannya sudah -60 dB, sedangkan pada filter orde 2, peredamannya masih -40 dB.

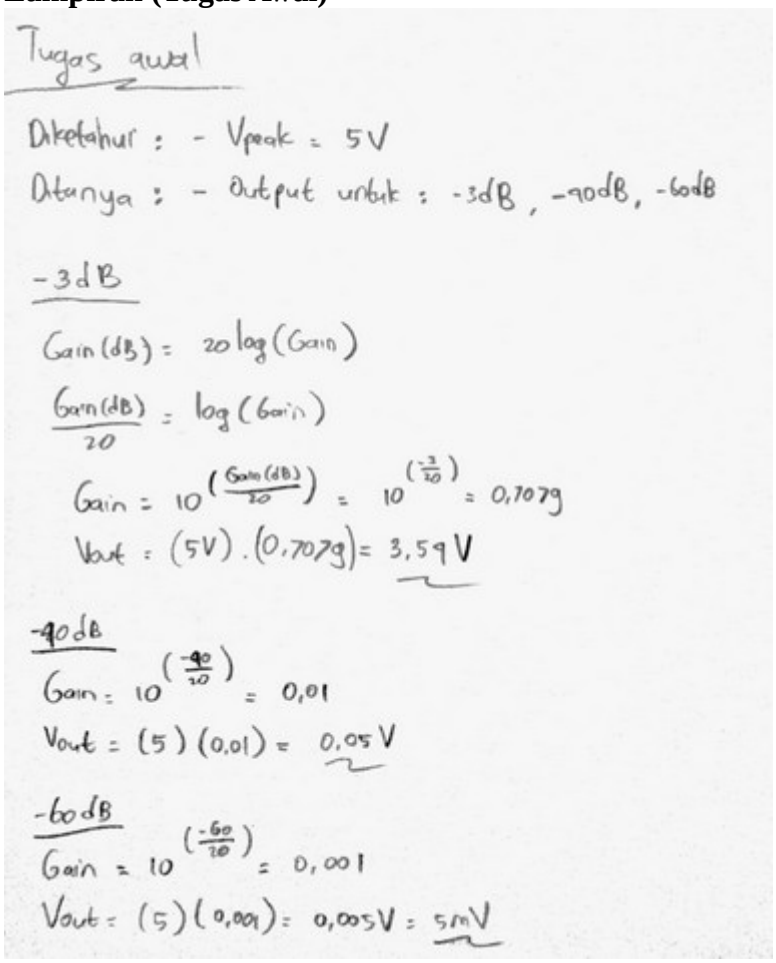


Kesimpulan

- Filter tipe Chebychev memberikan peredaman yang paling cepat dibandingkan jenis filter lain
- High Pass Filter berfungsi untuk menyaring sinyal dengan frekuensi dibawah parameter *cutoff frequency* agar teredam
- Besarnya peredaman bergantung dengan orde filter yang digunakan, untuk orde 2 adalah -40dB / decade dan -60dB / decade untuk filter orde 3.
- Walaupun filter Chebychev memiliki peredaman yang paling tajam, namun pada daerah *passband* terdapat *ripple* sehingga gain pada *passband* tidak 0 dB, melainkan berdeviasi sebesar n-dB, dimana **n** adalah tipe Chebychev yang digunakan, dan menentukan besarnya ripple maksimum pada daerah *passband* (dalam praktikum yang digunakan adalah 3-dB)



Lampiran (Tugas Awal)



Tugas awal

Diketahui : - $V_{peak} = 5V$

Ditanya : - Output untuk : -3dB, -40dB, -60dB

-3dB

$Gain(dB) = 20 \log(Gain)$

$\frac{Gain(dB)}{20} = \log(Gain)$

$Gain = 10^{\left(\frac{Gain(dB)}{20}\right)} = 10^{\left(\frac{-3}{20}\right)} = 0,707$

$V_{out} = (5V).(0,707) = 3,54V$

-40dB

$Gain = 10^{\left(\frac{-40}{20}\right)} = 0,01$

$V_{out} = (5)(0,01) = 0,05V$

-60dB

$Gain = 10^{\left(\frac{-60}{20}\right)} = 0,001$

$V_{out} = (5)(0,001) = 0,005V = 5mV$