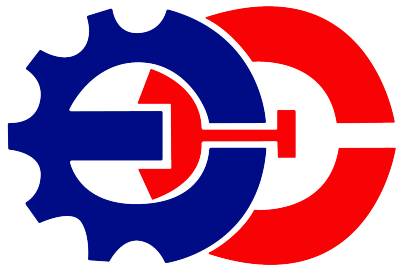
Active Filter

TE201414 - Rangkaian Elektronika 2

Program Studi Teknik Elektro



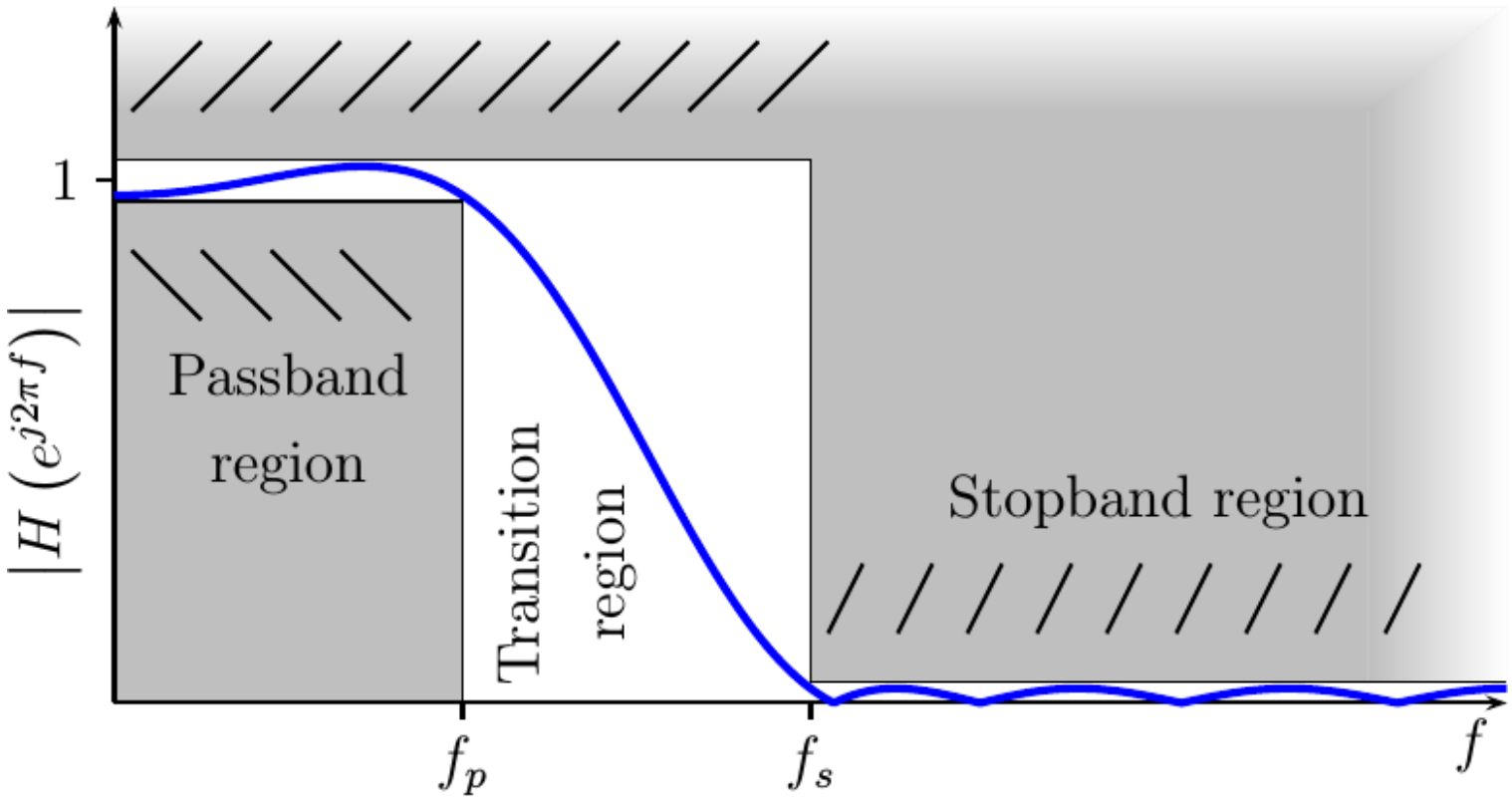
Institut Teknologi Kalimantan
agung.nursyeha@lecturer.itk.ac.id
agung.nursyeha@lecturer.itk.ac.id

April 14, 2025

Filter

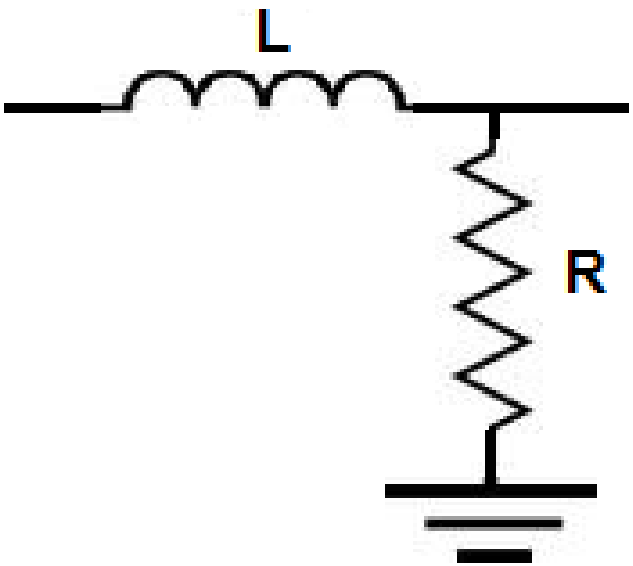
Is a circuit which has function to block and pass signal in certain range of frequency. type of filter can be classified as:

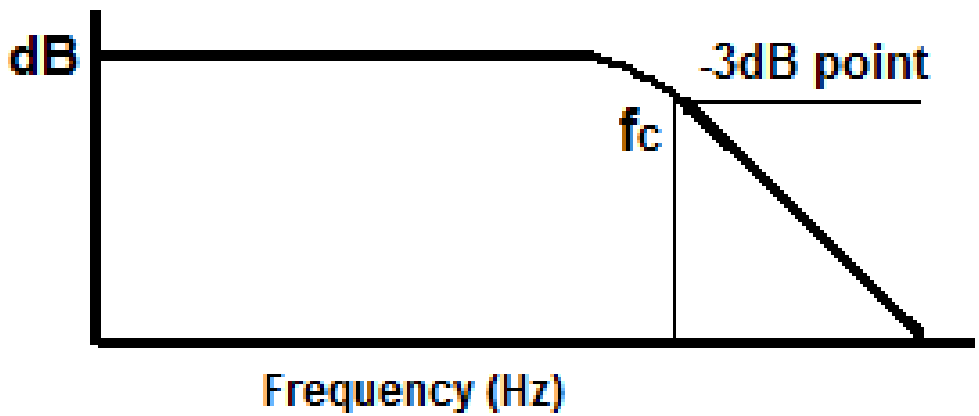
- Passive filter
- Active filter



Filter Pasif

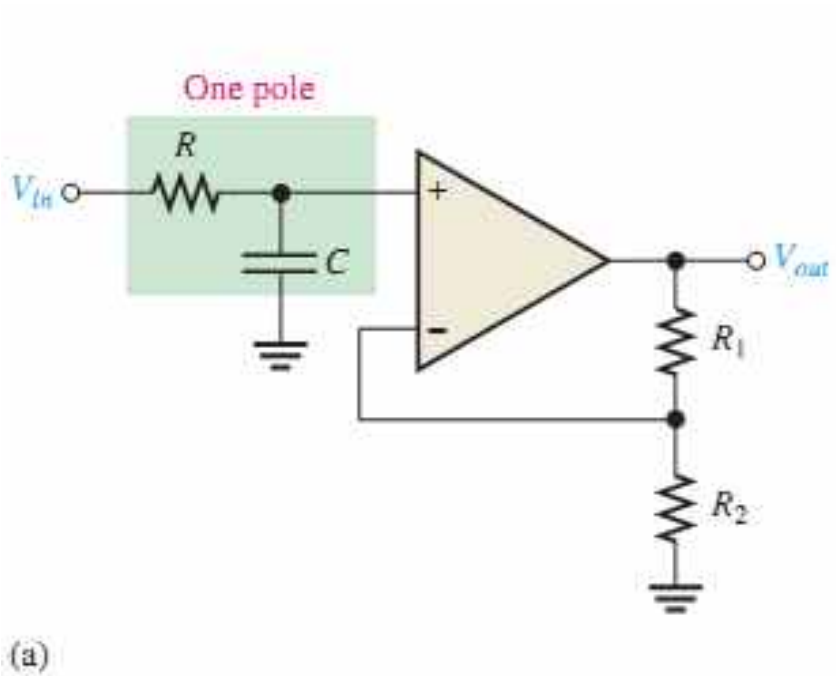
terdiri atas rangkaian RC, RL, RLC, contoh filter pasif low-pass dari rangkaian RL:

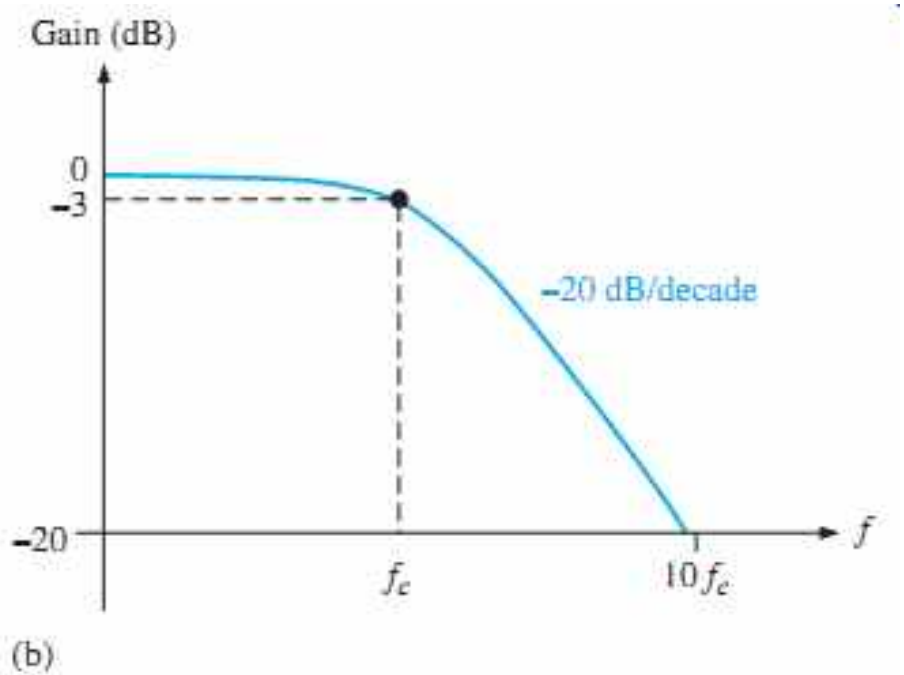




Filter Aktif

Rangkaian filter menggunakan operasional amplifier.
contoh filter aktif low-pass:

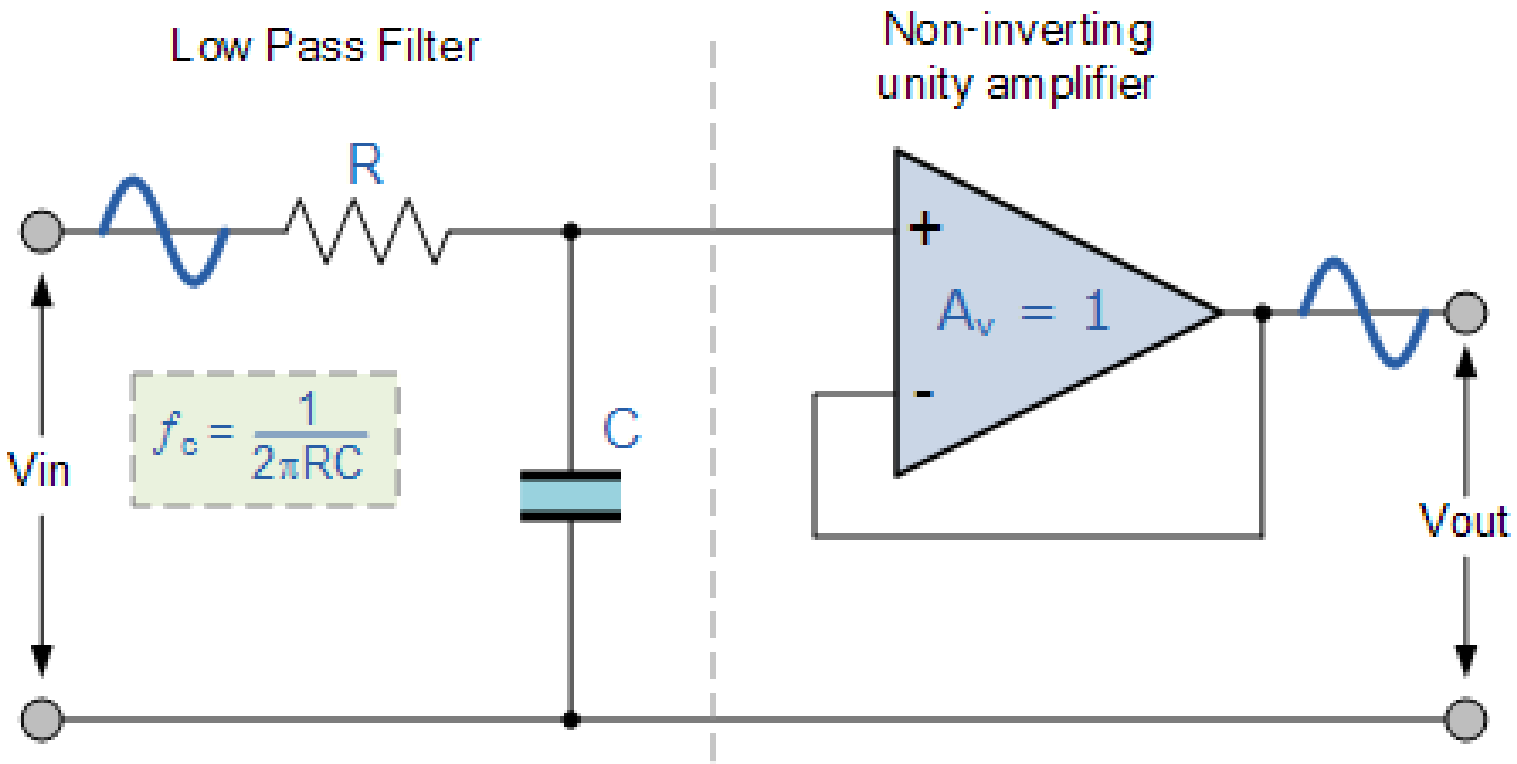




Keuntungan Filter Aktif

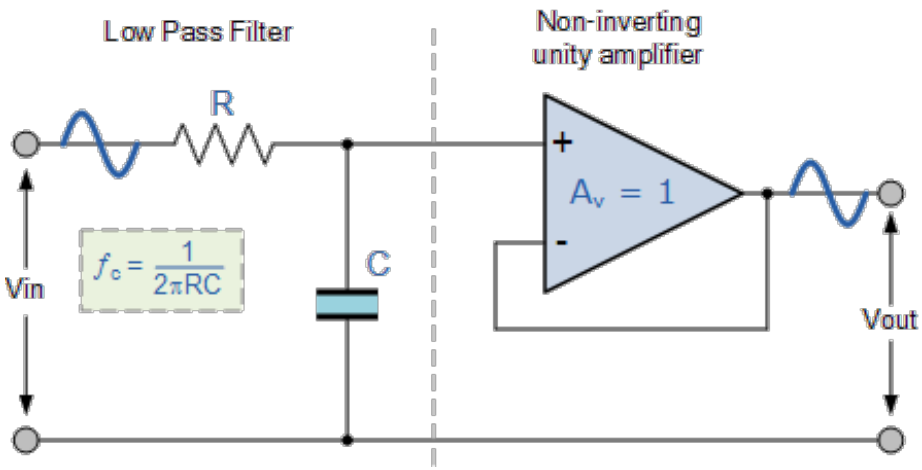
Beberapa keuntungan filter aktif:

- Gain filter dapat diatur.
- Impedansi input tinggi, sehingga tidak mempengaruhi rangkaian sebelumnya.



Filter Aktif Orde 1: Low-pass

Active low-pass filter orde 1:



$$V_C = \frac{-jX_C}{-jX_C + R} V_{in}$$

$$V_o = V_C$$

$$\frac{V_o}{V_{in}} = \frac{1}{1 + j\frac{R}{X_C}}$$

Frekuensi cut off ketika $\frac{V_o}{V_i n} = -3dB$ atau $\frac{1}{\sqrt{2}}$, maka

$$\frac{1}{\sqrt{2}} = \frac{1}{1 + j\frac{R}{X_C}}$$

$X_C = \frac{1}{2\pi fC}$, maka

$$\frac{1}{\sqrt{2}} = \frac{1}{1 + j2\pi fRC}$$

$$f_c = \frac{1}{2\pi RC}$$

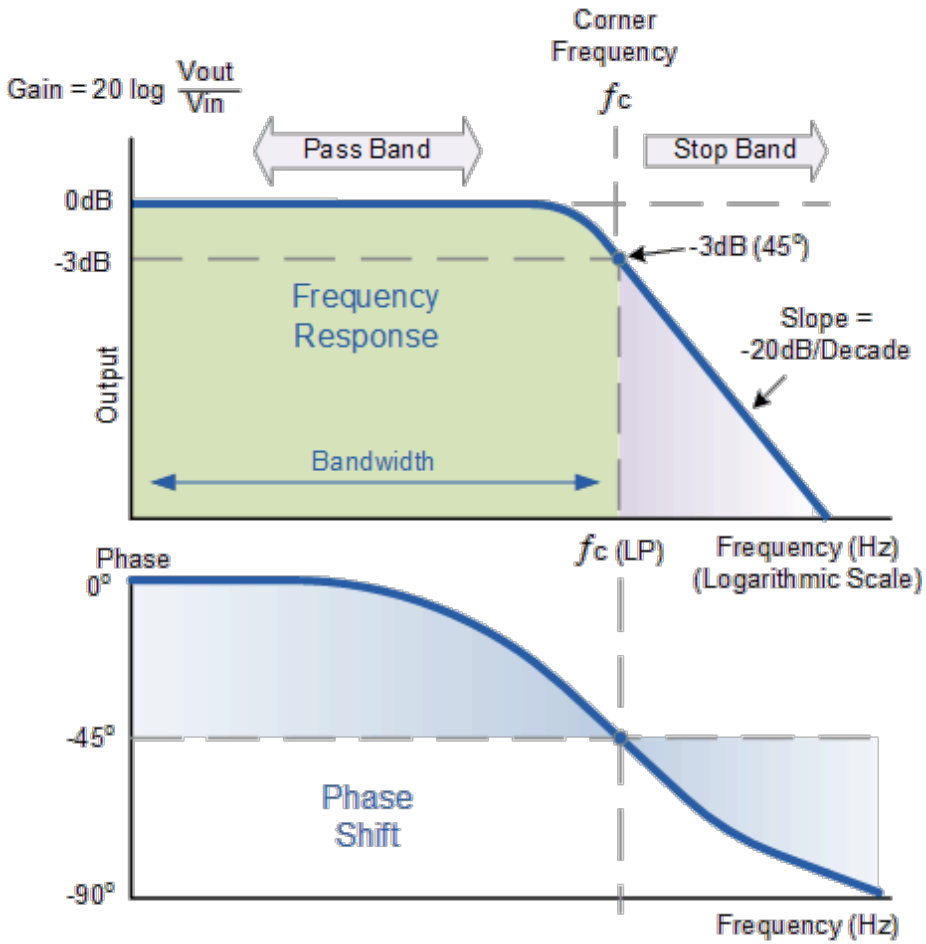
Filter Aktif Orde 1: Low-pass

Penguatan tegangan A_v pada untuk setiap frekuensi

$$|\frac{V_o}{V_in}| = \frac{1}{1+j\frac{f}{f_c}} = \frac{1}{\sqrt{1^2+(\frac{f}{f_c})^2}}$$

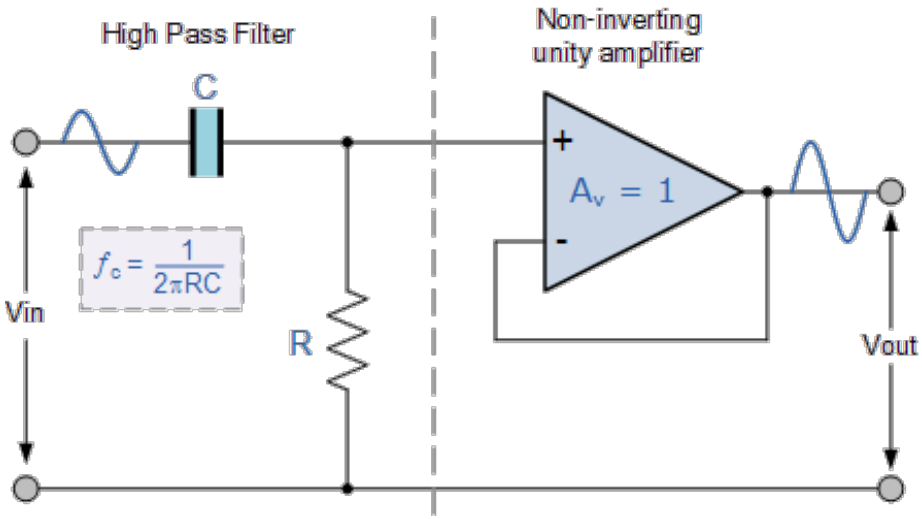
Pergeseran fasa

$$\theta = \frac{0^o}{tan^{-1}(\frac{f}{f_c})}$$



Filter Aktif Orde 1: High-pass

Active high-pass filter orde 1:



$$V_C = \frac{R}{-jX_C + R} V_{in}$$

$$V_o = V_C$$

$$\frac{V_o}{V_{in}} = \frac{1}{1 + j\frac{X_C}{R}}$$

Frekuensi cut off ketika $\frac{V_o}{V_in} = -3dB$ atau $\frac{1}{\sqrt{2}}$, maka

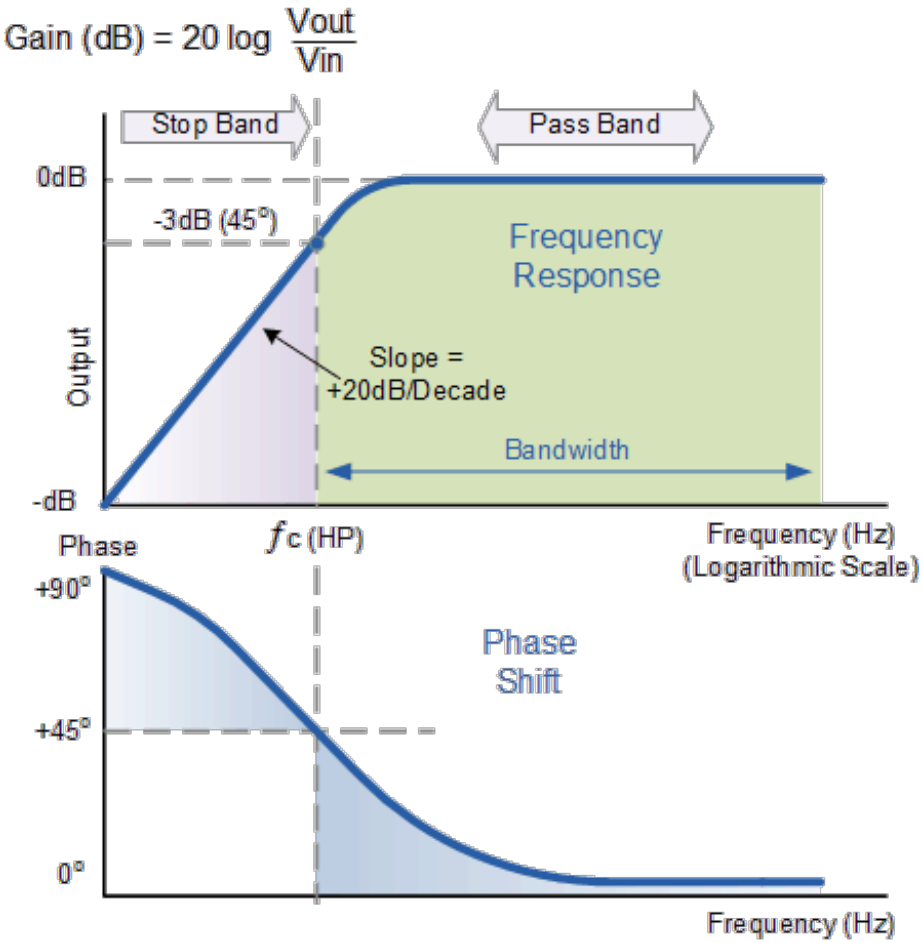
$$\frac{1}{\sqrt{2}} = \frac{1}{1 + j\frac{X_C}{R}}$$

$X_C = \frac{1}{2\pi fC}$, maka

$$\frac{1}{\sqrt{2}} = \frac{1}{1 + j/2\pi fRC}$$

$$f_c = \frac{1}{2\pi RC}$$

Filter Aktif Orde 1: High-pass



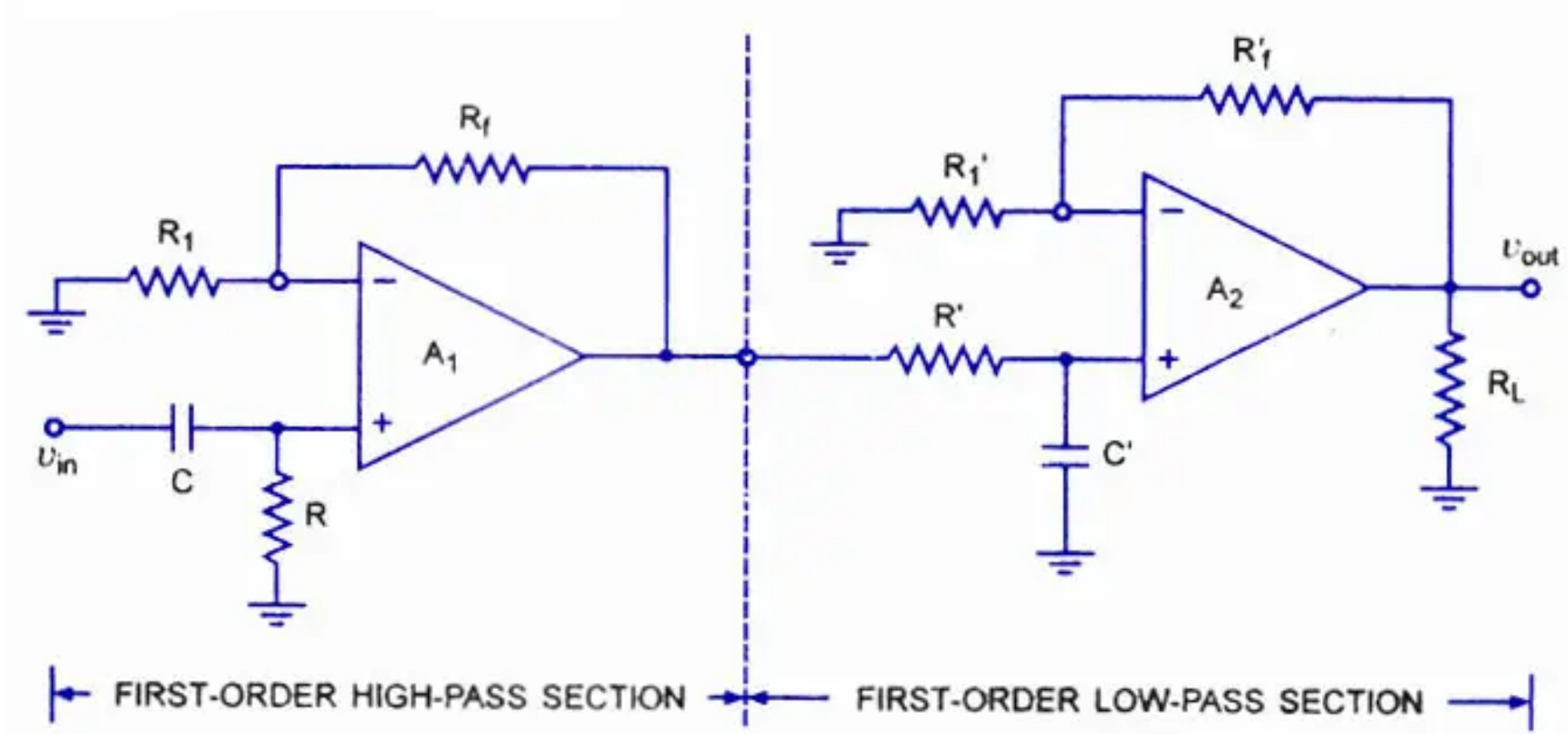
Penguatan tegangan A_v pada untuk setiap frekuensi

$$|\frac{V_o}{V_i n}| = \frac{1}{1 + j\frac{f_c}{f}} = \frac{1}{\sqrt{1^2 + (\frac{f_c}{f})^2}}$$

Pergeseran fasa

$$\theta = \frac{0^o}{tan^{-1}(\frac{f_c}{f})}$$

Cascaded Filter

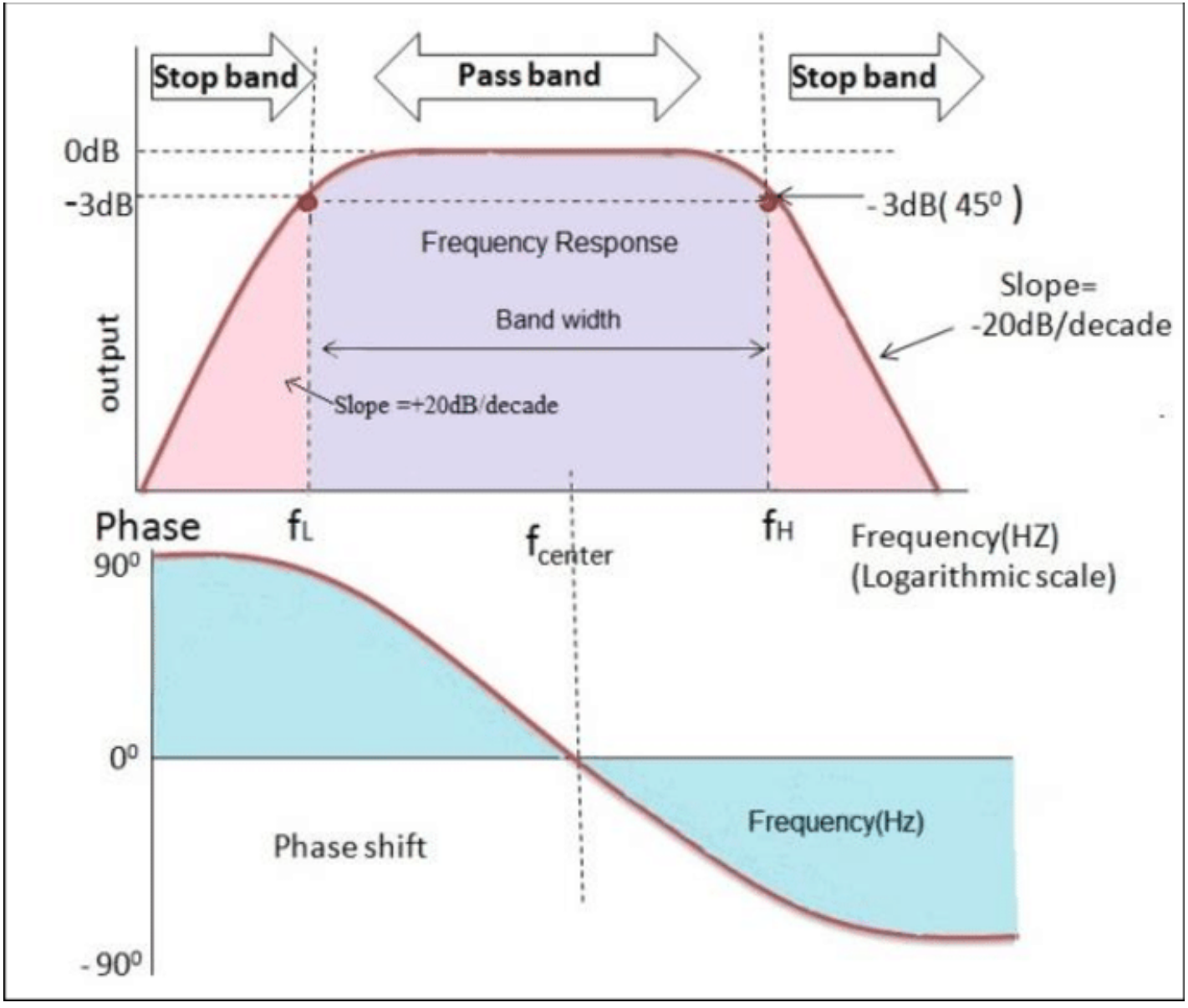


Circuit Diagram

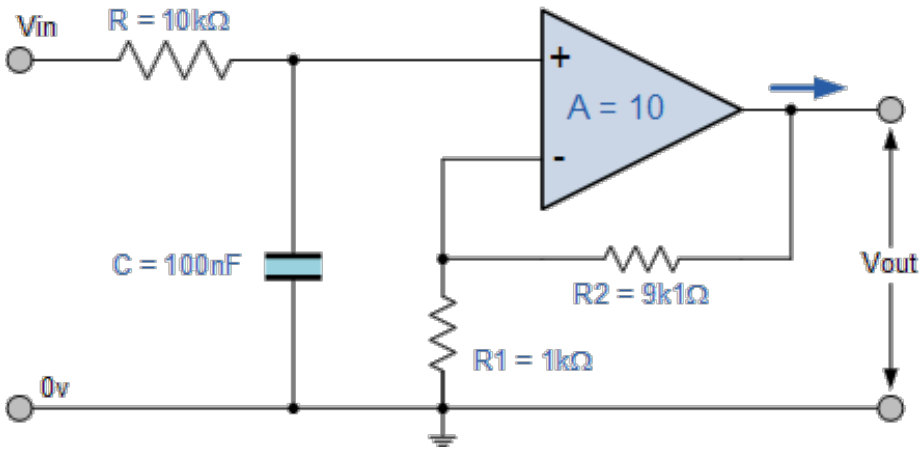
Wide Band Pass Filter

www.CircuitsToday.com

Cascaded Filter



Contoh

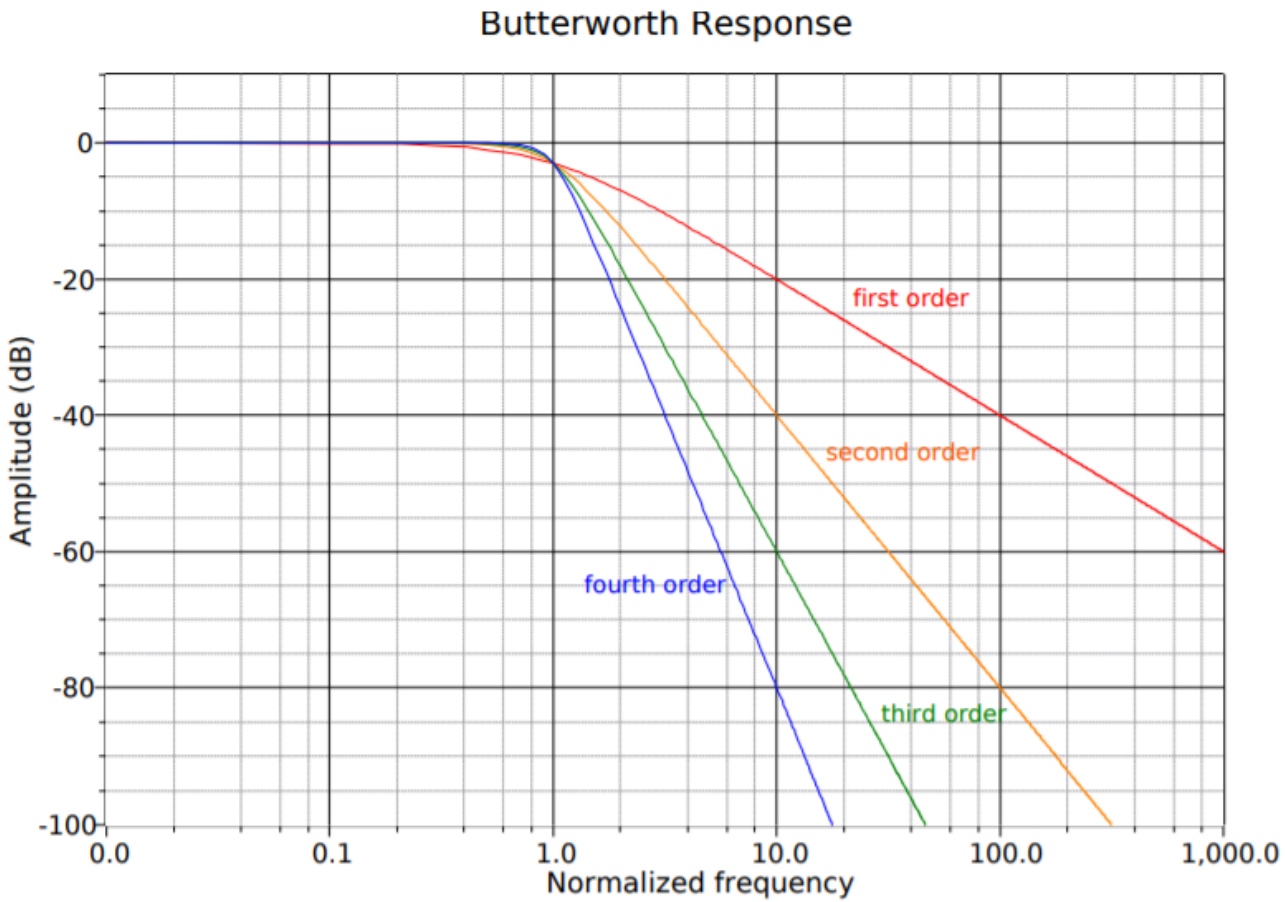


Tentukan!

- Frekuensi cut off (f_c)
- Penguatan tegangan (A_v) dan pergeseran fasa apabila $f = 0.1 f_c$
- Penguatan tegangan (A_v) dan pergeseran fasa apabila $f = 10 f_c$
- Bode plot frekuensi

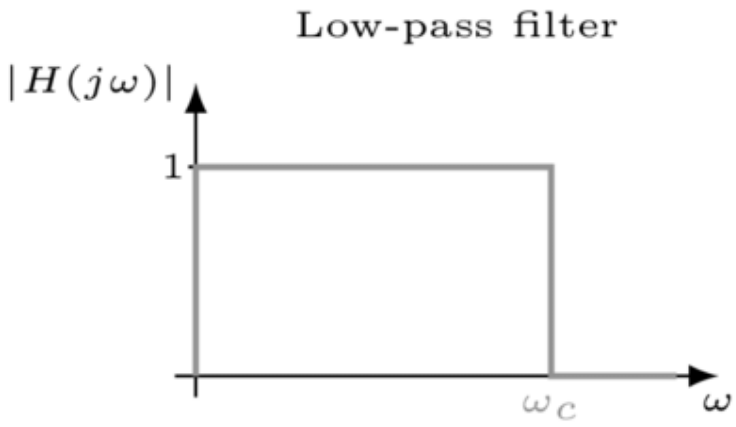
Filter Order

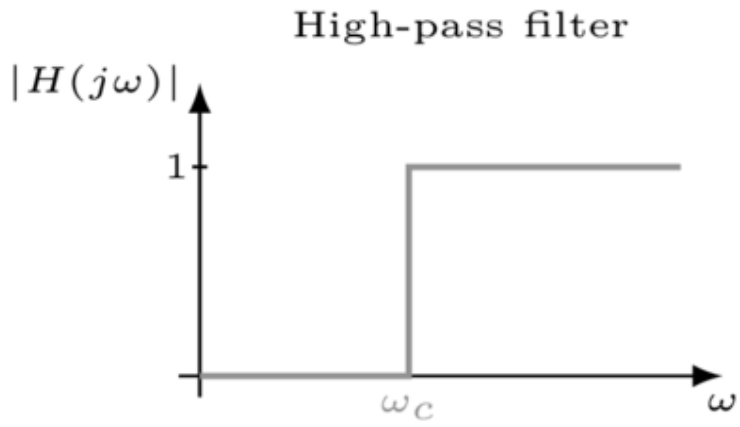
Pengaruh orde filter terhadap respon frekuensi

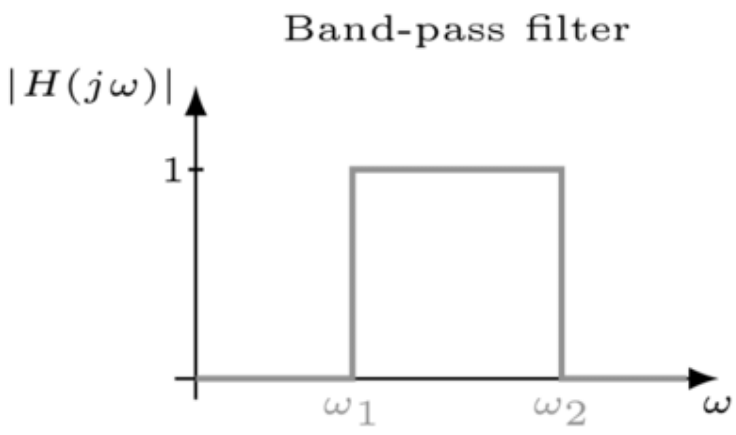


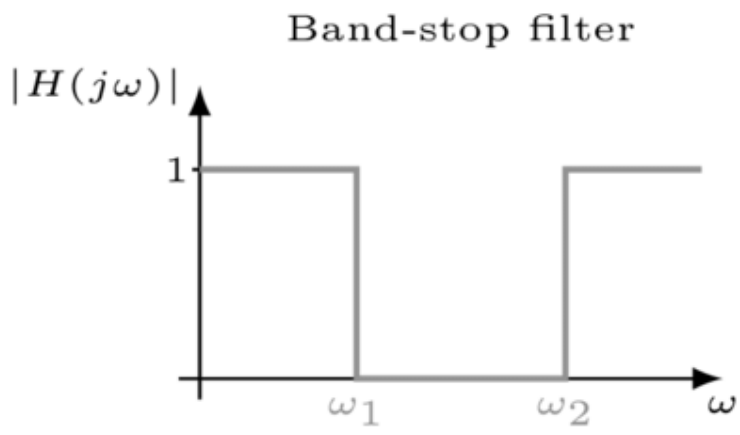
Ideal Filter

Respon filter ideal



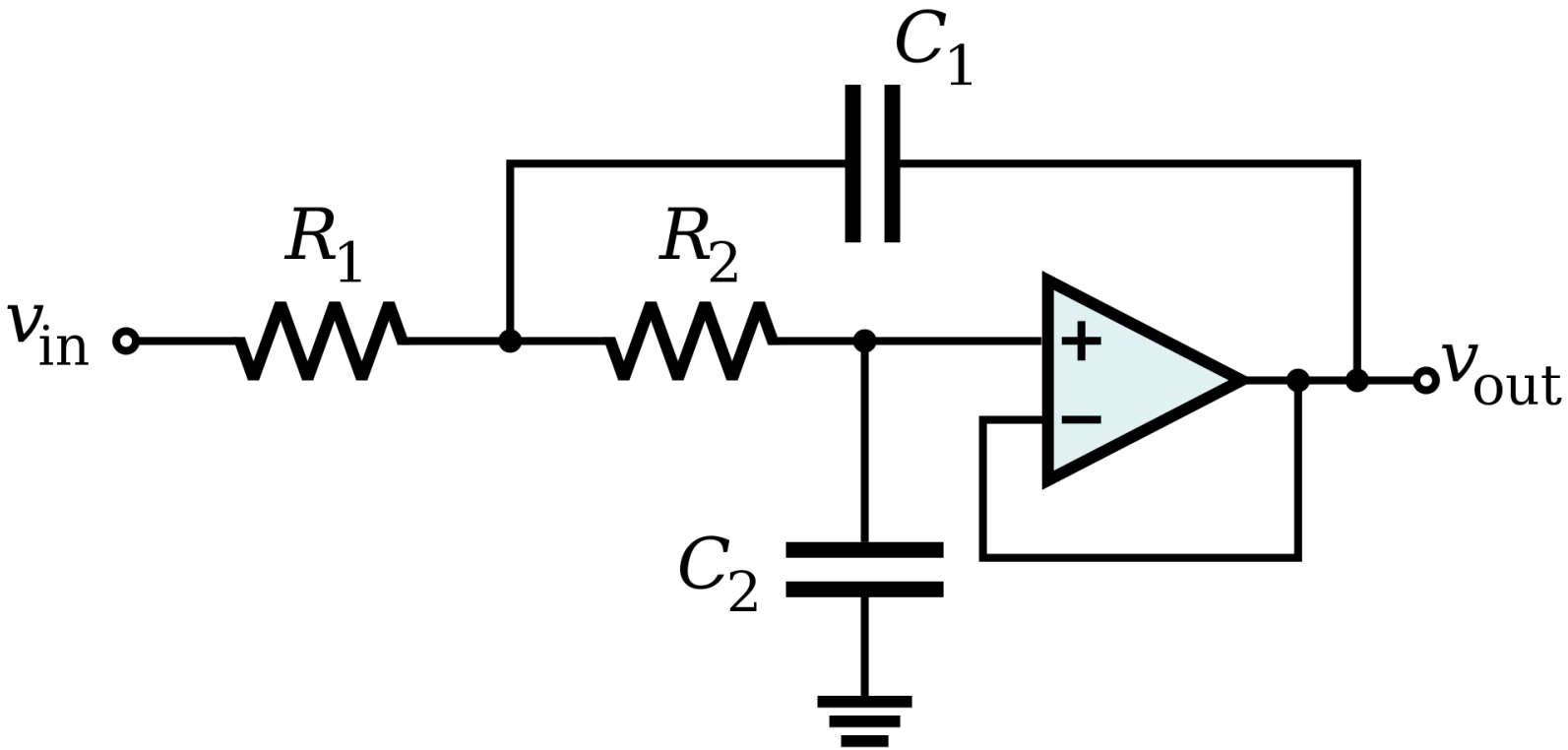






Filter Aktif Orde 2: Low-pass

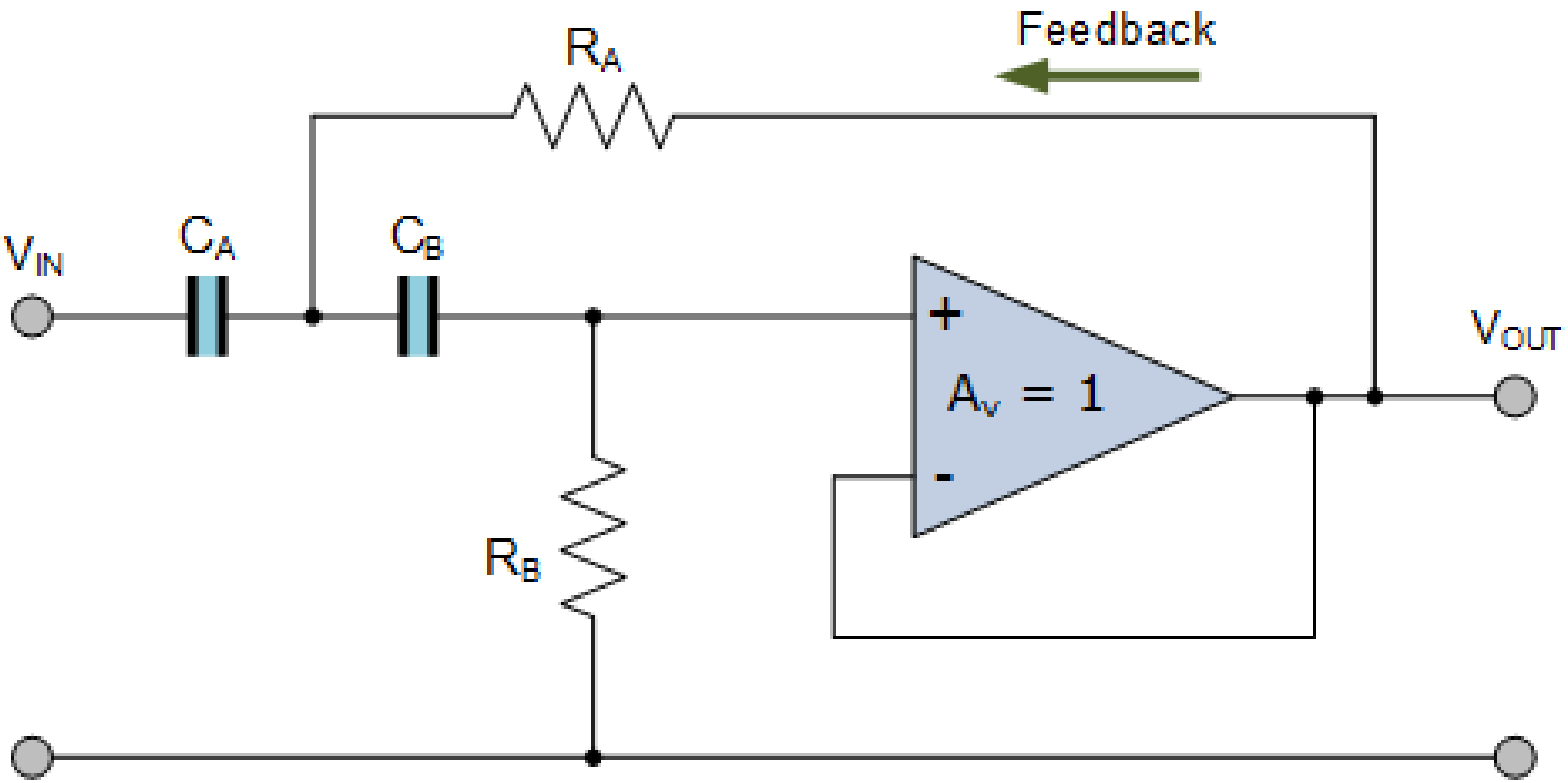
Active low-pass filter orde 2:



$$f_c = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

Filter Aktif Orde 2: High-pass

Active high-pass filter orde 2:

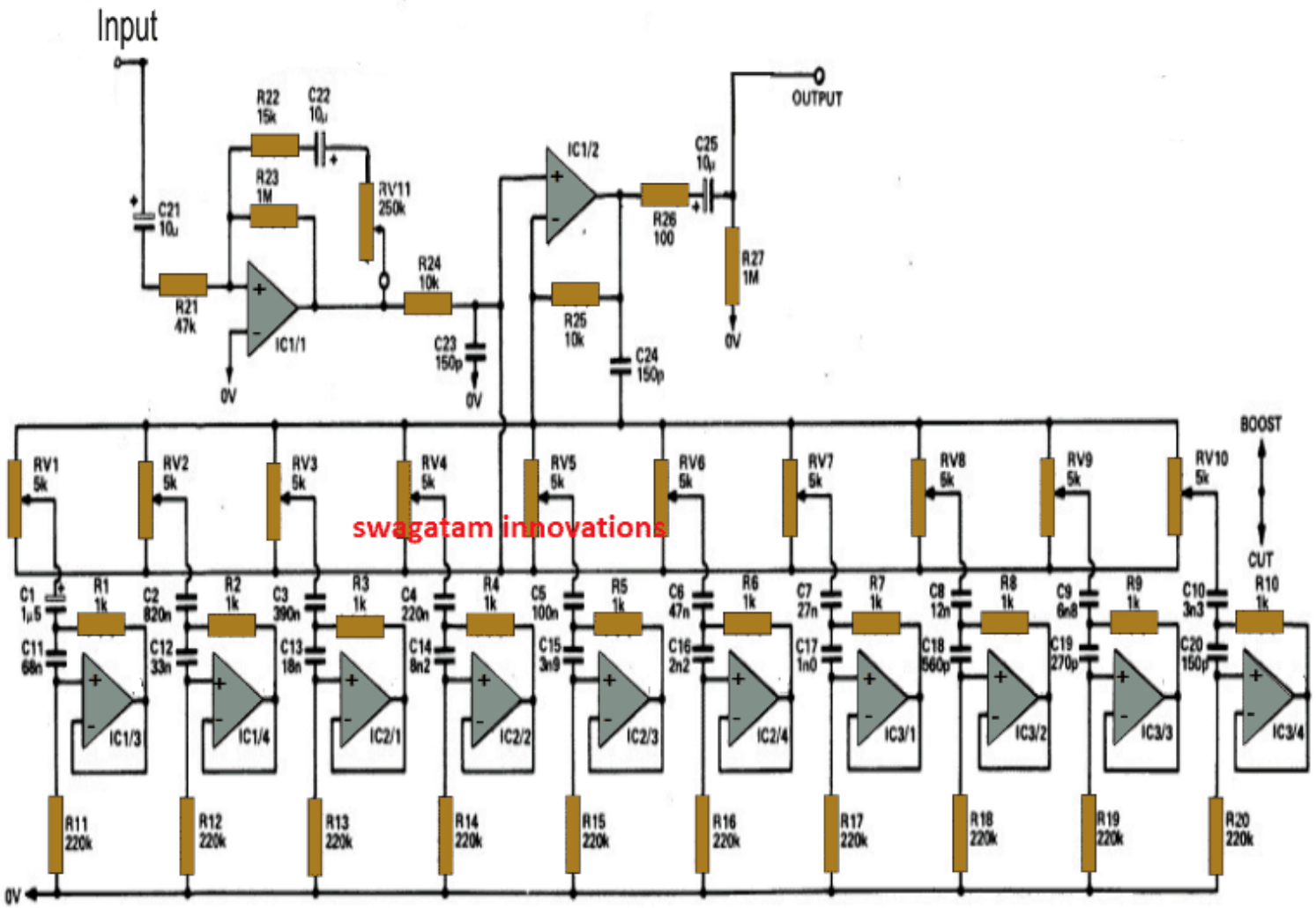


$$f_c = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

Aplikasi Filter Aktif

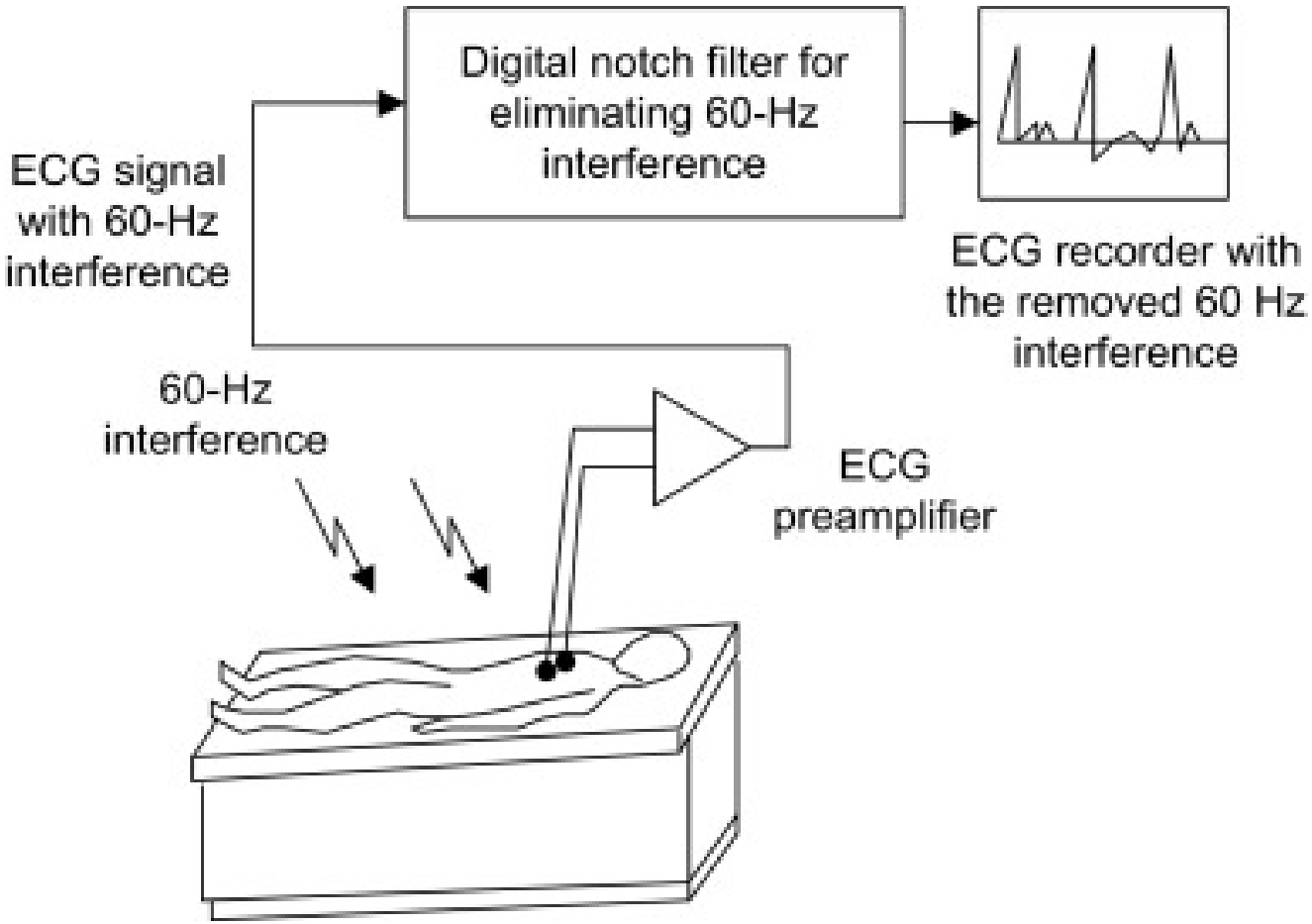
10-band equalizer

Aplikasi Filter Aktif



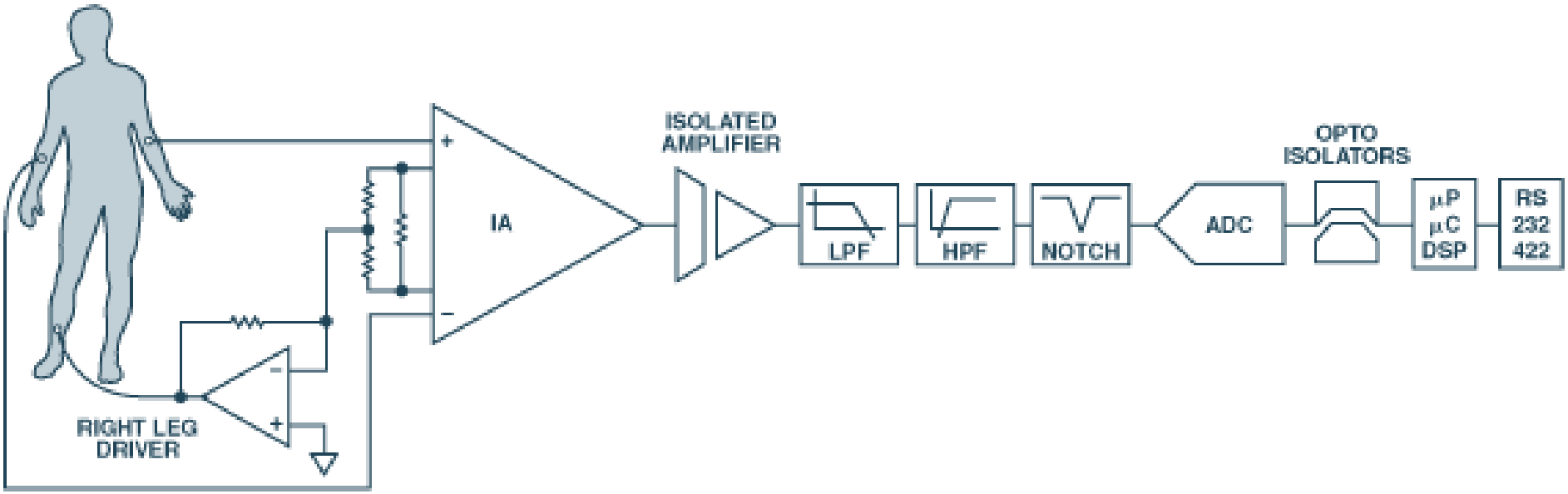
Aplikasi Filter Aktif

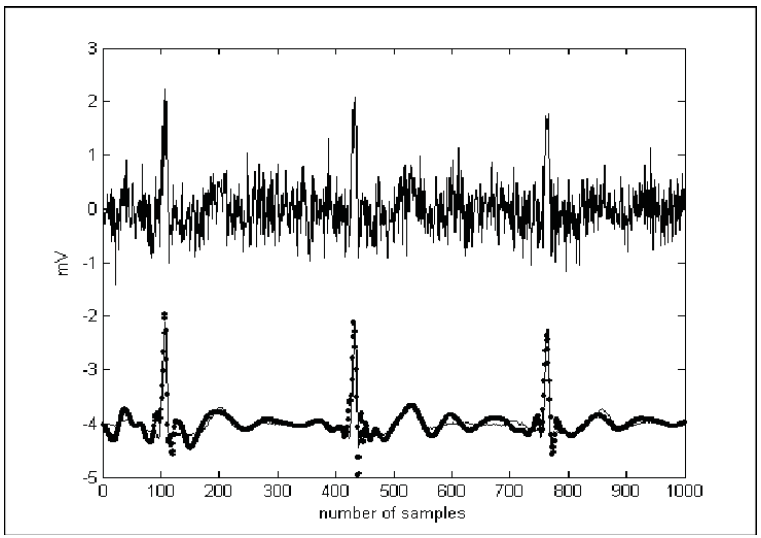
Notch filter ECG



ECG filter

Aplikasi Filter Aktif





References

Floyd,T.L., Fundamentals of Analog Circuits, Prentince Hall, .
Malvino,A., Electronic Principle, McGrawHill, 2016.
Boylestad, R.L., Nashelsky,L., Electronics Devices and Circuit Theory, Pearson, 2014.

Terima Kasih