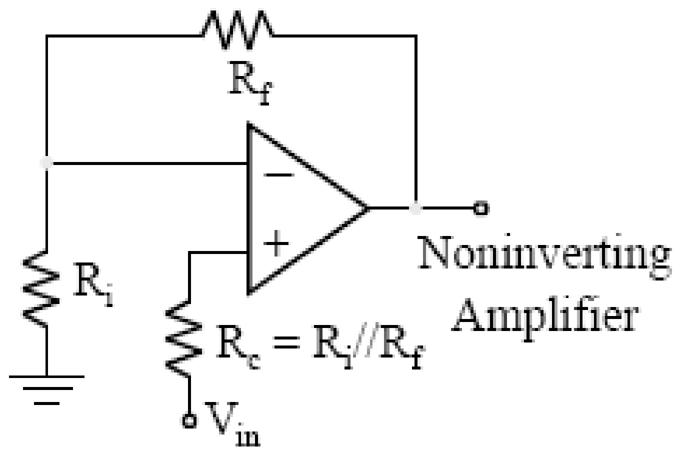
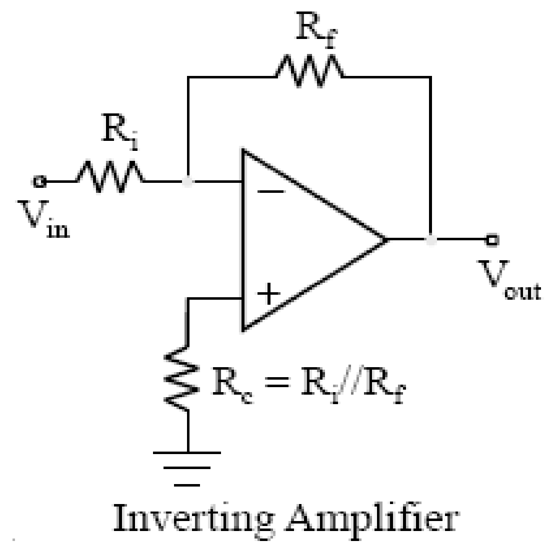
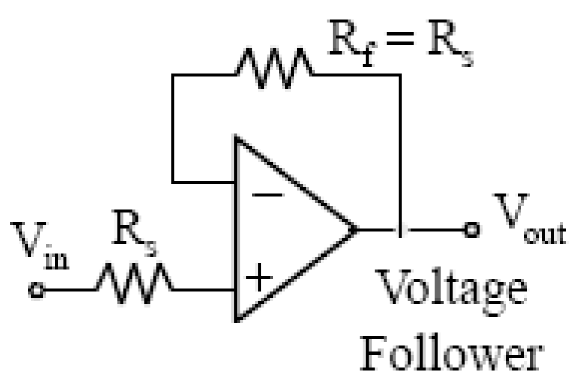
OP-AMPS WITH NEGATIVE FEEDBACK (2)

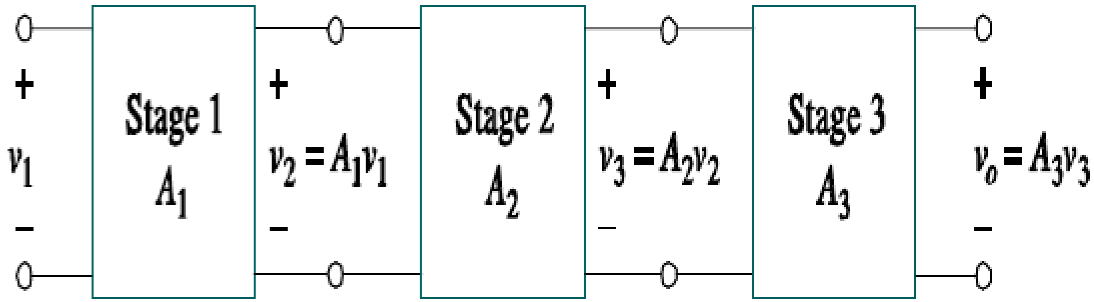
Bias Current Compensation



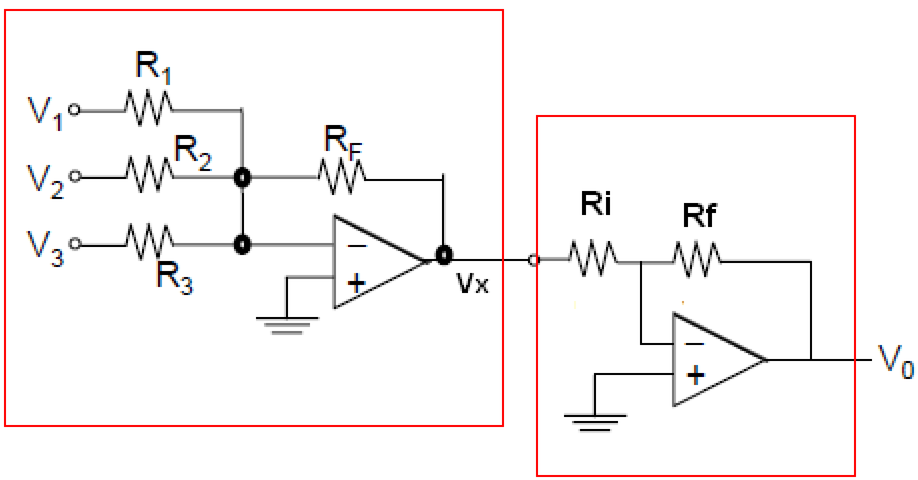




Rangkaian Cascade op-amp



Contoh :



- Stage 1 adalah rangkaian summing dengan output Vx

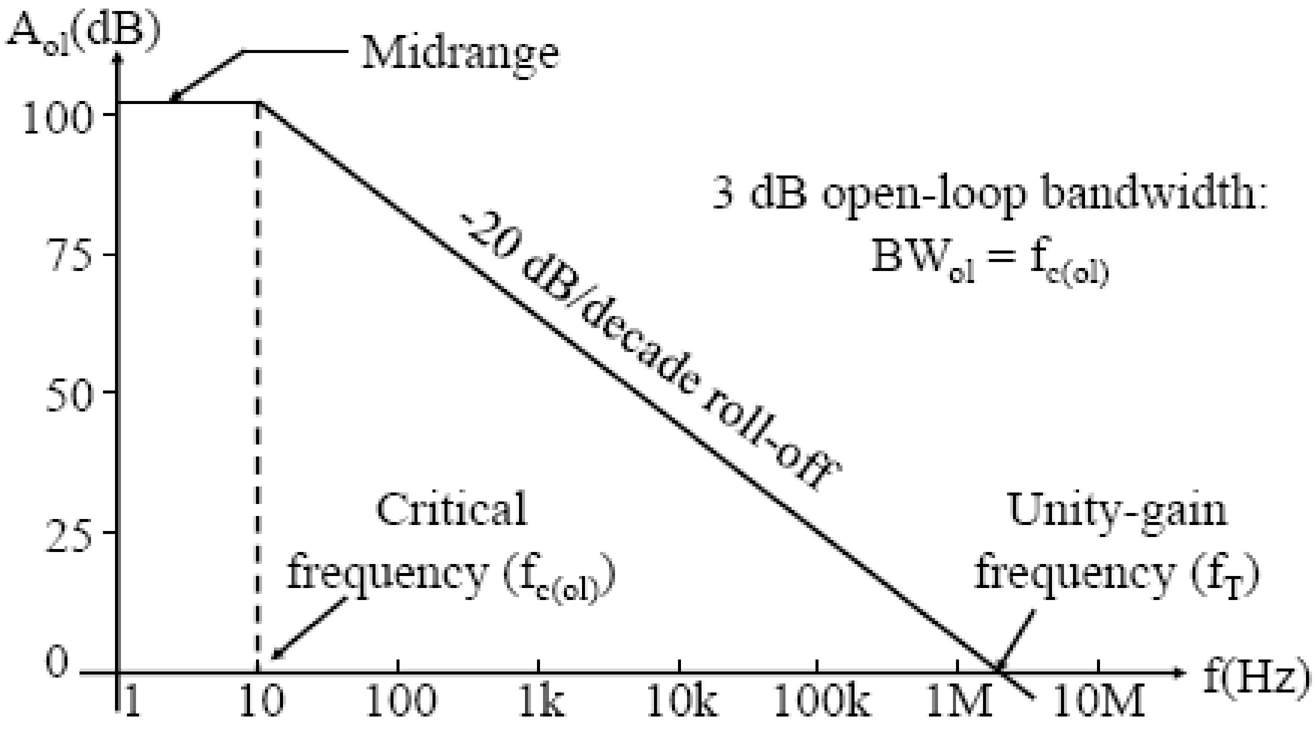
$$V_x = -\left(\frac{R_F}{R_1} V_1 + \frac{R_F}{R_2} V_2 + \frac{R_F}{R_3} V_3 \right)$$

- Stage 2 adalah rangkaian inverting dengan input Vx

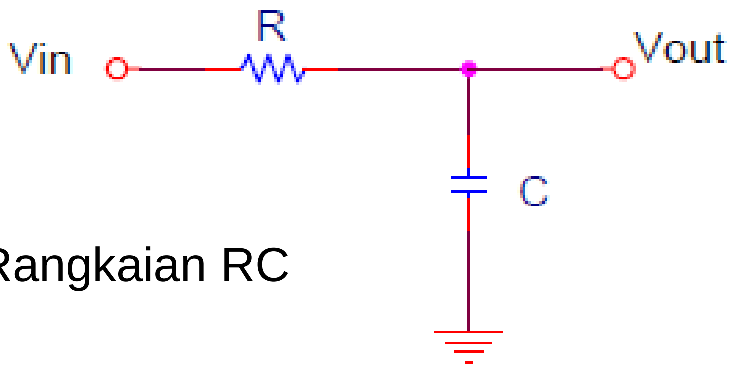
$$V_o = -\frac{R_f}{R_i} V_x$$

Bandwidth Frekuensi Open Loop

- Bandwidth dari ac amplifier → range frekuensi antara titik dimana gain turun 3 dB dari nilai maksimumnya (midrange gain)
- BW = fc–fcl
- fcl pada op-amp =nol → BW = fc



Gain vs Analisa Frekuensi



Rangkaian RC

Voltage gain rangkaian RC:

$$\frac{V_{out}}{V_{in}} = \frac{X_C}{\sqrt{R^2 + X_C^2}}$$

Bila sisi kanan dibagi dengan Xc :

$$\frac{V_{out}}{V_{in}} = \frac{1}{\sqrt{1 + R^2 / X_C^2}} \text{..........}(a)$$

$$f_C = \frac{1}{2\pi RC} \text{...............}(b)$$

$$(b) \div f$$

$$\frac{f_C}{f} = \frac{1}{2\pi RCf} = \frac{1}{(2\pi fC)R}$$

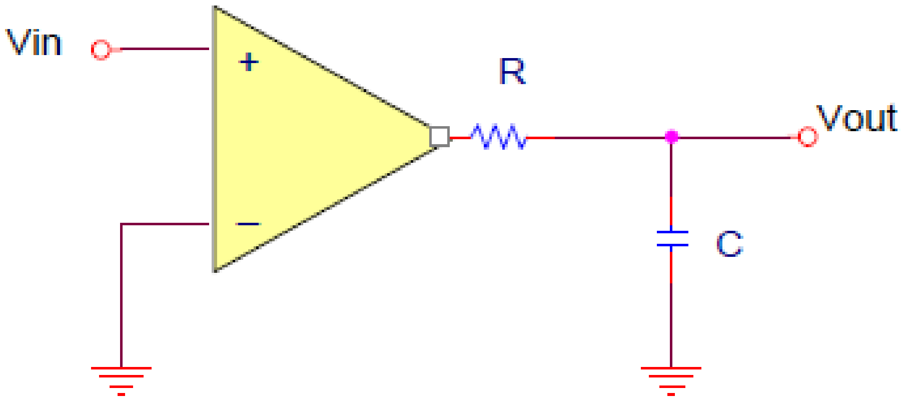
$$put \rightarrow X_C = \frac{1}{(2\pi fC)}$$

$$\frac{f_C}{f} = \frac{X_C}{R} \text{........}(c)$$

$$(c) \rightarrow (a)$$

$$\frac{V_{out}}{V_{in}} = \frac{1}{\sqrt{1 + f^2 / f_C^2}}$$

Representasi Op- Amp



Jika Op-amp di representasikan oleh Aol(mid) ditambah rangkaian RC maka total open-loop gain adalah :

$$A_{ol} = \frac{A_{ol(mid)}}{\sqrt{1 + f^2 / f_C^2}}$$

Contoh :

Tentukan Aol f untuk beberapa nilai f dibawah ini. Asumsikan fc(ol)=100 Hz dan Aol(mid)=100,000.

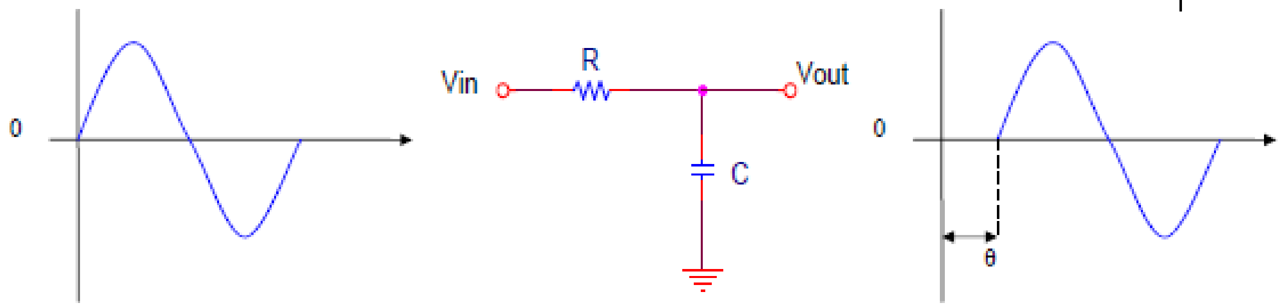
A) f=0Hz

B) f=10Hz

C) f=100Hz

D) f=1000Hz

Phase Shift



- Rangkaian RC menyebabkan adanya pergeseran fase pada output

- Secara teori pergeseran fase Ө adalah

$$\theta = -\tan^{-1}\left(\frac{R}{X_C}\right)$$

- Karena R/Xc= f/fc,

$$\boxed{\theta = -\tan^{-1}\left(\frac{f}{f_C}\right)}$$

Contoh :

Hitung pergeseran fase pada rangkaian RC untuk setiap frekuensi dan plot kurva pergeseran fase vs frekuensi . Asumsikan fc=100Hz.

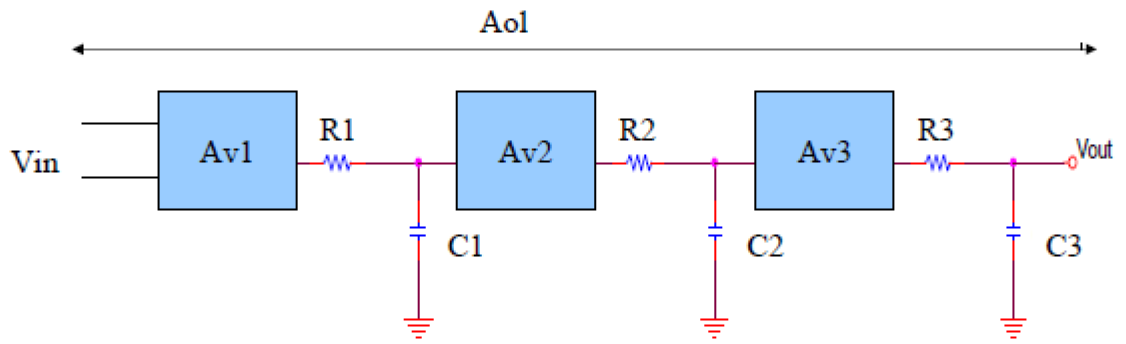
A) 1Hz

B) 10Hz

C) 100Hz

D) 1000Hz

E) 10000Hz



Representasi op-amp tiga stages

Pergeseran fase merupakan penjumlahan total dari ketiga stage

$$\boxed{\theta_{tot} = -\tan^{-1}\left(\frac{f}{f_{c1}}\right) - \tan^{-1}\left(\frac{f}{f_{c2}}\right) - \tan^{-1}\left(\frac{f}{f_{c3}}\right)}$$

Closed-Loop Response

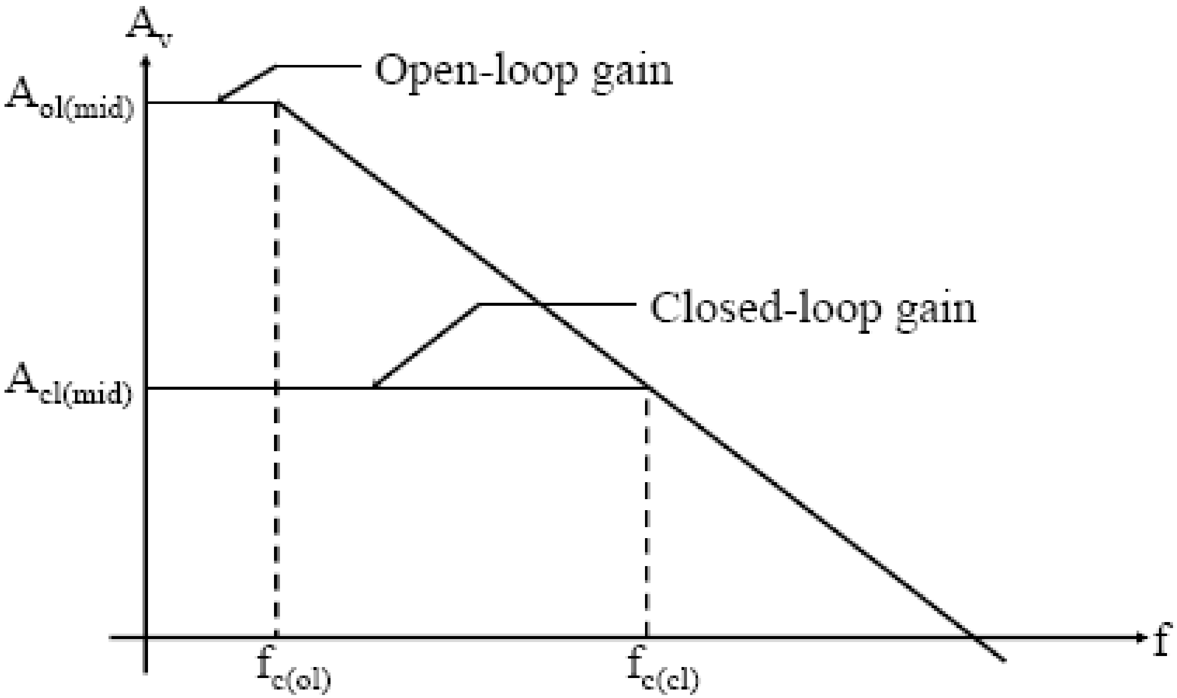
- Efek Negative Feedback pada Bandwidth
  - Closed-loop critical frequency op-amp:

$$\boxed{f_{c(cl)} = f_{c(ol)}(1 + BA_{ol(mid)})}$$

  - Karena fc(cl) samadengan bandwidth pada closed-loop amplifier, maka closed-loop bandwidth(BWcl)

$$\boxed{BW_{cl} = BW_{ol}\,(1 + BA_{ol(mid)})}$$

Closed Loop vs Open loop Gain



Contoh :

Amplifier memiliki open-loop midrange gain sebesar 150,000 dan open-loop 3dB bandwidth sebesar 200Hz. Gain pada feedback loopsebesar B=0.002. Berapa nilai closed-loop bandwidth?

Closed-Loop Response

- **Gain Bandwidth**
  Acl →gain pada konfigurasi closed-loop , fc(cl) →closed-loop critical frequency maka

$$\boxed{A_{cl}f_{c(cl)} = A_{ol}f_{c(ol)}}$$

Unity-gain bandwidth

$$\boxed{\text{Unity gain BW} = A_{cl}f_{c(cl)}}$$