

(1)

(a) A differential amplifier should have high differential voltage gain (A_{Dm}) and very low common mode voltage gain (A_{cm}). The ratio $A_{\text{Dm}}/A_{\text{cm}}$ is called "common-mode rejection ratio (CMRR)".

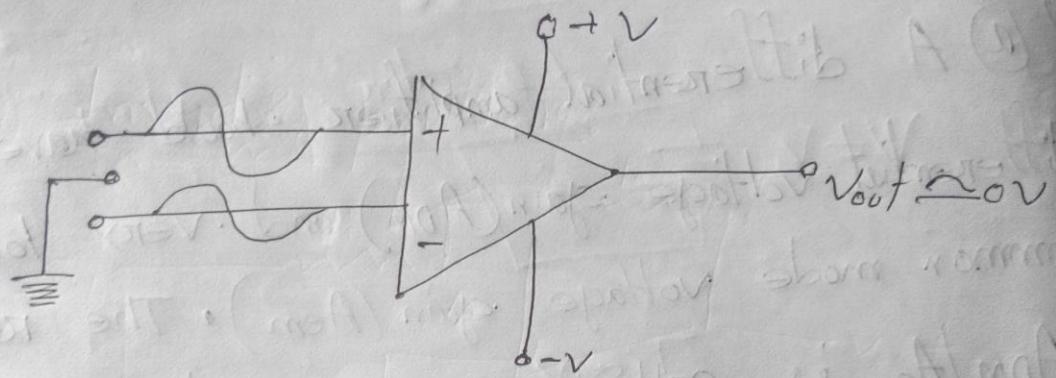
$$\text{CMRR} = \frac{A_{\text{Dm}}}{A_{\text{cm}}}$$

Very often the CMRR is expressed in decibels

$$\text{CMRR}_{\text{dB}} = 20 \log_{10} \frac{A_{\text{Dm}}}{A_{\text{cm}}}$$

$$= 20 \log_{10} \text{CMRR}$$

Importance of CMRR: The CMRR is the ability of a DA to reject the common mode signals. The larger the CMRR, the better the DA is at eliminating common-mode signals. Let us illustrate this point.



This means that the output produced by a difference between the inputs would be 1500 times as great as an output produced by a common mode signal.

Common Mode Rejection Ratio (CMRR): It is the ratio of the voltage gain of the有用信号 to the voltage gain of the common mode signal. It is given by the formula:

$$CMRR = \frac{A_{vD}}{A_{vC}}$$

(b)

Differential gain $A_{\text{om}} = 100 \text{ volt}$

Common-mode gain $A_{\text{em}} = 3.2 \text{ volt}$

$$A_{\text{em}} = \frac{V_{\text{out}}}{V_{\text{in}}} = \frac{26}{32} = 8.125$$

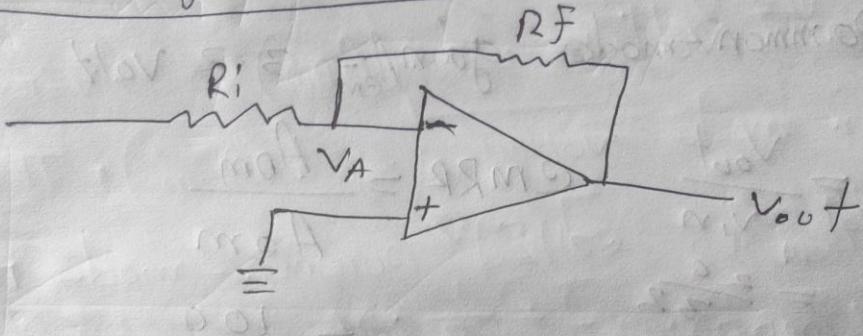
$$\text{CMRR} = \frac{A_{\text{om}}}{A_{\text{em}}} = \frac{100}{8.125} = 12.30$$

The CMRR in dB $\Rightarrow 20 \log_{10}(12.30)$

$$= 26.25 = 12.3$$

(c)

Inverting amplifier:



$$I_{in} = \frac{V_{in} - V_A}{R_i}$$

$$= \frac{V_{in} - 0}{R_i} = \frac{V_{in}}{R_i}$$

$$I_f = \frac{V_A - V_{out}}{R_f}$$

$$= \frac{0 - V_{out}}{R_f}$$

$$= -\frac{V_{out}}{R_f}$$

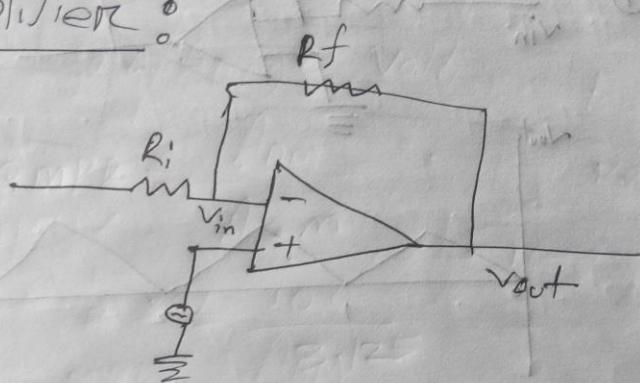
Since $I_+ = I_{in}$

$$-\frac{V_{out}}{R_f} = \frac{V_{in}}{R_i}$$

$$A_{cl} = \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_i}$$

Question to the Answer z(a)

Noninverting Amplifier:



Current through R_i = Current through R_f

$$\frac{V_{in} - 0}{R_i} = \frac{V_{out} - V_{in}}{R_f}$$

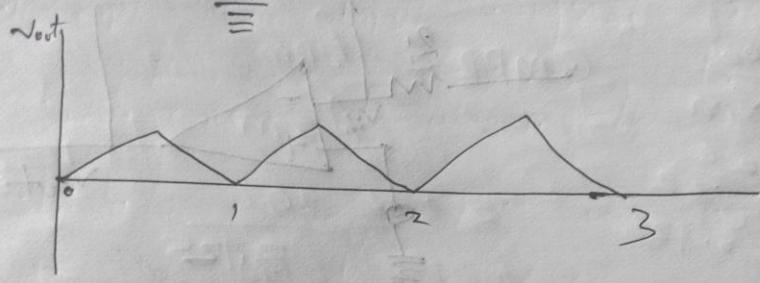
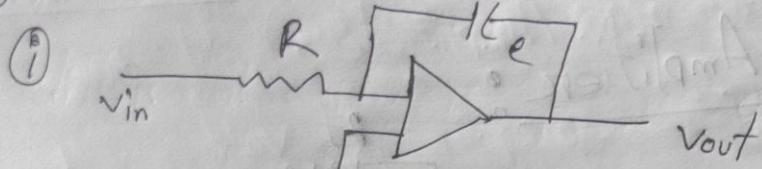
$$V_{in} R_f = V_{out} R_i - V_{in} R_i$$

$$V_{in} (R_f + R_i) = V_{out} R_i$$

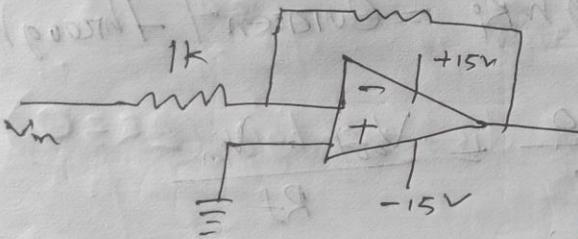
$$\frac{V_{out}}{V_{in}} = \frac{R_f + R_i}{R_i}$$
$$= 1 + \frac{R_f}{R_i}$$

$$\therefore \text{Closed-loop voltage gain } A_{CL} = \frac{V_{out}}{V_{in}} = 1 + \frac{R_f}{R_i}$$

(B) Required add & subtract



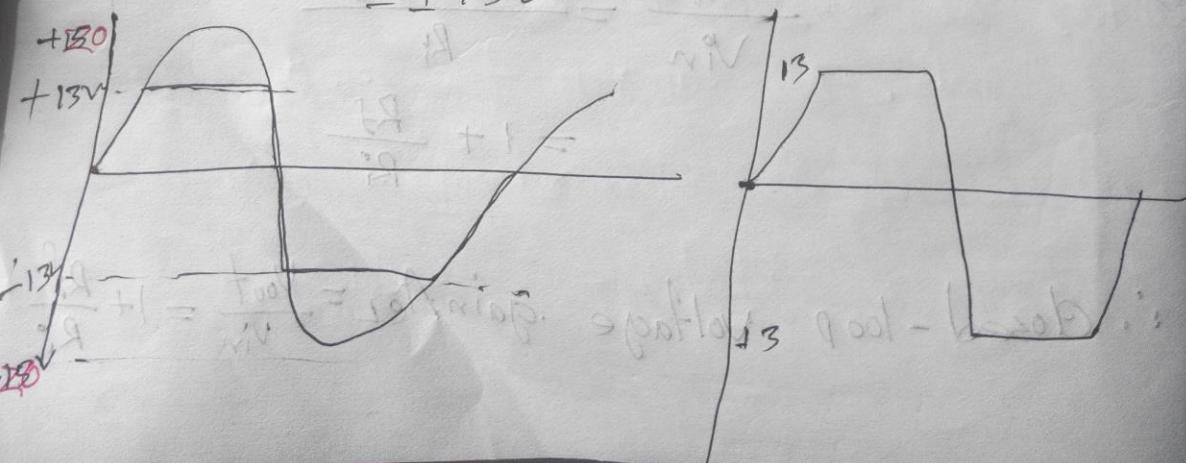
(ii)



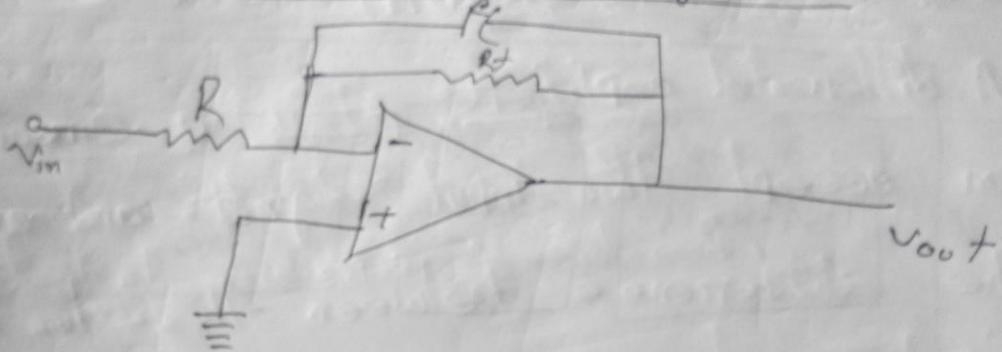
$$A_{cl} = -\frac{R_f}{R_i} = \frac{40}{R_i} = 40$$

$$V_{out} = 40 \times 0.5 \\ = 20 \text{ V}$$

$$V_{sat} = \cancel{\text{SUPPLY}} \pm 2 \\ = 15 - 2 \\ = \pm 13 \text{ V}$$

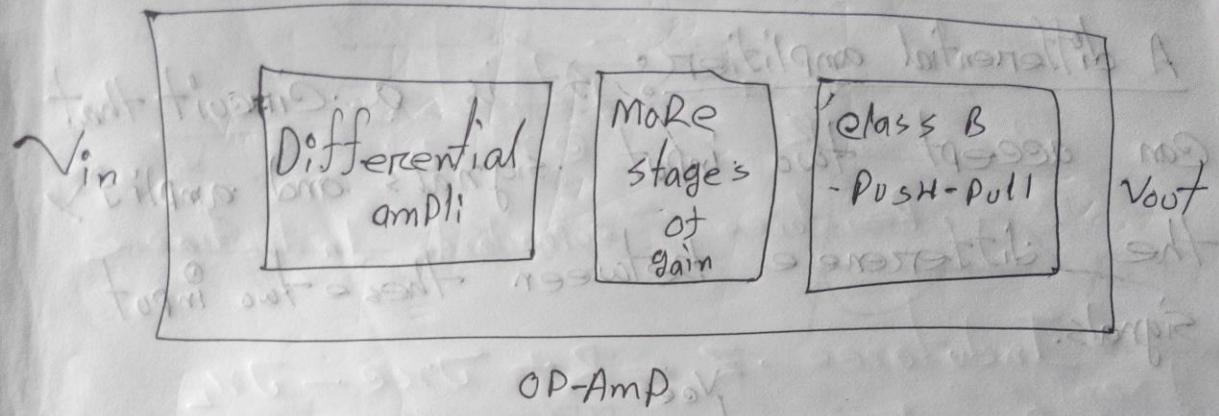


④ Critical Frequency of Integrators:



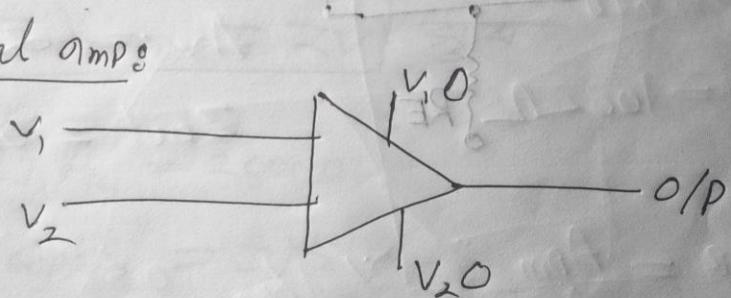
$$f_c = \frac{1}{2\pi R_f C}$$

* operational Amplifier (op-amp):



An operational amplifier: op-amp is a circuit that can perform such mathematical operations as addition, subtraction, integration and differentiation.

Differential amp:

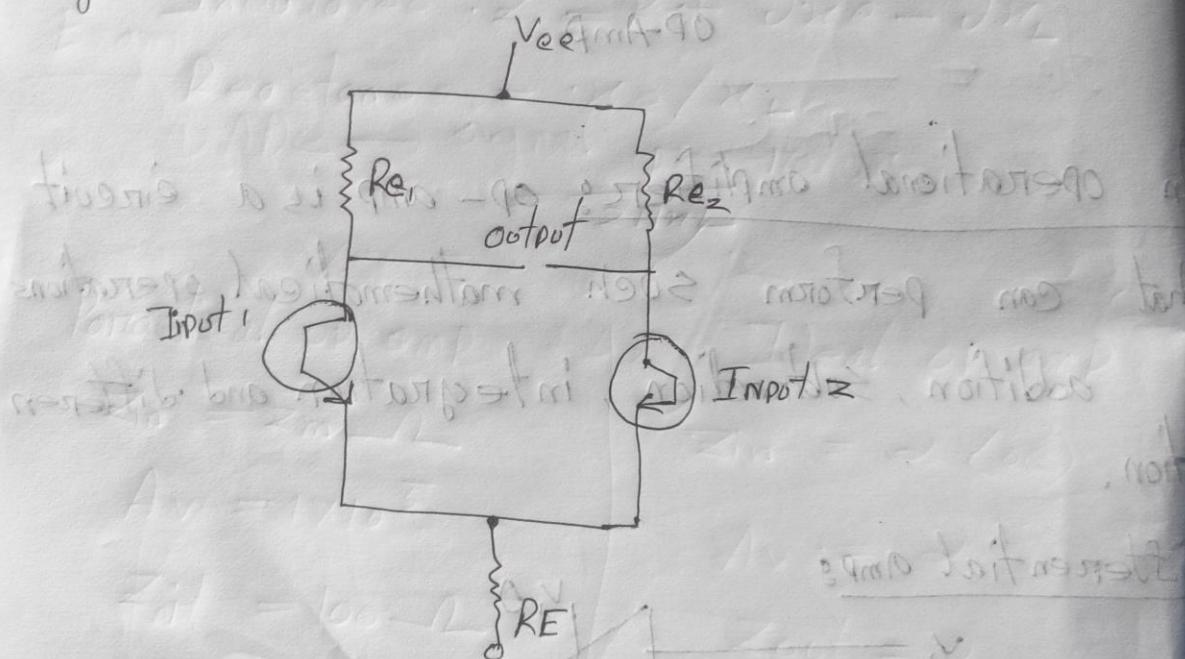


$$\text{Gain} = \frac{\text{O/P}}{\text{I/P}}$$

$$A(V_1 - V_2) = \text{O/P}$$

Differential amplifier (DA)

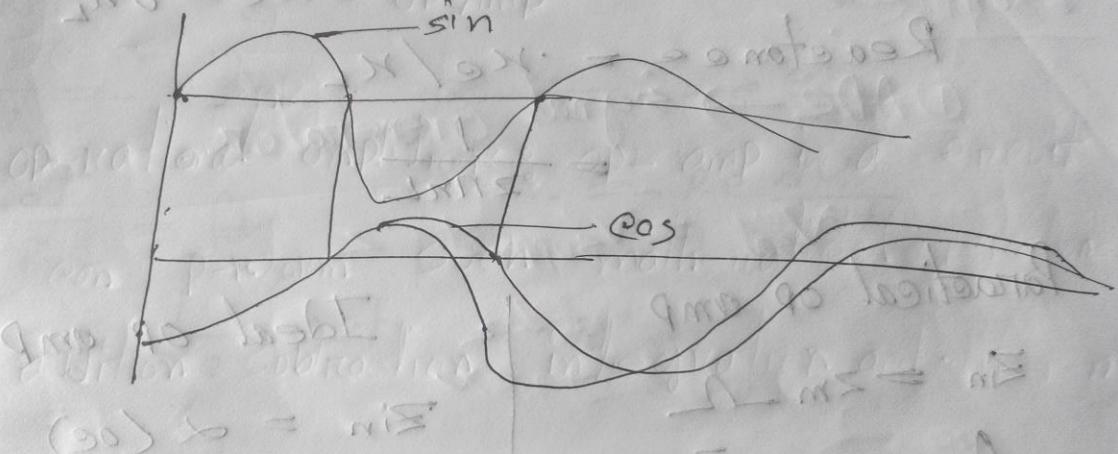
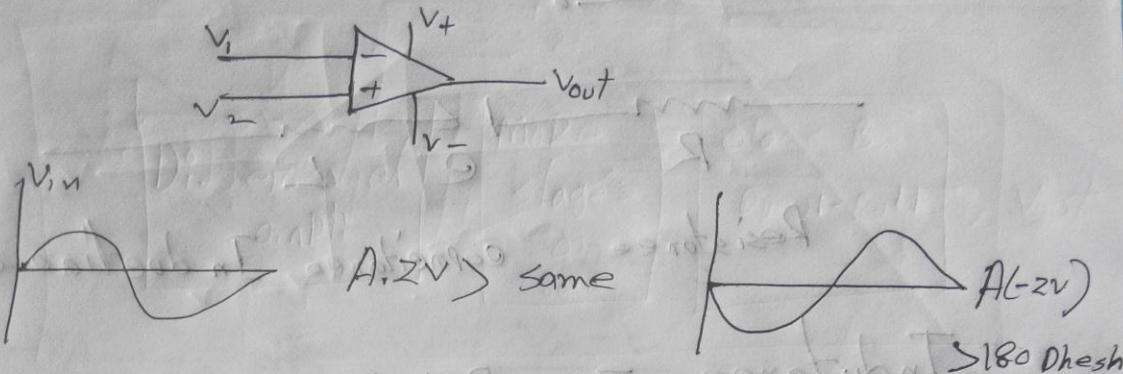
A differential amplifier: It is a circuit that can accept two input signals and amplify the difference between these two input signals.



$$\frac{v_o}{v_s} = \text{mid}$$

$$\text{Differential gain} = (v_o - v_s) A$$

Schematic Diagram of op-amp



$$V_{set} = V_{SUPPLY} \pm 2V$$

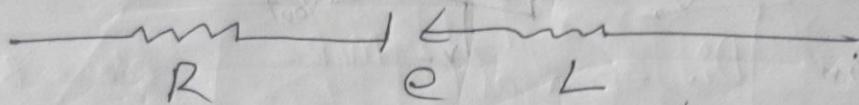
If \$A_{OL} = 20000

$$V_{SUPPLY} = \pm 15V$$

$$V_{set} = 15 - 2 = 13V$$

$$V_{ia} = \frac{V_{set}}{A_{OL}} = \frac{13}{20000} = 6.5 \times 10^{-5} V$$

Passive element:



Resistance capacitance Inductance

$$\text{Inductance} \cdot z = R + j\omega c - j\omega L$$

$$\text{Reactance} = \omega c / \omega L$$

$$= \frac{1}{2\pi f L}$$

Practical op amp

$$Z_{in} = Z_m - L$$

$$A_v = 1 \times 10^5$$

$$Z_{out} = 100 - L$$

Ideal op amp

$$Z_{in} = \infty (\text{dc})$$

$$A_v = \infty$$

$$Z_{out} = 0$$

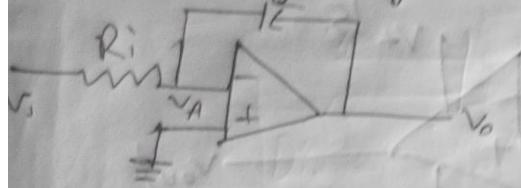
$$* \text{ CMRR} = \frac{A_{dm}}{A_{cm}} = \frac{\frac{V_{out}/V_{in}}{V_{out}/V_{in}}}{\frac{0.5}{-0.5}} = 0.5$$

$$= \frac{8}{12} = \frac{2}{3} \frac{1 \text{ mV}}{1 \text{ mV}} = 12 \text{ mV}$$

$$\text{Differential gain } A_{dm} = \frac{0.5}{-0.5} = -1$$

$$\text{Common mode } A_{cm} = \frac{1}{1} = 1$$

OP-amp Integrator



$$iR = iC = i$$

$$\Rightarrow \frac{v_i - v_A}{R_i} = C \cdot \frac{dv_o}{dt}$$

$$\Rightarrow \frac{v_i}{R_i} = -C \cdot \frac{dv_o}{dt}$$

$$\Rightarrow \int \frac{v_i dt}{R_i C} = \int dv_o$$

$$\Rightarrow v_o = -\frac{1}{R_i C} \cdot \int v_i dt$$

$$\therefore v_o = -\frac{1}{R_i C}$$

$$= -\frac{1}{t}$$

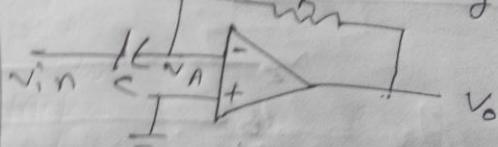
$$= -1 \times \int v_i dt$$

$$= - \int v_i dt$$

$$\Rightarrow -1 \int_0^t$$

$$= -1$$

OP-amp Differentiator



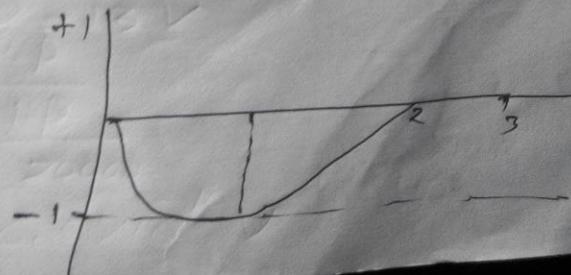
$$iR = iC = i$$

$$\Rightarrow \frac{v_A - v_o}{R} = C \cdot \frac{dv_o}{dt} = -C \left(\frac{dv_i}{dt} \right)$$

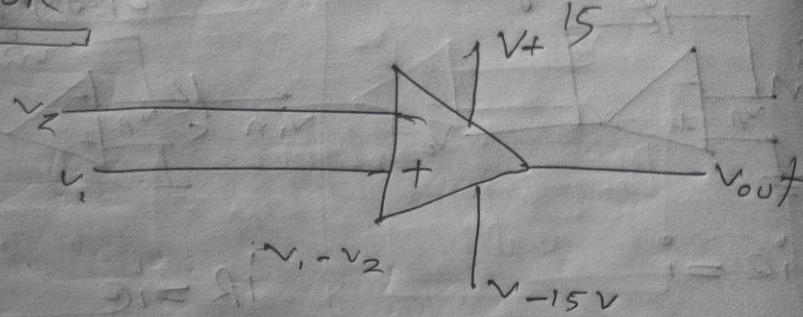
$$\Rightarrow \frac{v_o}{R} = -C \cdot \frac{dv_i}{dt}$$

$$\Rightarrow v_o = -RC \cdot \frac{dv_i}{dt}$$

$$= -RC \cdot \frac{d}{dt}$$



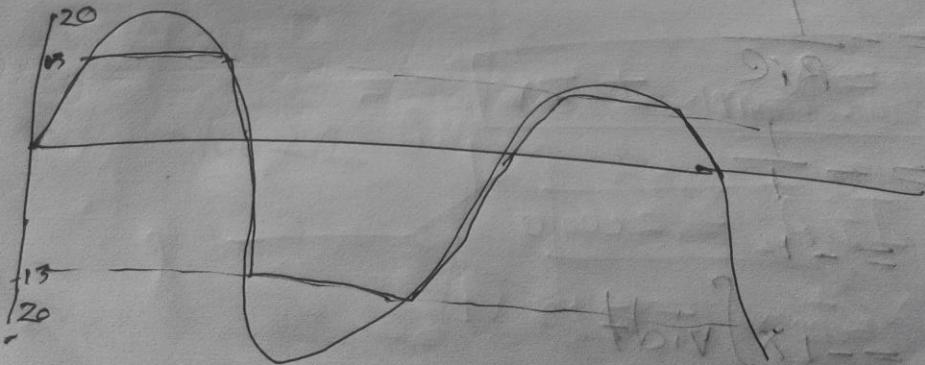
comparator



Example

① A/D \rightarrow signal generator

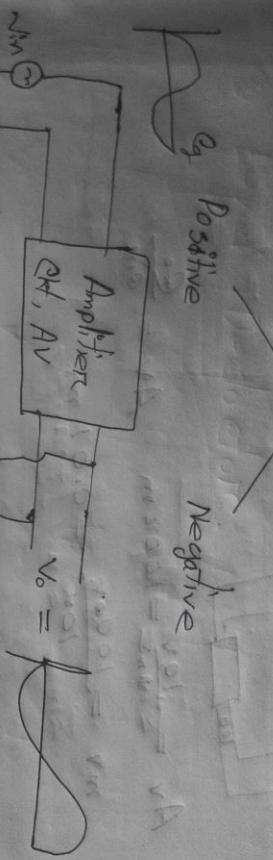
$$V_{sat} = V_{supply} \pm z$$
$$= 15 - 2$$
$$\approx \pm 15V$$



③ Zero
Crossing detector
Level detector.

EP43:337

Phasor 13 Feedback



$\frac{1}{\omega A} \rightarrow$

$$A(1 + \frac{V_o}{V_m}) = 0$$

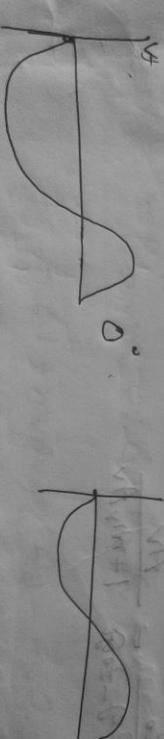
Feedback
CH, mv

Amplifier
CH, AV

$\sim V_m$

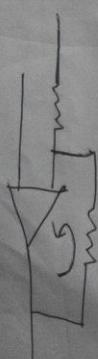
$\sim V_o$

V_o

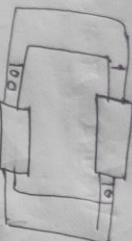


Positive Excit.: Oscillator

Negative Excit.: Op. Amp



*



$$A_v = \frac{10v}{1mV} = 10000m$$

$$Av = \frac{Q_0}{cm}$$

$$mV = \frac{100mV}{10m} = 0.01m$$

* Av

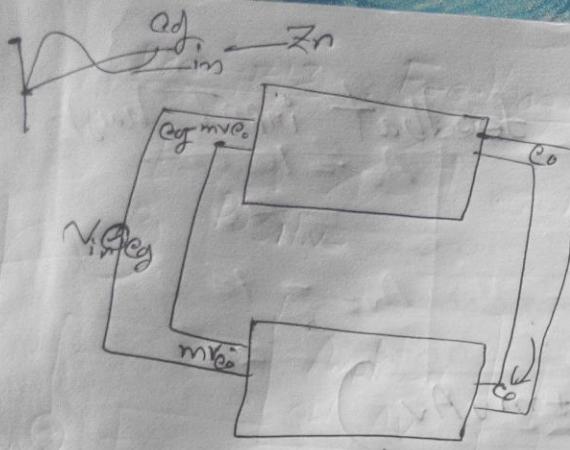
$$Q_0 = (eg - mve) Av$$

$$Q_0 = egAv - mveAv$$

$$\Rightarrow Q_0(1 + mvaV) = egAv$$

$$\Rightarrow Av_f = \frac{Q_0}{eg - 2mV} = \frac{Av}{1 + mvaV}$$

the form: $Q_0 = egAv - mveAv$



P 39Q
Month 339
H.W 13.1 - 13.8

$$i_{Zn} = E_g - m_v \varrho_o$$

$$E_g = (E_g - m_v \varrho_o) + e \cdot m v$$

$$= E_g - m_v \varrho_o + m v A v (E_g - m_v \varrho_o)$$

$$= E_g - m_v \varrho_o + m v A v E_g - m_v^2 A v \varrho_o$$

$$= m_v \varrho_o (1 + m_v A_v) + E_g (1 + m_v A_v)$$

$$= (1 + m_v A_v) (E_g - m_v \varrho_o)$$

$$= (1 + m_v A_v) \cdot i_{Zn}$$

$$Z_{in} = \frac{E_g}{(1 + m_v A_v)}$$

Amplifier circuit with feedback input high

$$Z_{in} = \frac{eg}{i}$$

$$Z_{in}' = Z_{in} (1 + mvA_v)$$

$$v_{out} - \beta v = n \xi i$$

$$v_{out} + (\beta v_{out} - \beta v) = \beta v$$

output low:

$$(v_{out} - \beta v) + \beta v_{out} + \beta v =$$

$$\Rightarrow v_{out} - \beta v + \beta v_{out} + \beta v = v_{out} - \beta v =$$

$$\Rightarrow (1 + \beta) v_{out} + \beta v = v_{out} - \beta v =$$

13.1

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

$$= \frac{3000}{1 + 3000 \times 0.01}$$

$$= \frac{3000}{31}$$

$$= 97$$

$$\left| \begin{array}{l} A_v = 3000 \\ m_v = 0.01 \end{array} \right.$$

$$OP = \sqrt{m_v^2 + OS}$$

$$= \frac{OS - OS}{OS} = 0.01$$

13.3

$$A_{vf} = \frac{A_v}{1 + m_v m_v}$$

$$50 = \frac{100}{1 + 100 m_v}$$

$$50 + 5000 m_v = 100$$

$$m_v = \frac{100 - 50}{5000}$$

$$= 0.01$$

$$\left| \begin{array}{l} A_v = 100 \\ A_{vf} = .50 \end{array} \right.$$

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

$$75 = \frac{A_v}{1 + 0.01 A_v}$$

$$75 + 0.75 A_v = A_v$$

$$A_v = \frac{75}{1 - 0.75}$$

$$= 300$$

$$\left| \begin{array}{l} A_{vf} = 75 \\ m_v = 0.01 \end{array} \right.$$

$$A_v = ?$$

13.4

$$A_{v+j} = \frac{A_v}{1+A_v m_v}$$

$$20 = \frac{40}{1+40m_v}$$

$$20 + 800m_v = 40$$

$$A_v = 10/0.25 = 40$$

$$A_{v+j} = 10/0.5$$

$$20 + 800m_v = 40$$

$$m_v = \frac{40 - 20}{800}$$

$$= \frac{1}{40}$$

13.5

$$A_{v+j} = \frac{A_v}{1+A_v m_v}$$

$$25 = \frac{50}{1+50m_v}$$

$$m_v = \frac{1}{50}$$

Age reduction in stage \rightarrow gain

$$= \frac{50 - 40}{50} \times 100$$

$$= 20\%$$

(11)

$$\text{Negative feedback} = \frac{A_v}{1 + A_v m_v}$$
$$= \frac{40}{1 + (40 \times 1/50)}$$
$$= 22.2$$

$$\text{Stage gain} = \frac{25 - 22.2}{25} \times 100$$
$$= 11.2\%$$



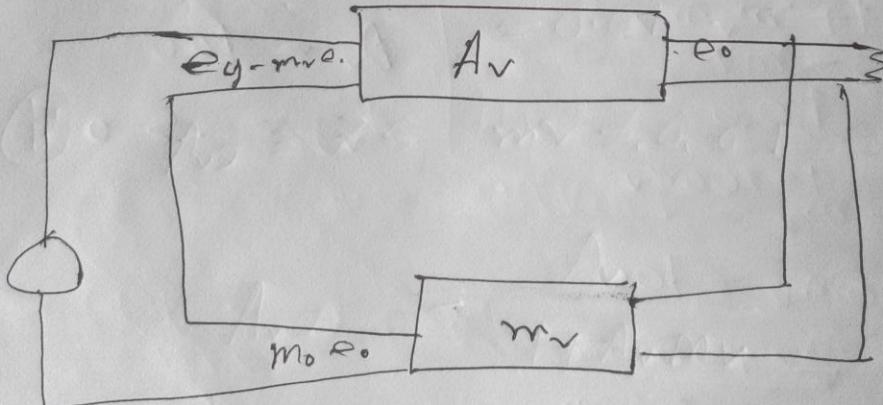
$$(eg - m_v e_0) A_v v = e_0$$

$$eg A_v v - A_v m_v e_0 = e_0$$

$$e_0 (1 + A_v m_v) = eg A_v$$

$$\frac{e_0}{eg} \geq \frac{A_v}{1 + A_v m_v}$$

$$A_v f = \frac{A_v}{1 + A_v m_v}$$



13.1

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

$$= \frac{3000}{1 + 3000 \times 0.01}$$

$$= \frac{3000 + 1}{31} = 97$$

13.2

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

$$A_v = 190$$

$$A_{vf} = \frac{190}{1 + 190 m_v} = 17.5$$

$$17.5 + 2450 m_v = 190$$

$$m_v = \frac{190 - 17.5}{2450} = 0.07$$

$$= \frac{1}{20\sqrt{A}} = A^{-0.04 + 0.07}$$

$$\frac{28}{38.0 - 1} = 5A$$

$$0.05 =$$

$$\textcircled{1} \quad A_v = 100 \quad A_{vT} = 50$$

$$A_{vT} = \frac{A_v}{1 + A_v m_v}$$

$$50 = \frac{100}{1 + 100m_v}$$

$$50 + 5000m_v = 100$$

$$m_v = \frac{100 - 50}{5000} = 0.01$$

$$\textcircled{1.1} \quad A_{vT} = 75 \quad m_v = 0.01 \quad A_v = ?$$

$$A_{vT} = \frac{A_v}{1 + A_v m_v} \quad \text{GPI} = \sqrt{m_v} = \sqrt{0.01} = 0.1$$

$$75 = \frac{A_v}{1 + 0.01 A_v} = \frac{A_v}{1 + 0.01 A_v} = \sqrt{m_v}$$

$$75 + 0.75 A_v = A_v \quad =$$

$$A_v = \frac{75}{1 - 0.75}$$

$$= 300$$

(4)

$$A_{v2} = \frac{A_v}{1 + A_v m_v} \quad \left| \begin{array}{l} A_v = \frac{10}{0.25} = 40 \\ A_{vf} = \frac{10}{0.5} = 20 \end{array} \right.$$
$$Z_0 = \frac{40}{1 + 40m_v}$$

$$Z_0 + 800m_v = 40$$

$$m_v = \frac{40 - 20}{800}$$

$$A_v = \frac{1}{40}$$

(5)

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

$$25 = \frac{50}{1 + 50m_v}$$

$$m_v = \frac{1}{50}$$

(1) without feedback :

$$\text{Reduction in stage gain} = \frac{50 - 20}{50} \times 100$$

$$= 20\%$$

(ii)

New gain with negative feedback

$$\begin{aligned} \text{OP} &= \frac{A_v}{1+A_v m_v} = \frac{A_v}{1+40 \times \frac{1}{50}} = \frac{40}{1+0.8} = \frac{40}{1.8} = 22.22 \approx 22.2 \\ \text{OZ} &= \frac{\text{OP}}{1+m_v} = \frac{22.22}{1+0.2} = \frac{22.22}{1.2} = 18.5 \end{aligned}$$

$$\begin{aligned} \text{Stage gain} &= \frac{25 - 22.2}{25} \times 100 \\ &= 11.2 \times \frac{100}{1+0.2} = 11.2 \times \frac{100}{1.2} = 93.33 \end{aligned}$$

$$\frac{\text{OZ}}{\text{OP}} = \frac{18.5}{22.2} = 0.83$$

$$\frac{1}{\text{OZ}} = 1.2$$

: best voltage

$$\frac{\text{OP} - \text{OZ}}{\text{OZ}} = 0.18 = 18\% \text{ at output}$$

⑥

$$A_v = 100 \quad m_v = 0.1 \quad A_{v,f} = ?$$

$$A_{v,f} = \frac{A_v}{1 + A_v m_v}$$

$$\Rightarrow A_{v,f} = \frac{100}{1 + 100 \times 0.1} \\ = 9.09$$

$$20 \quad \log_{10} \frac{A_v}{A_{v,f}} = 6$$

$$\log_{10} \frac{A_v}{A_{v,f}} = \frac{6}{20} = 0.3$$

$$\frac{A_v}{A_{v,f}} = \text{Antilog } 0.3 = 2$$

$$A_{v,f} = \frac{A_v}{2} = \frac{100}{2} = 50$$

$$\text{New } A_{v,f} = \frac{A_v}{1 + A_{v,f} m_v}$$

$$\Rightarrow \frac{50}{1 + 50 \times 0.1}$$

$$= 9.33$$

$$\text{System gain} = \frac{9.33 - 8.33}{9.33} \times 100 \\ = 8.33\%$$

④ Input Impedance :

$$eg - m_v e_o = i_1 Z_{in}$$

$$eg = (eg - m_v e_o) + m_v e.$$

$$= eg - m_v e_o + A_v m_v (eg - m_v e_o)$$

$$= (eg - m_v e_o)(1 + A_v m_v)$$

$$= i_1 Z_{in} \frac{1}{(1 + A_v m_v)}$$

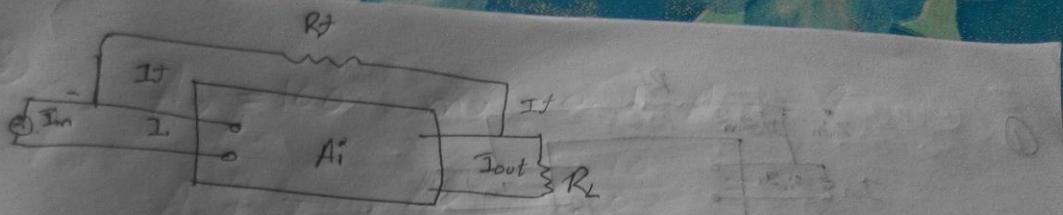
$$\frac{eg}{i_1} = Z_{in} (1 + A_v m_v)$$

$$Z_{in} = Z_{in} (1 + A_v m_v)$$

$$\frac{V_o}{A} = V_o (1 + A_v m_v)$$

$$1 + A_v m_v$$

$$22.8 =$$



$$\text{Feedback current } I_f = m_i I_{\text{out}}$$

$$\text{fraction } m_i^o = \frac{I_f}{I_{\text{out}}} = \frac{\text{Feedback C}}{\text{output C}}$$

$$I_{\text{in}} = I_i + I_f$$

$$I_{\text{in}} = I_i + m_i I_{\text{out}}$$

$$I_{\text{in}} = I_i + m_i A_i I_i$$

$$\therefore A_{if}^o = \frac{I_{\text{out}}}{I_{\text{in}}}$$

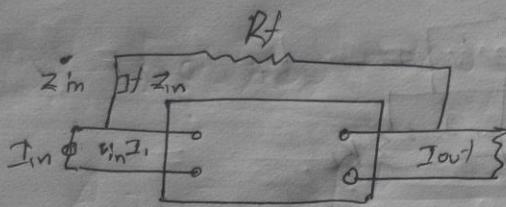
$$= \frac{A_i I_i}{I_i + m_i A_i I_i}$$

$$A_{if}^o = \frac{A_i}{1 + m_i A_i} \quad \left. \begin{array}{l} A_i = 200 \\ m_i = 0.012 \end{array} \right\}$$

$$= \frac{200}{1 + (0.012)(200)}$$

$$= 58.8 \approx$$

①



$$Z_{in} = \frac{V_{in}}{I_i}$$

$$Z_{in} = \frac{V_{in}}{I_{in}}$$

$$Z_{in} = \frac{V_{in}}{I_i}$$

$$V_{in} = I_i Z_{in}$$

$$I_{in} = I_i + I_f$$

$$= I_i + m_i I_{out}$$

$$= I_i + m_i A_i I_i$$

$$Z_{in} = \frac{I_i \cdot Z_{in}}{I_i + m_i A_i I_i}$$

$$= \frac{Z_{in}}{1 + m_i A_i} \cdot \frac{1}{A_i + 1}$$

$$Z_{in, MA} = \frac{Z_{in}}{1 + m_i A_i}$$

$$(0.02)(0.0002) + 1 = 0.0004$$

(6)

$$A_v = 100 \quad m_v = 0.1 \quad A_{vf} = ?$$

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

$$= \frac{100}{1 + 100 \times 0.1} = 9.09$$

Then

$$20 \log_{10} \frac{A_v}{A_{v1}} = 6$$

$$10 \log \frac{A_v}{A_{v1}} = \frac{6}{20} = 0.3$$

$$\frac{A_v}{A_{v1}} = 10^{0.3} \log 10.3 = 2$$

$$A_{v1} = \frac{A_v}{2} = \frac{100}{2} = 50$$

$$\text{New } A_{vf} = \frac{A_{v1}}{1 + A_{v1} m_v} = \frac{50}{1 + 50 \times 0.1} = 8.33$$

$$\text{Change} = \frac{9.09 - 8.33}{9.09} \times 100$$

$$= 8.33\%$$

$$= 8.33\% \times \frac{100}{100} = 8.33\%$$

(2)

$$A_v = 500 \quad A_{vf} = 100 \quad m_v = ?$$

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

$$100 = \frac{500}{1 + 500 m_v}$$

$$100 + 500 m_v = 500$$

$$500 m_v = 500 - 100$$

$$m_v = \frac{500 - 100}{500}$$

$$\frac{400}{500}$$

$$= 0.8$$

$$A_v = \frac{80}{100} \times 500$$

$$= 400 \quad m_v = 0.8 \quad A_{vf} = ?$$

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

$$= \frac{400}{1 + 400 \times 0.8}$$

$$= \frac{400}{4.2} = 95.3$$

$$A_{vf} = \frac{100 - 95.3}{100} \times 100 \\ = 4.7\%$$

(8)
;

$$= 20 \log_{10} 100000$$

$$= 20 \log_{10} 10^5$$

$$= 100 \text{db}$$

$$20 \log = 100 - 10 = 90$$

Now,

$$20 \log_{10}(A_{v2}) = 90$$

$$\log_{10} A_{v2} = \frac{90}{20} = 4.5$$

$$A_{v2} = \text{Antilog } 4.5 = 31622$$

$$A_{v2} = \frac{A_v}{1 + A_v m v}$$

$$31622 = \frac{100000}{1 + 100000 \times m v} \rightarrow m v = \frac{100000}{31622} = 31622^{-1}$$
$$\approx 2.17 \times 10^{-5}$$
$$\frac{2.17 \times 10^{-5}}{1 + 2.17 \times 10^{-5}} \approx 2.17 \times 10^{-5}$$

$$\frac{2.17 \times 10^{-5}}{1 + 2.17 \times 10^{-5}} \approx 2.17 \times 10^{-5}$$

(8)

$$= 20 \log_{10} 100000$$

$$\begin{aligned} &= 20 \log_{10} 10^5 \\ &= 100 \text{db} \end{aligned}$$

$$= 100 - 10 = 90$$

Now,

$$20 \log_{10}(A_{v2}) = 90$$

$$\log_{10} A_{v2} = \frac{90}{20} = 4.5$$

$$A_{v2} = \text{Antilog } 4.5 = 31622$$

$$A_{v2} = \frac{A_v}{1 + A_v m v}$$

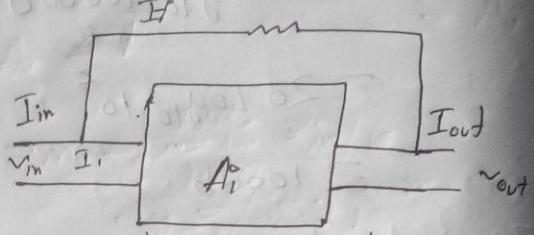
$$31622 = \frac{100000}{1 + 100000 \times m v}$$

$$= 2.17 \times 10^5$$

$$\frac{2.17 \times 10^5}{1 + 2.17 \times 10^5} =$$

$$\frac{2.17 \times 10^5}{2.17 \times 10^6} = 0.17$$

Current Feedback



$$\text{Feedback current } I_f = m_i I_{out}$$

$$\text{Feedback fraction } m_i = \frac{\text{Feedback}}{\text{i/p current}} = \frac{I_f}{I_{out}}$$

$$\begin{aligned} \text{Current gain } I_m &= I_i + I_f \\ &= I_i + m_i I_{out} \\ &= I_i + m_i A_i I_i \end{aligned}$$

with negative current feedback

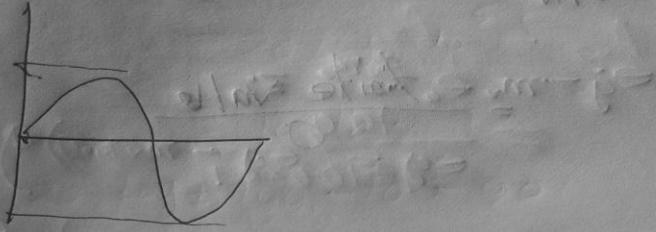
$$\begin{aligned} A_{if} &= \frac{I_{out}}{I_{in}} \\ &= \frac{A_i I_i}{I_i + m_i A_i I_i} \end{aligned}$$

$$A_{if} = \frac{A_i}{1 + m_i A_i}$$

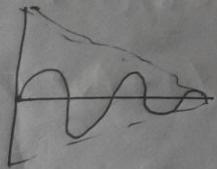
oscillator

20-03-18

Positive Feedback Amplifier

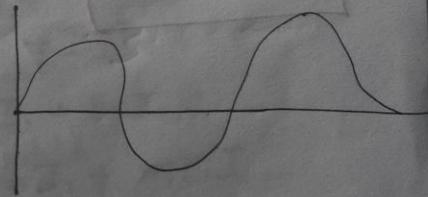


* Damped



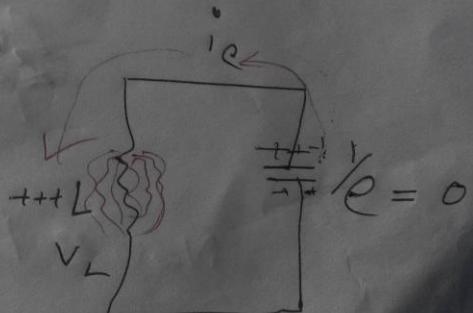
Undamped

$\omega_0 = \frac{1}{\sqrt{LC}}$



* Tank - circuit

$\downarrow L - \text{eqt}$



$$\omega_L = \omega_0$$

$$\Rightarrow 2n\omega_L = \frac{1}{2n\sqrt{LC}}$$

$$\Rightarrow \omega^2 = \frac{1}{4n^2 LC} \quad \omega_r = \frac{1}{2n\sqrt{LC}} \quad (\text{maximum frequency})$$

21-80-05

27 Mar

* Bach Hansen

distilled water

mv Av ≤ 1

$$e_g - m = \frac{\text{finite value}}{0}$$

Fall in $e_g - m = 0$

14.1 - 14.8

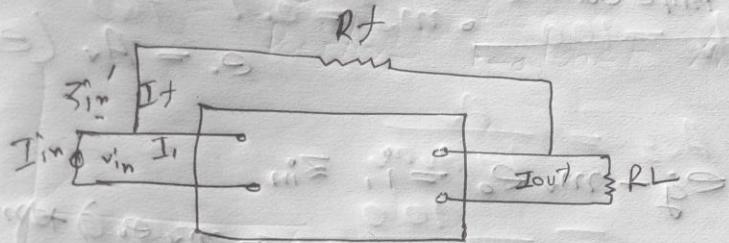
bamboo

green (14)

Ho - root

Ho - stem

Effects of negative current feedback



$$Z_{in} = \frac{v_{in}}{I_i}$$

$$Z_{in} = \frac{v_{in}}{I_{in}}$$

$$\begin{aligned} v_{in} &= I_i Z_{in} & I_{in} &= I_i + I_f \\ & & &= I_i + m_i I_{out} \\ & & &= I_i + m_i f_i I_i \end{aligned}$$

$$Z_{in} = \frac{I_i Z_{in}}{I_i + m_i A_i I_i}$$

$$Z_{in} = \frac{Z_{in}}{1 + m_i A_i I_i}$$

Increases bandwidth:

$$B\omega' = B\omega (1 + m_i A_i)$$

Input impedance

$$e_o = A_v (e_g - m_v e_o)$$

$$e_g + m_v e_o = i_1 Z_{in}$$

$$e_g = (e_g - m_v e_o) + m_v e_o$$

$$\text{Fall in gain} = \frac{(e_g - m_v e_o)}{e_g} + A_v m_v$$

$$\frac{m_v}{m_v + 1} = \frac{(e_g - m_v e_o)}{e_g}$$

$$= (e_g - m_v e_o)(1 + A_v)$$

$$= i_1 Z_{in} (1 + A_v m_v)$$

$$\frac{e_g}{e_g} = Z_{in} (1 + A_v m_v)$$

$$Z_{in} = Z_{in} (1 + A_v m_v)$$

$$(A_v m_v) \text{ loss} = \omega B - f_m$$

Q304-83
Q304-100
Q304-100
Q304-83

Gain of negative voltage feedback

- Actual input to amplifier

$$= e_g - A_v e_o$$

$$(e_g - A_v e_o) A_v = e_o$$

$$A_v e_g - A_v^2 e_o = e_o$$

$$e_o (1 + A_v^2) = A_v e_g \quad \text{Hence}$$

$$\frac{e_o}{e_g} = \frac{A_v}{1 + A_v^2}$$

$$e_o = A_v t = \frac{A_v}{1 + A_v^2}$$

$$S = S/A \Rightarrow \frac{A}{1 + A^2}$$

$$0.2 = \frac{0.1}{1 + A^2} \Rightarrow \frac{1}{2} = 1 + A^2$$

$$A^2 = \frac{1}{2} - 1 = -\frac{1}{2}$$

$$A = \sqrt{\frac{1}{2}} = \sqrt{0.5} = 0.707$$

$$\frac{0.2}{1 + 0.2^2} = 0.173$$

$$0.173 \rightarrow 0.173 \times 10^6 = 173,000$$

(6) hand best equation suitable to min.

$$A_{vf} = 100 \quad m_v = 0.1, \quad A_{vf} = ?$$

Stability of form factor.

$$\Rightarrow A_{vf} = \frac{A_v}{1 + A_v m}$$

$$\Rightarrow \frac{100}{1 + 100 \times 0.1} = 9.09$$

$$\text{Fall in gain} = 6 \text{ dB}$$

$$\frac{20 \log_{10} A_v}{A_{v1}} = 6$$

$$\frac{\log_{10} A_v}{A_{v1}} = \frac{6}{20} = 0.3$$

$$\Rightarrow \frac{A_v}{A_{v1}} = \text{Antilog } 0.3 = 2$$

$$A_{v1} = \frac{A_v}{2} = \frac{100}{2} = 50$$

$$\text{New } A_{vf} = \frac{A_{v1}}{1 + A_{v1} m_v}$$

$$\Rightarrow \frac{50}{1 + 50 \times 0.1}$$

$$= \frac{0.09 - 8.33}{50.9} \times 100 = 8.33$$

$\approx 8.367.$