\# **Analog Elex** 6 Feb

Ckts "opamp Based"

\# integrator ✓

\# Differentiator ✓

\# Precision amplifiers ✓

\# Wave form generators ✓

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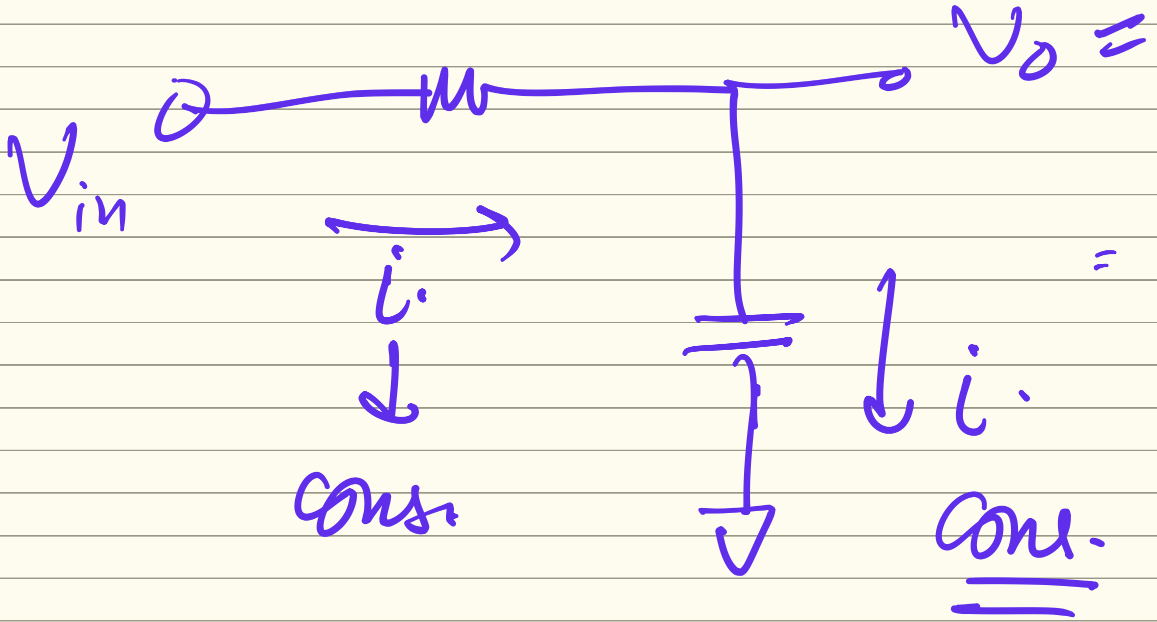
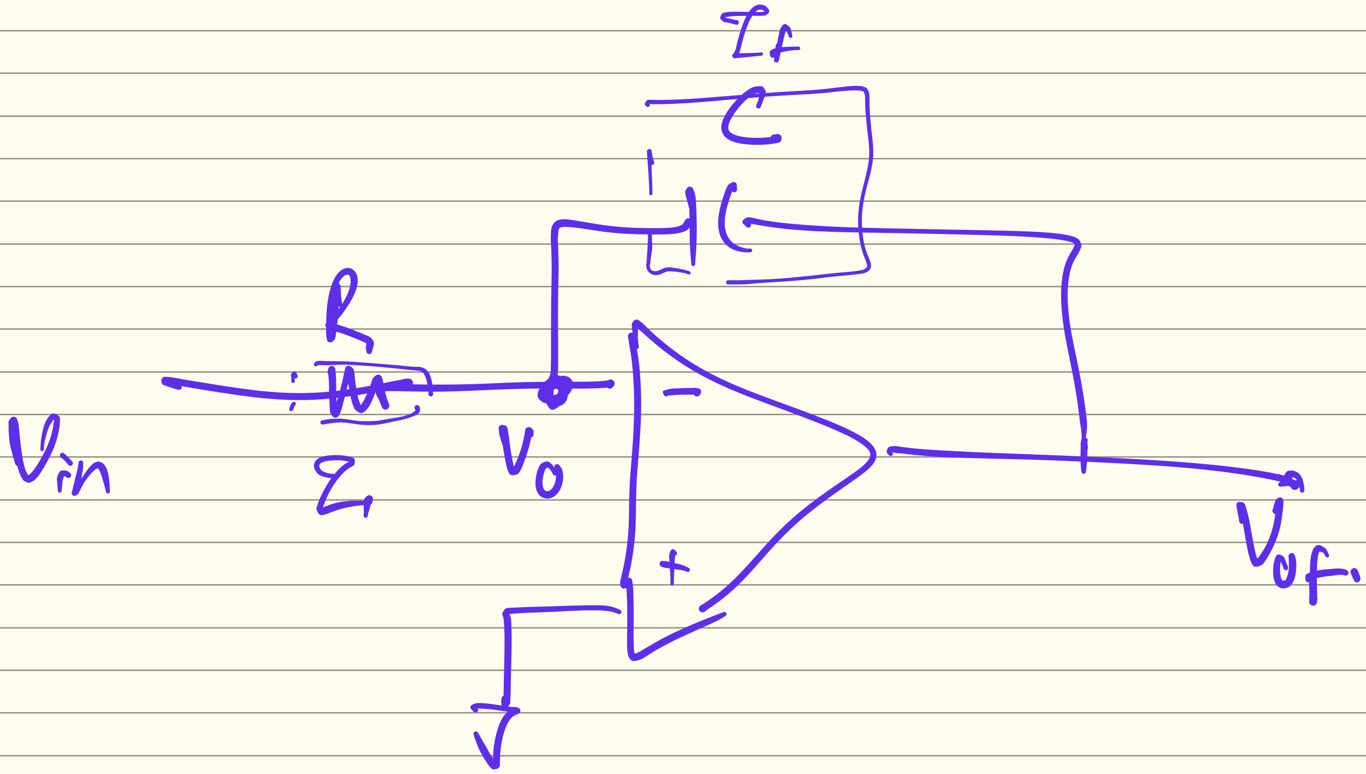
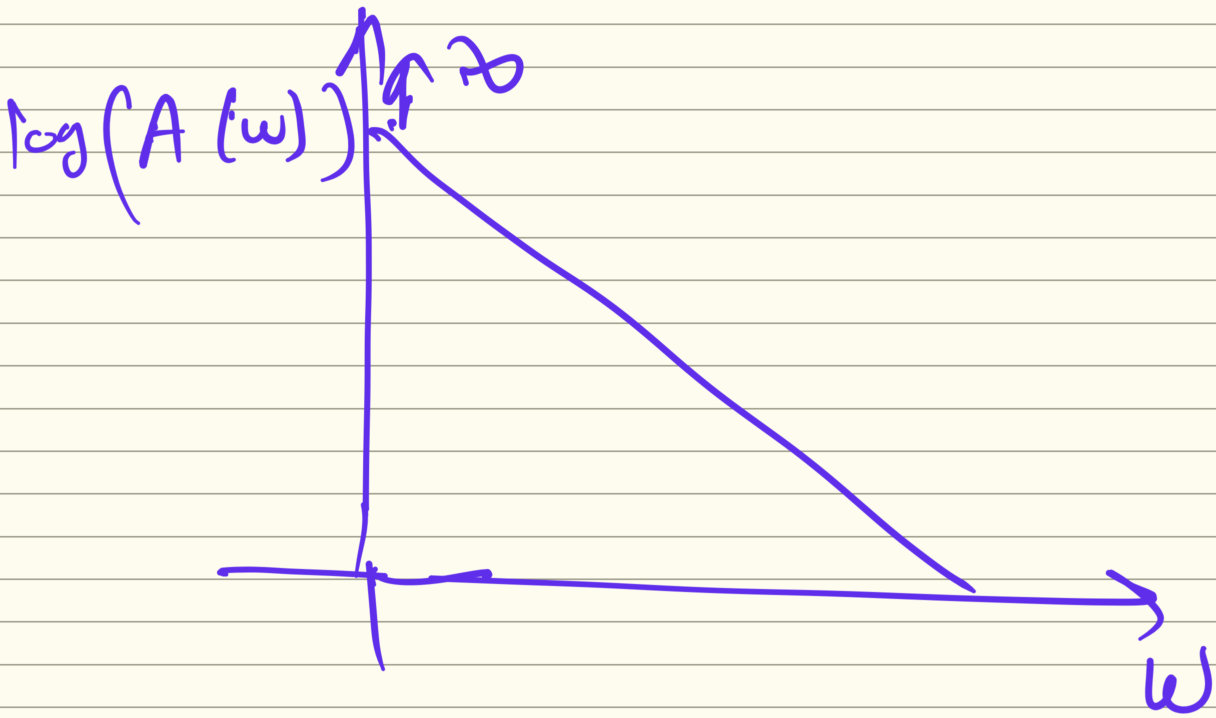
Integrator

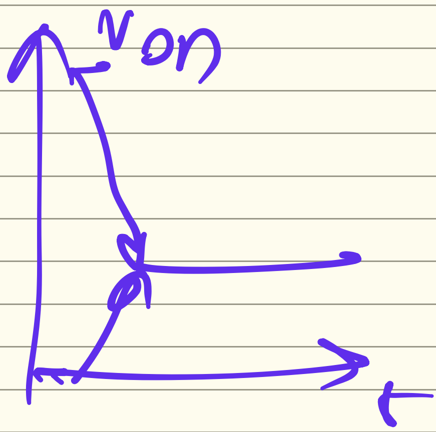


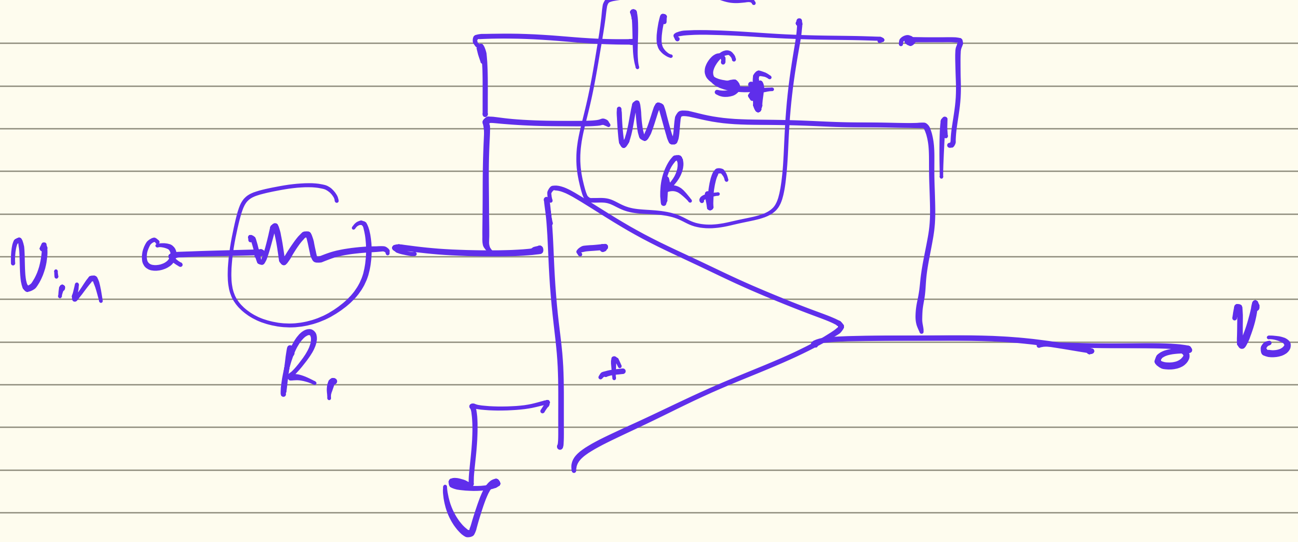


$$V_{of} = -\frac{1 \; V_{in}}{SC \cdot R} = -\frac{Z_f}{Z_1} V_{in}(t)$$

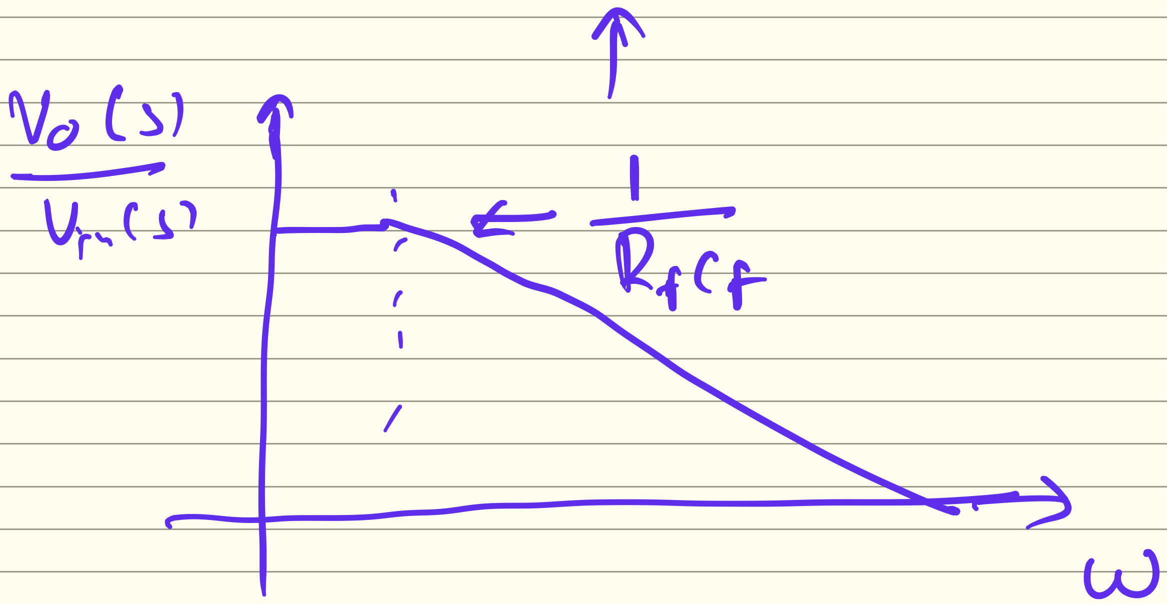
$$\boxed{\frac{V_o(t)}{V_{in}(t)} = \frac{1}{SC \cdot R}}$$



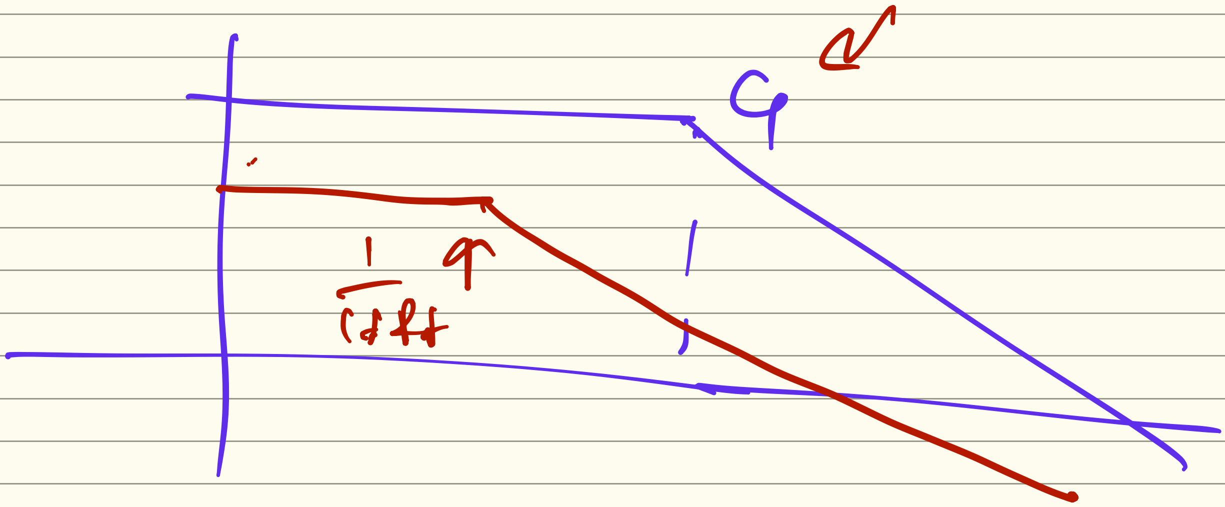




$$\frac{V_o(s)}{V_{in}(s)} = \frac{1}{(R_f s C_f + 1) \cdot R_1}$$



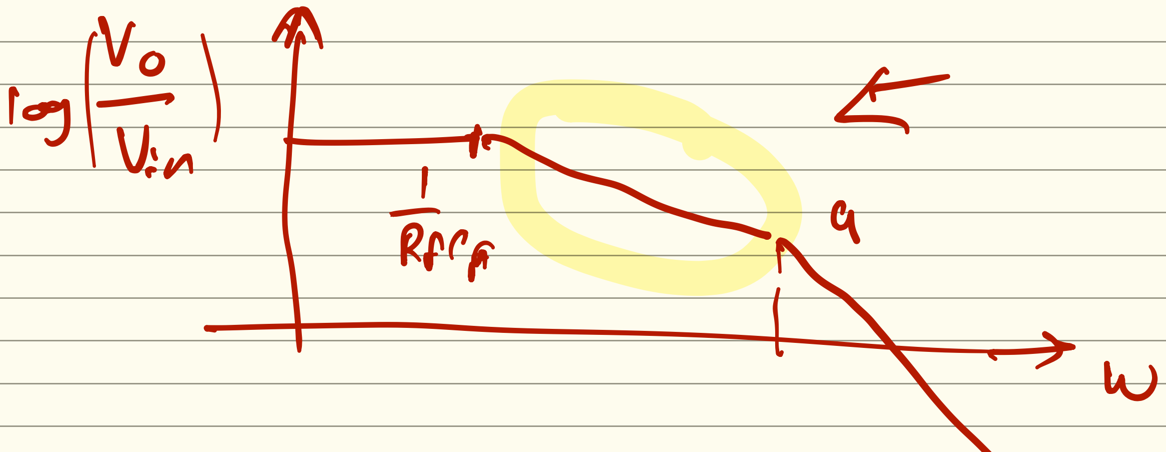
$$\frac{A}{\left(1+\frac{s}{a}\right)}$$



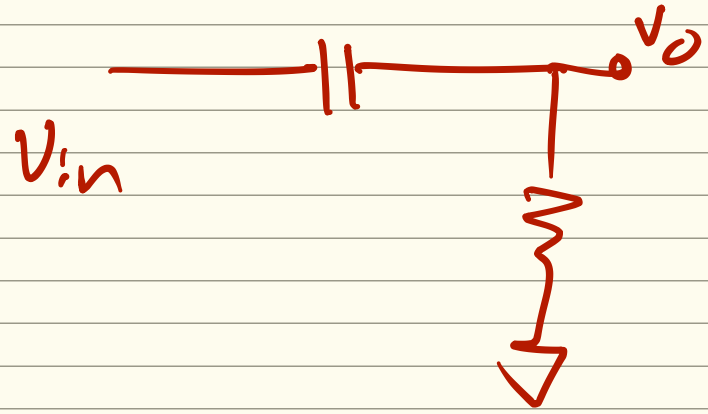
$$\frac{V_o}{V_{in}} = \frac{1}{(R_f C_f s + 1) R_1 \left(1+\frac{s}{a}\right)}$$

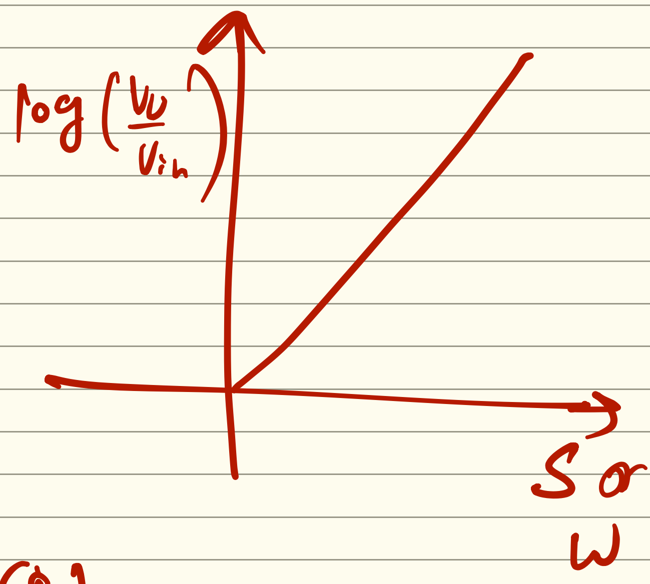
int.

B.W opamp

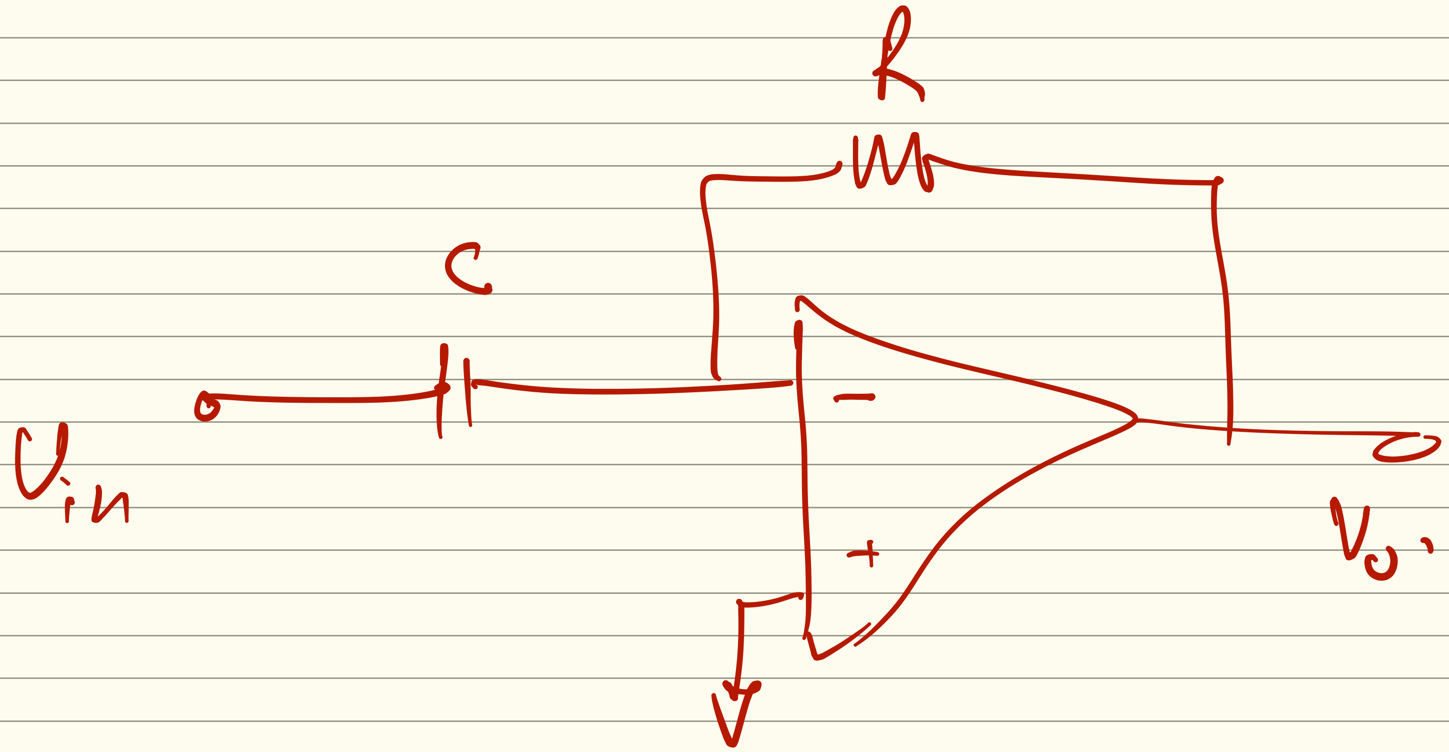


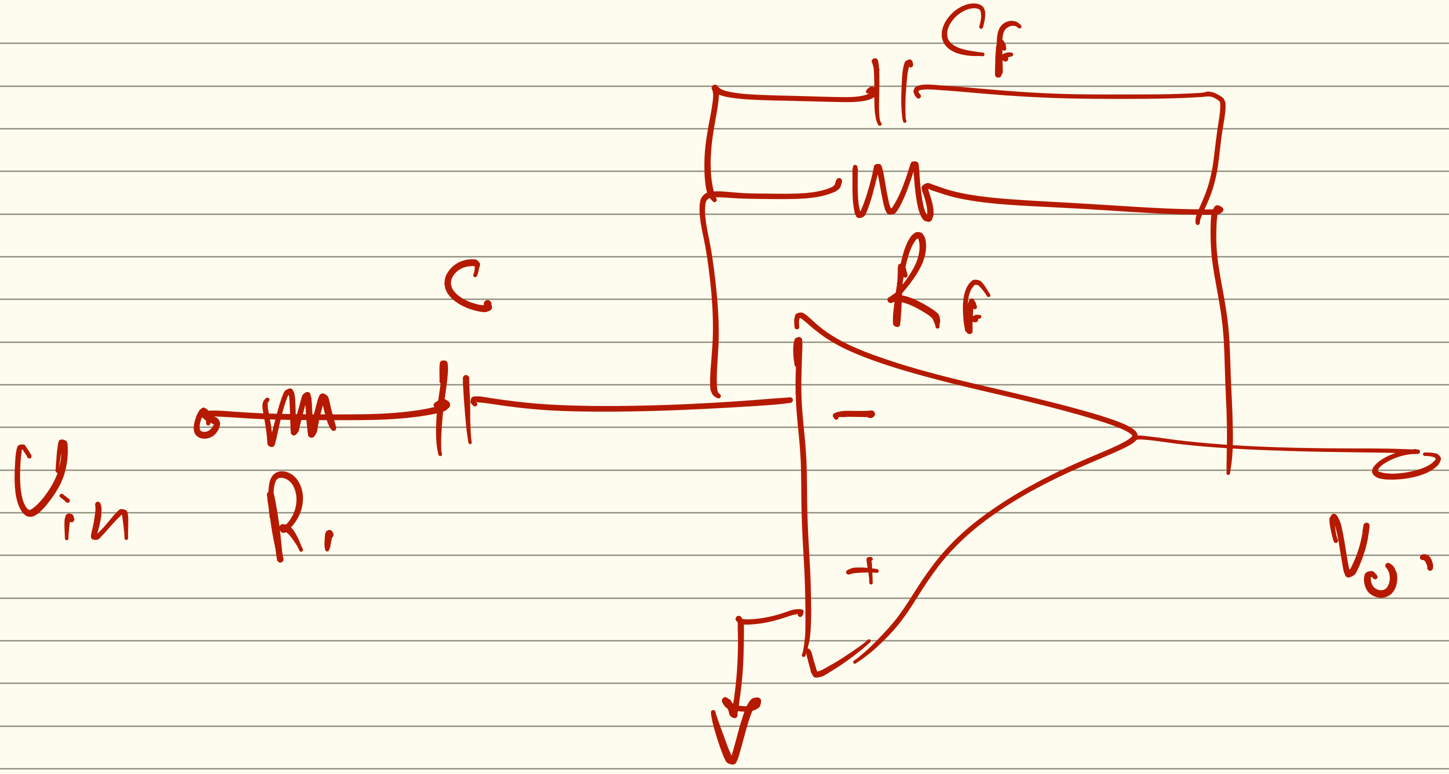
Differentiator



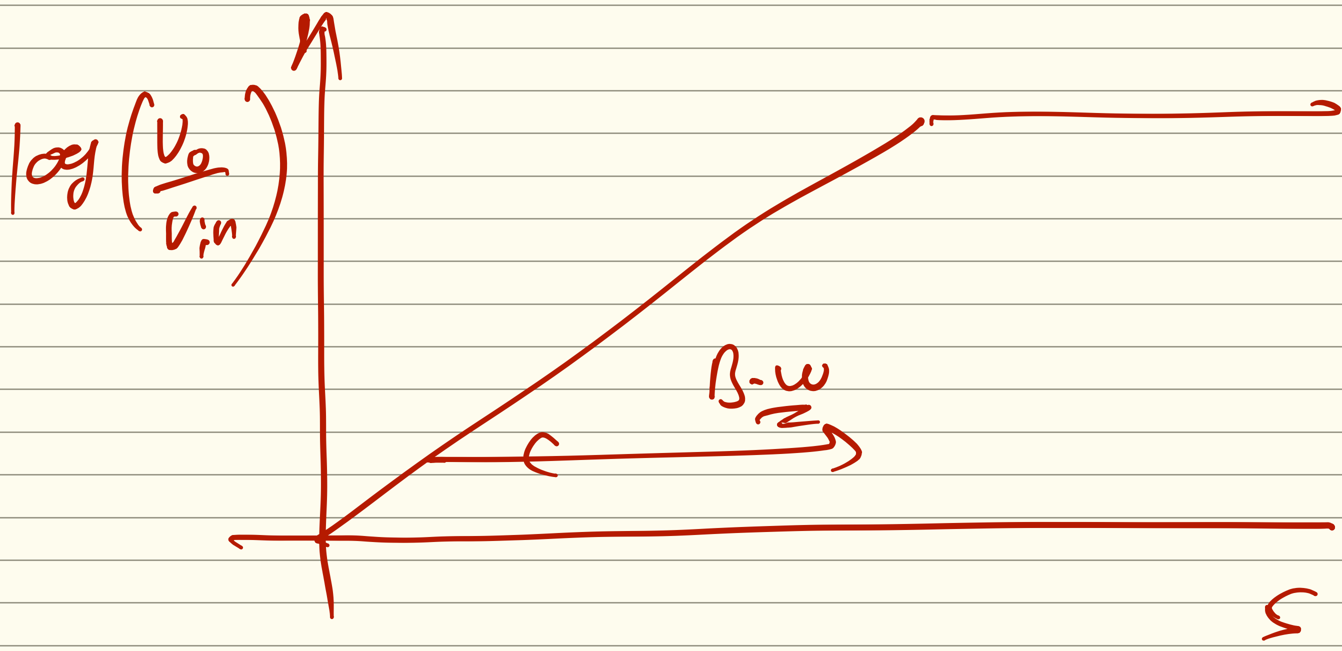


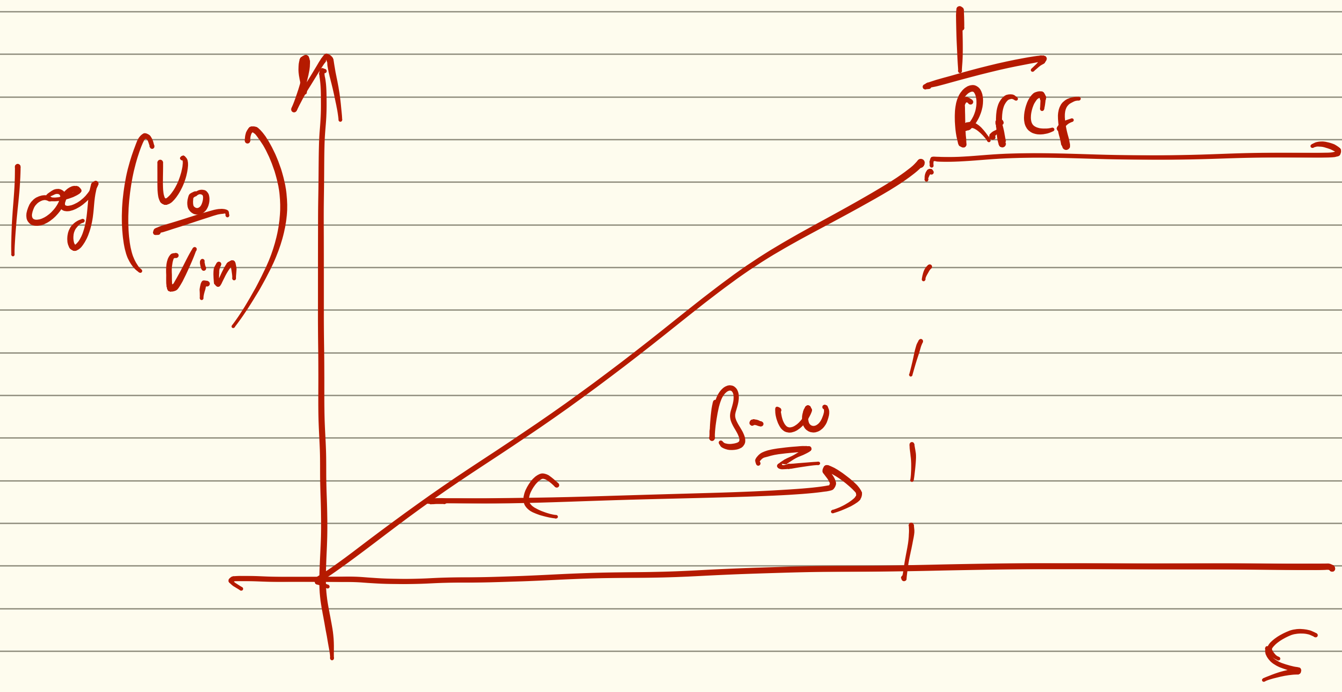
$$V_o(s) = A\,s \cdot v_{in}(s)$$



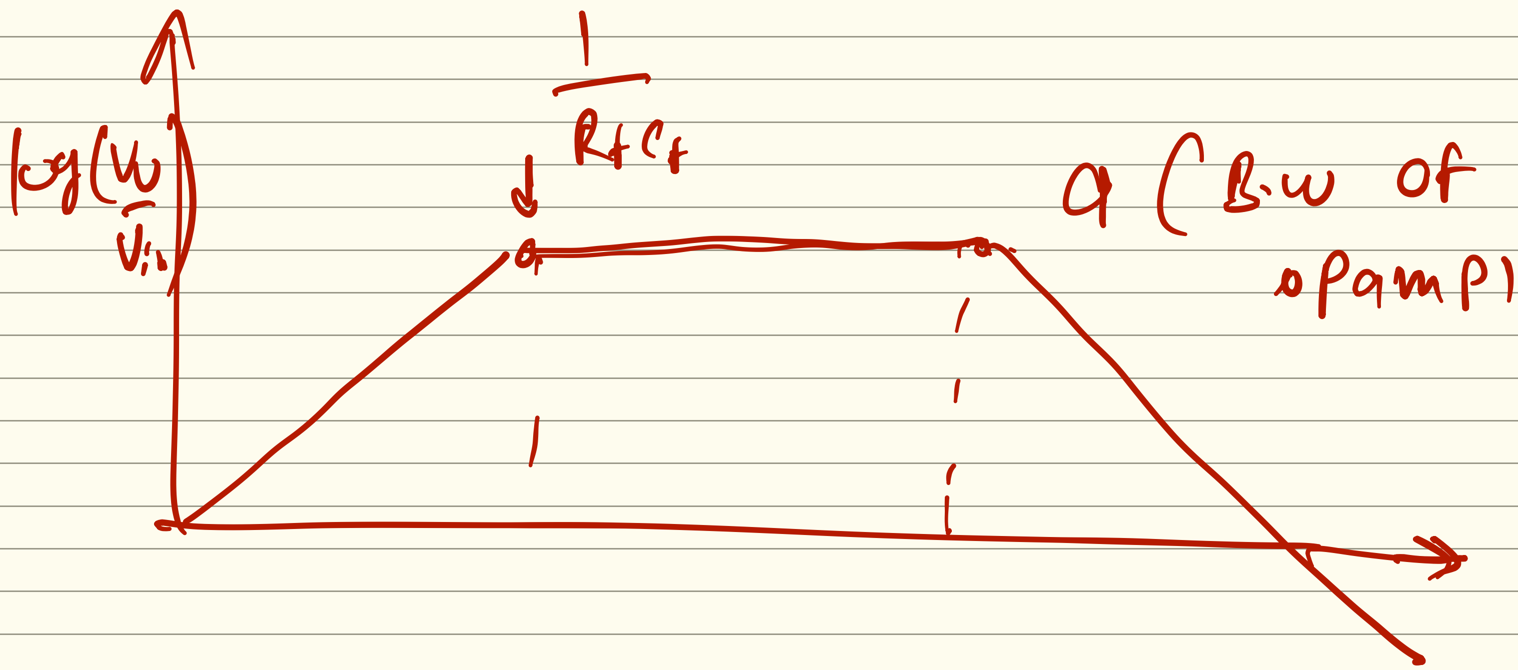


$$V_o(S) = \frac{S C_1 V_{in}(s)}{1 + C_f R_f S}$$

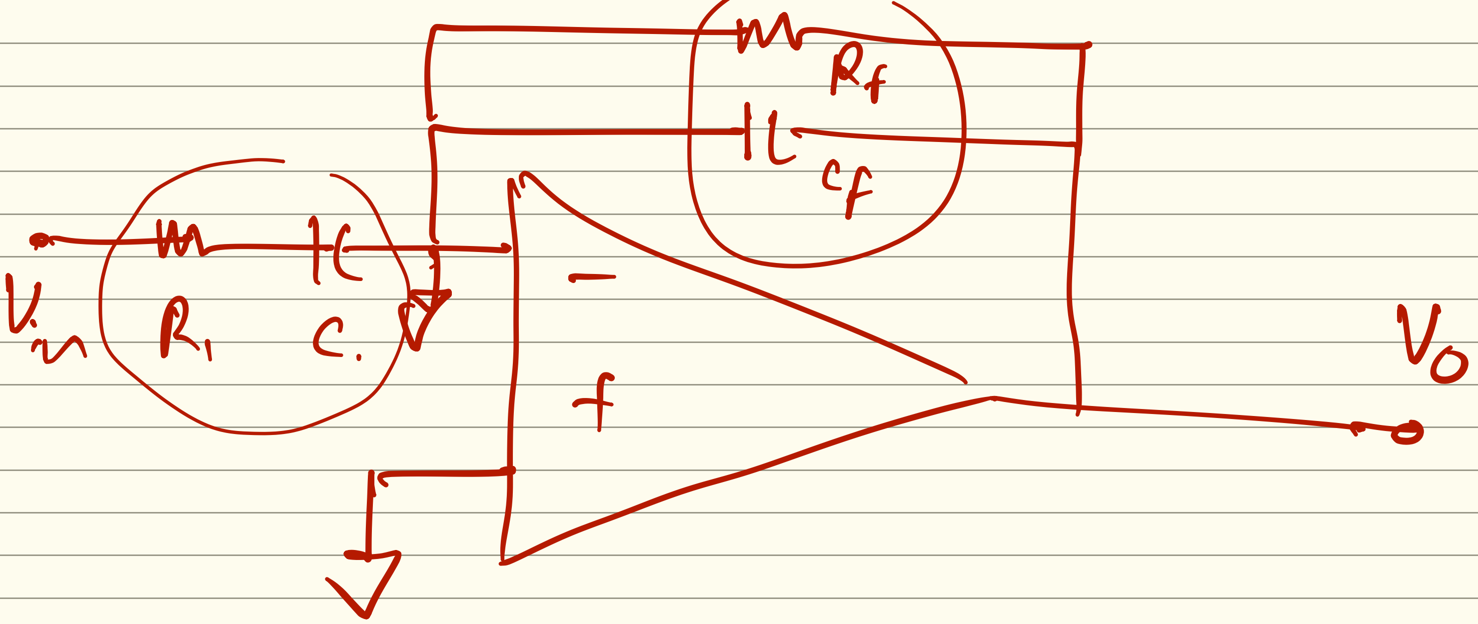




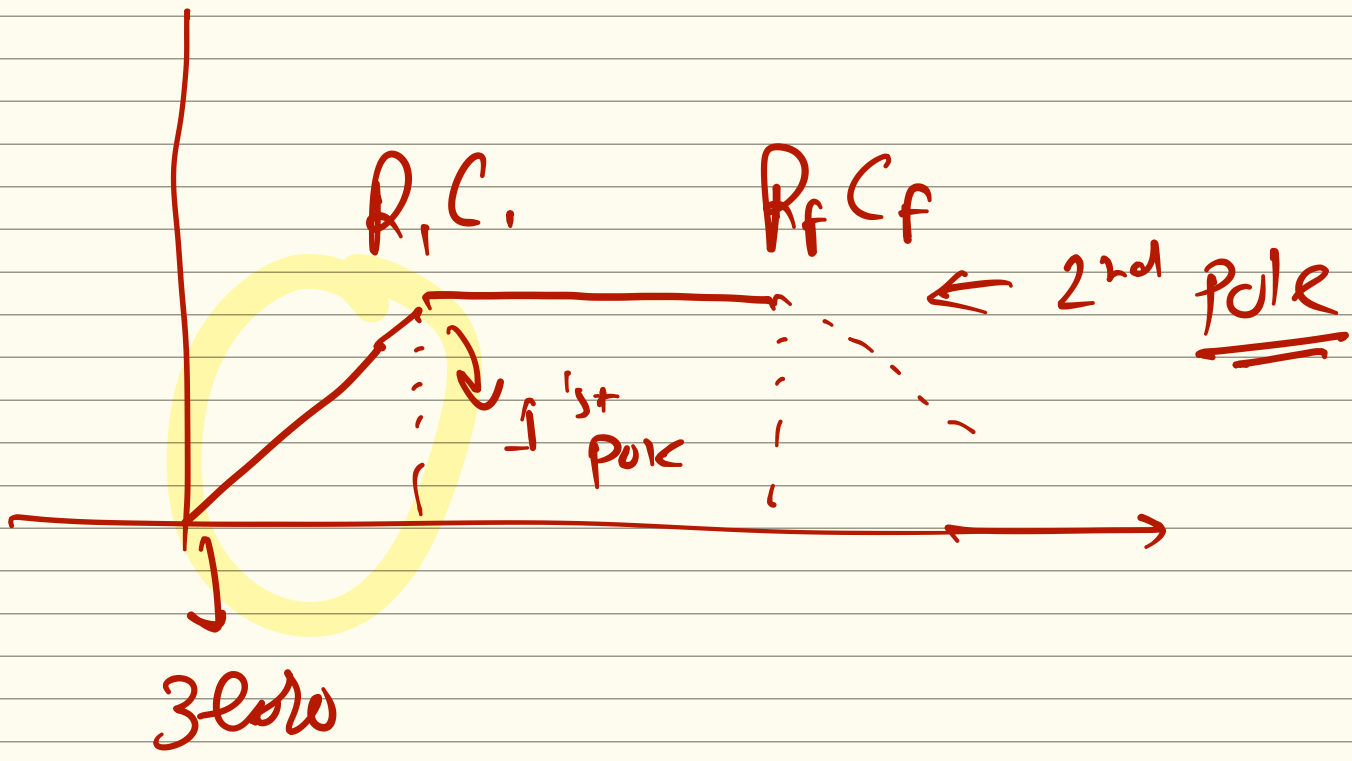
$\log\left(\frac{V_o}{V_{in}}\right)$
$\frac{1}{R_f C_f}$
B.W
s



$\log\left(\frac{V_o}{V_{in}}\right)$
$\frac{1}{R_f C_f}$
a (B.W of opamp)



$$A(s) \Rightarrow \frac{sCR_1}{(1+R_1C_1)\,(1+R_fC_f)}$$



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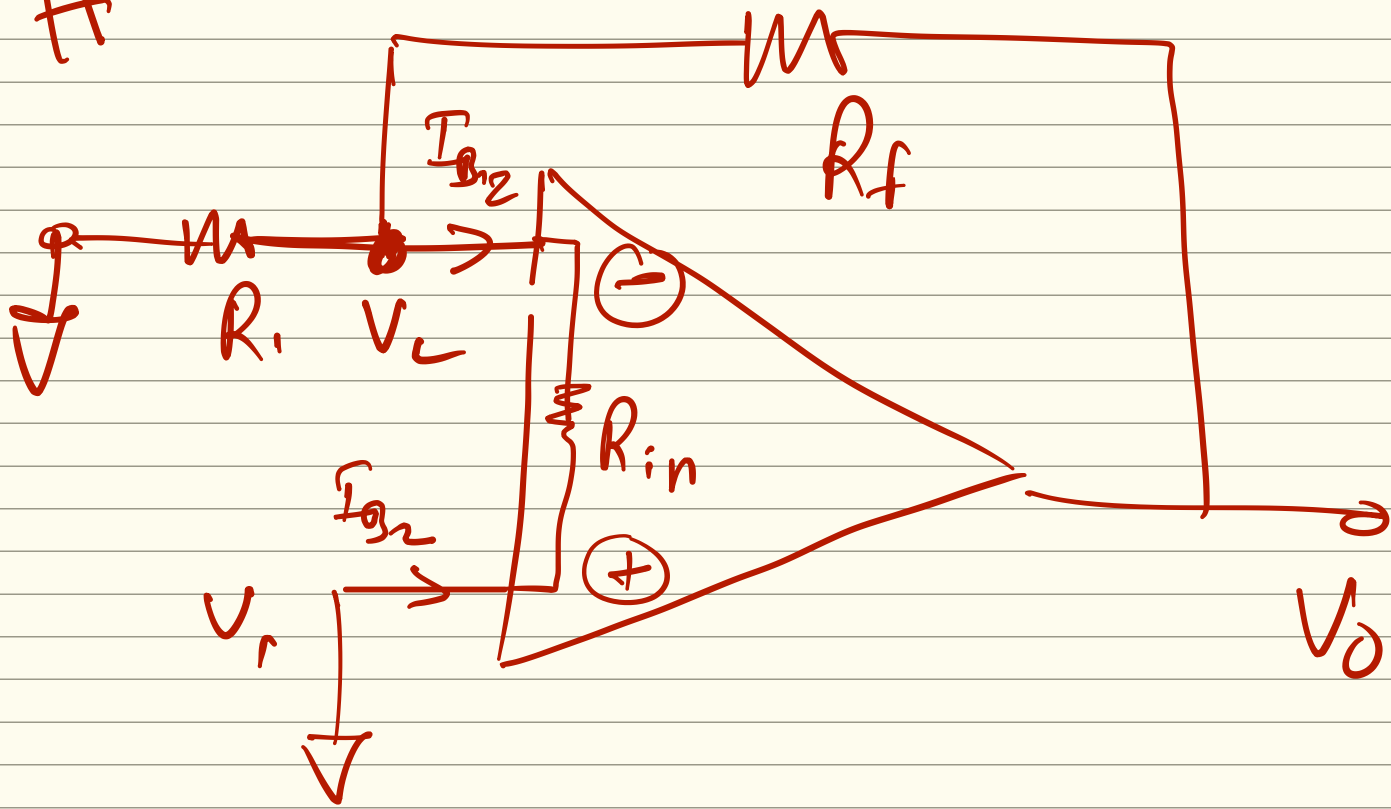
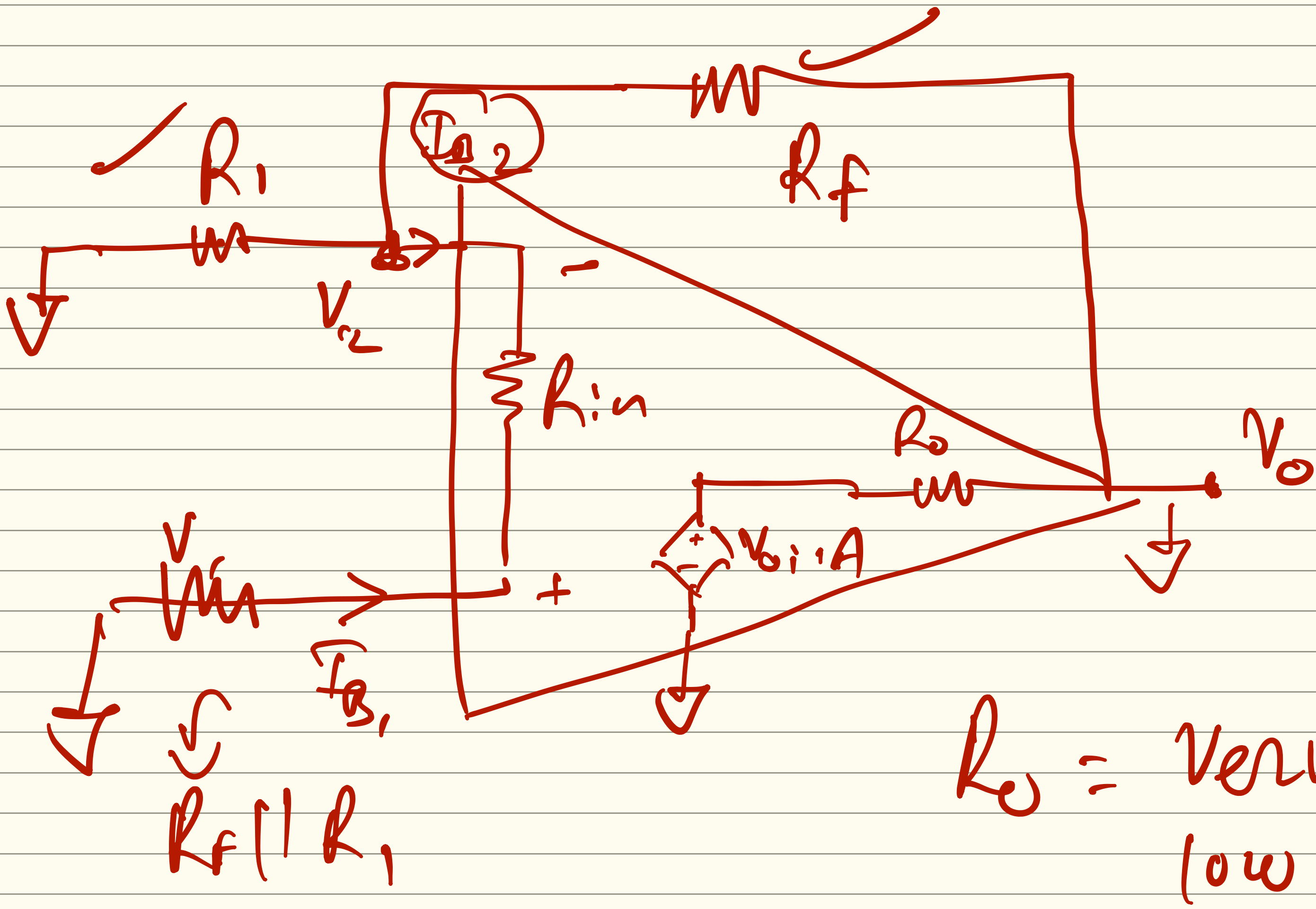


$$I_{B_1} = I_{B_2} = I_B$$

Bias current of op-amp



R_o = very low

V_{io} = very low ≈ 0

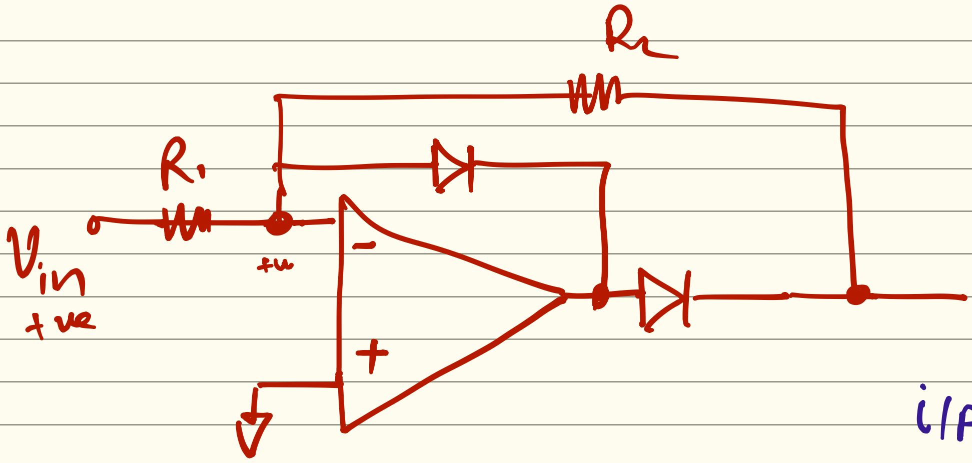
I_{B_2}

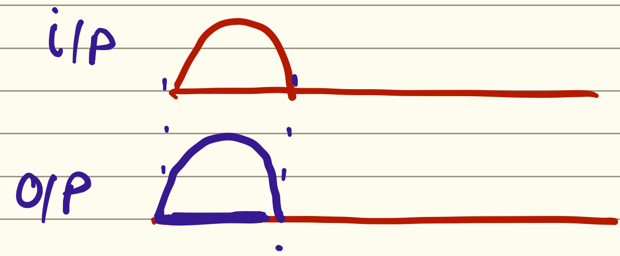
$$V_2 = f(I_{B_2})$$

$$= (R_f \parallel R_1) \cdot I_{B_1}$$

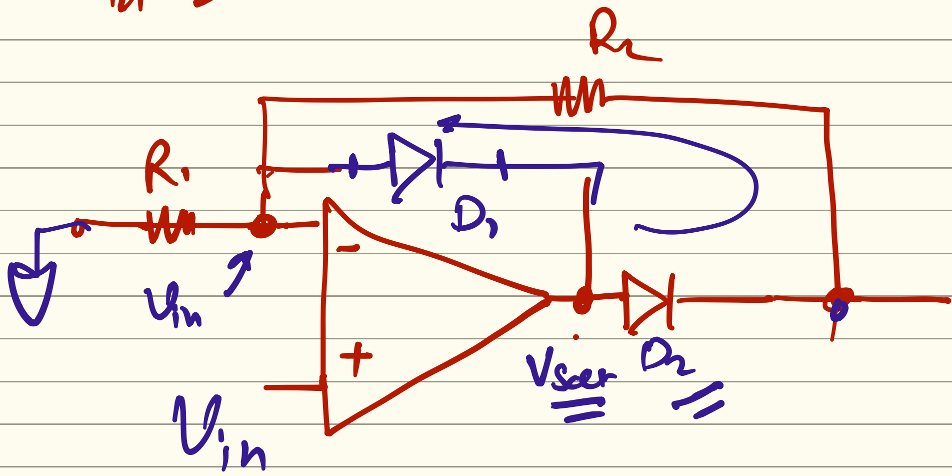
13 Feb

Analog Elex





When $V_{in} > 0$

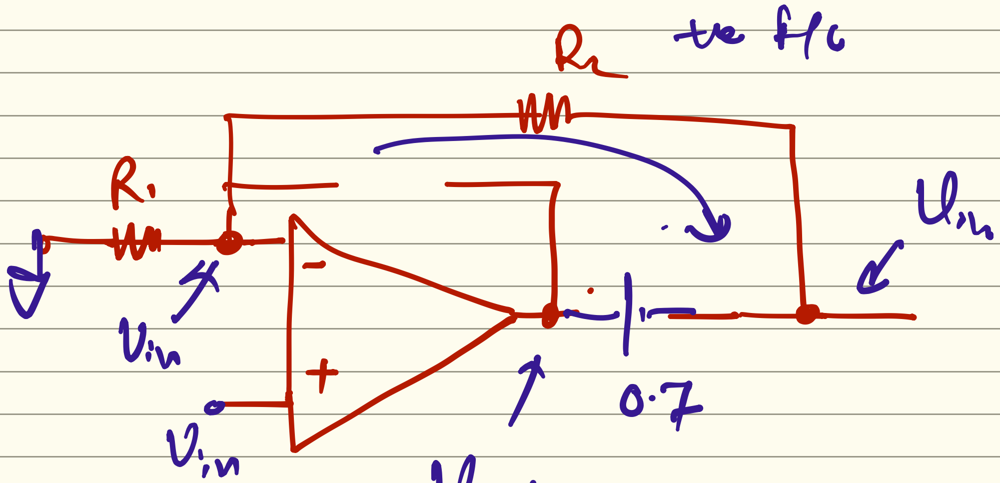


D_1 = R.B

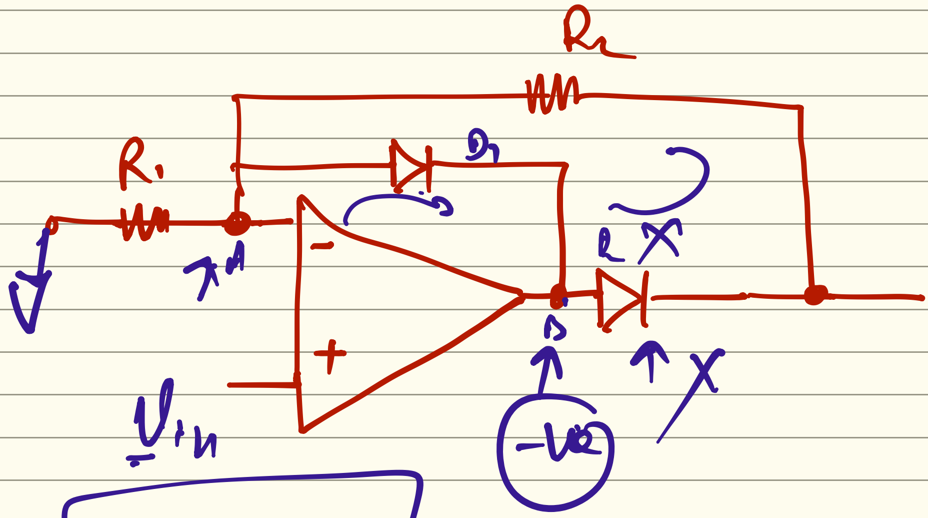
D_2 : F.B

V_{in} is +ve

-ve f/b



$V_{in} + 0.7$

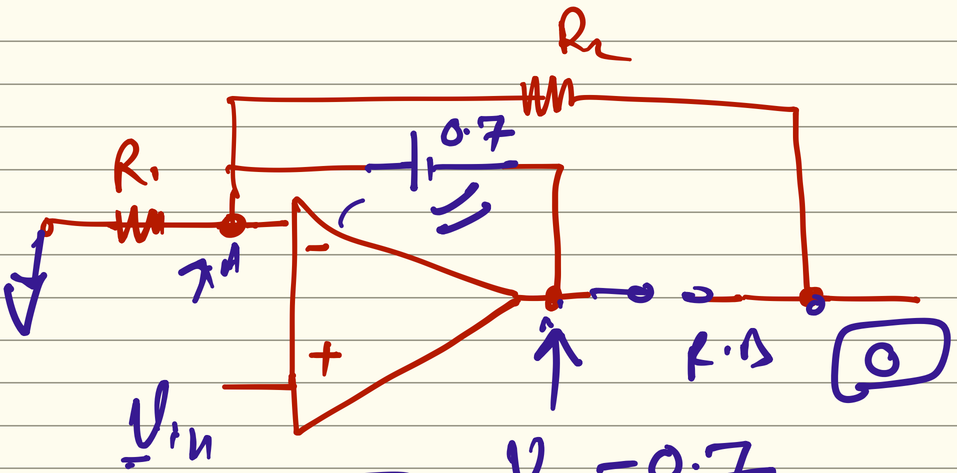


$D_1 =$ F.B

$D_2 =$ R.B

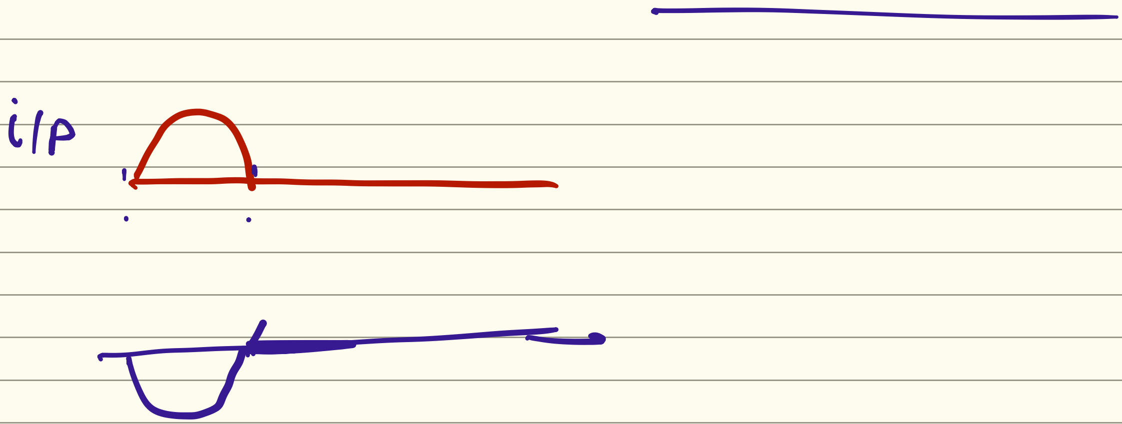
$\boxed{V_{in} < 0}$

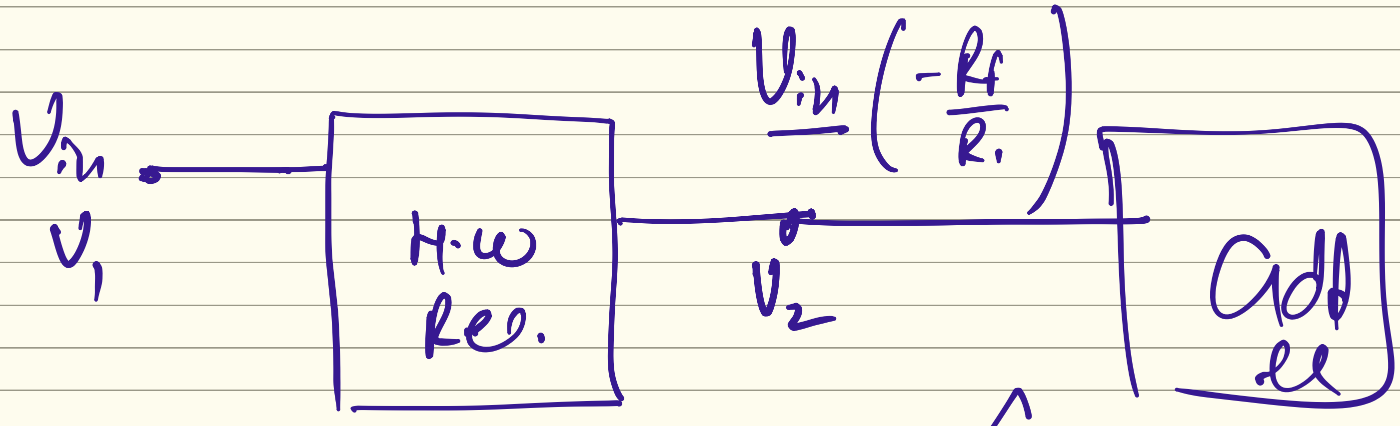
−Sat

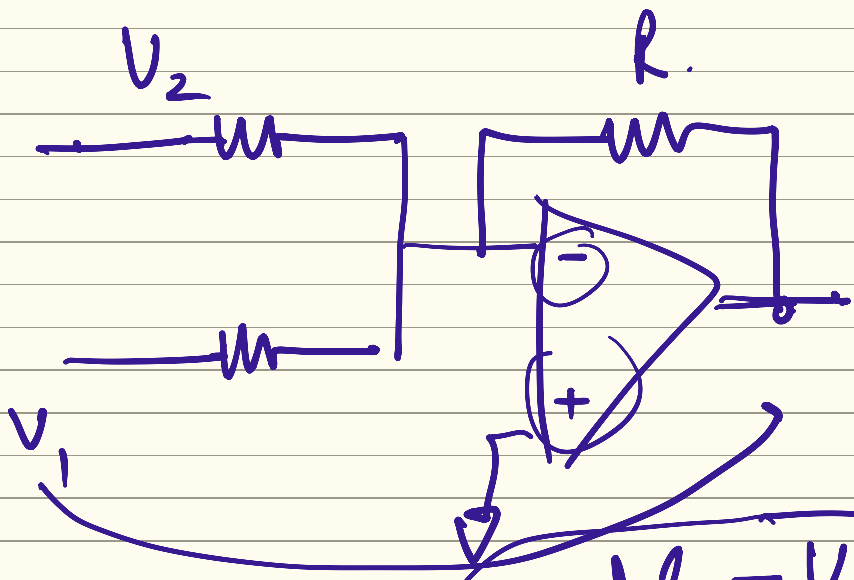


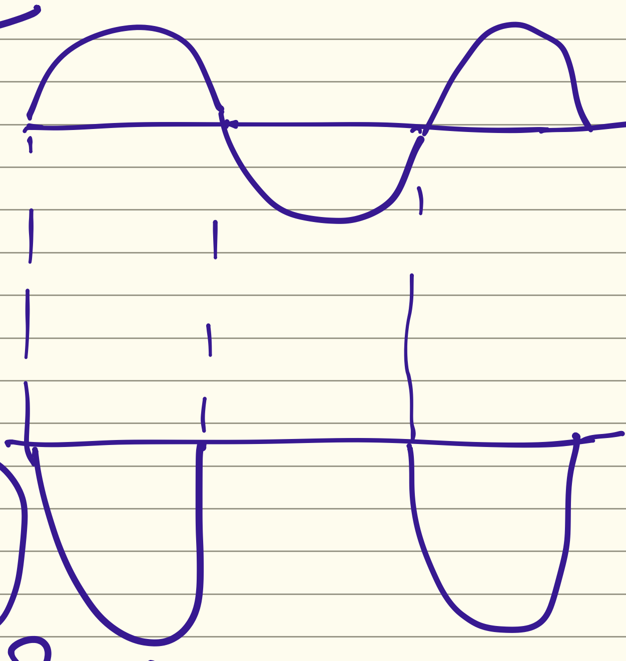
$V_{in} - 0.7$

$\boxed{V_{in} < 0}$



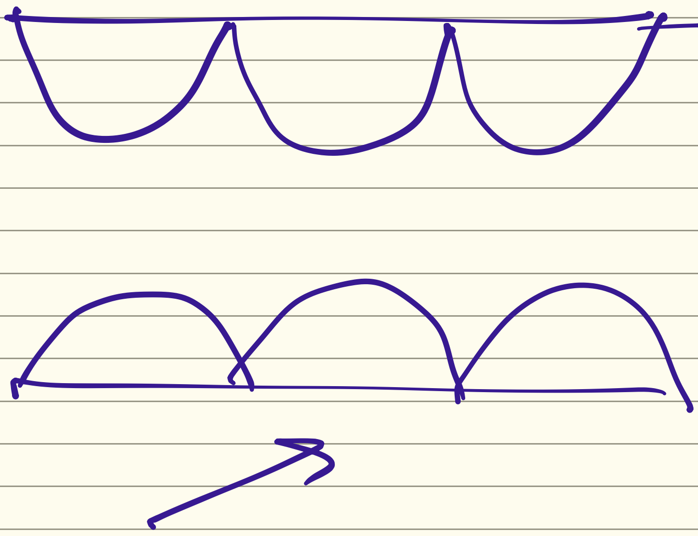


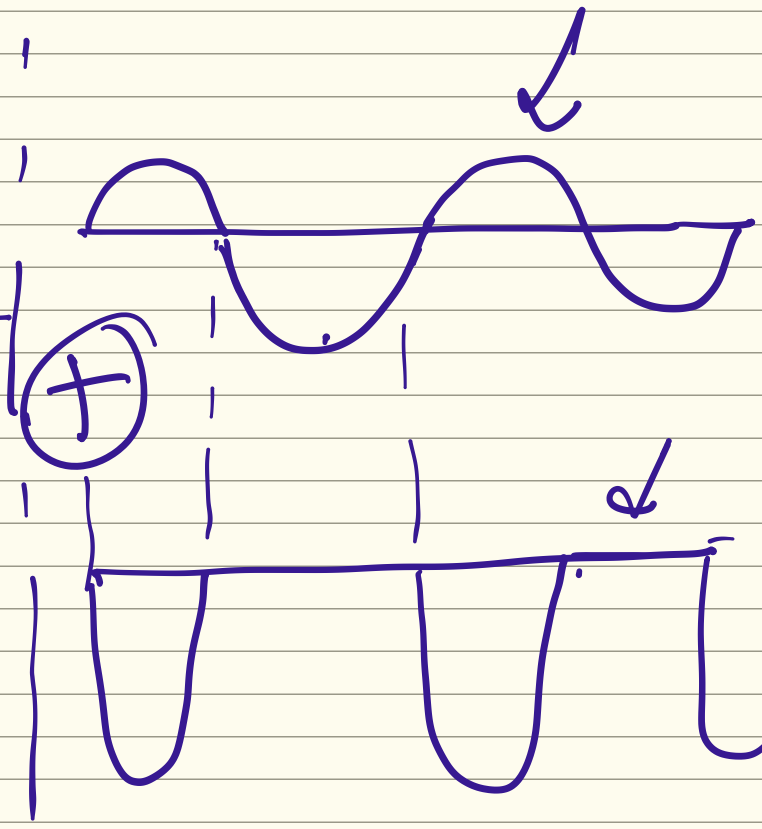


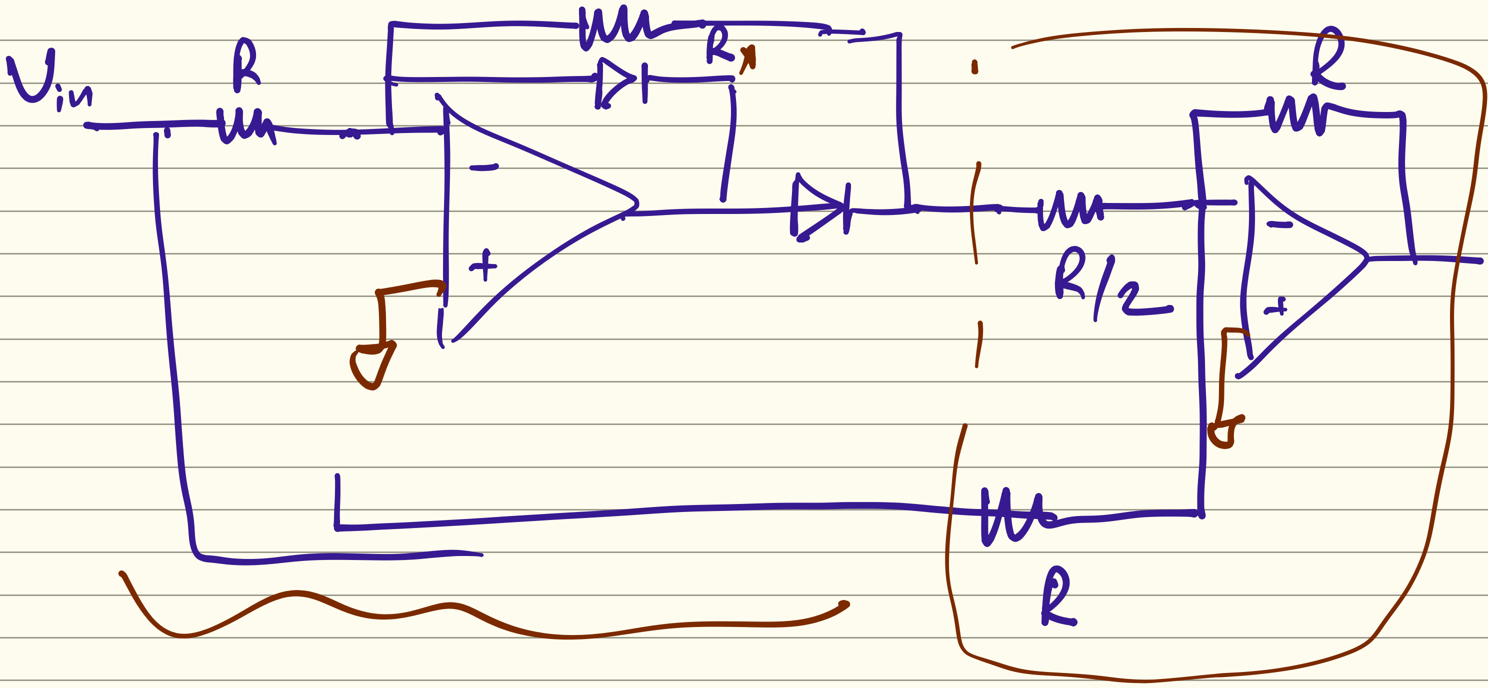


$$-V_1 - \frac{V_2}{2} = 2 \cdot V_{in}$$

$$\Rightarrow \quad -\frac{V_2}{2} - V_1$$

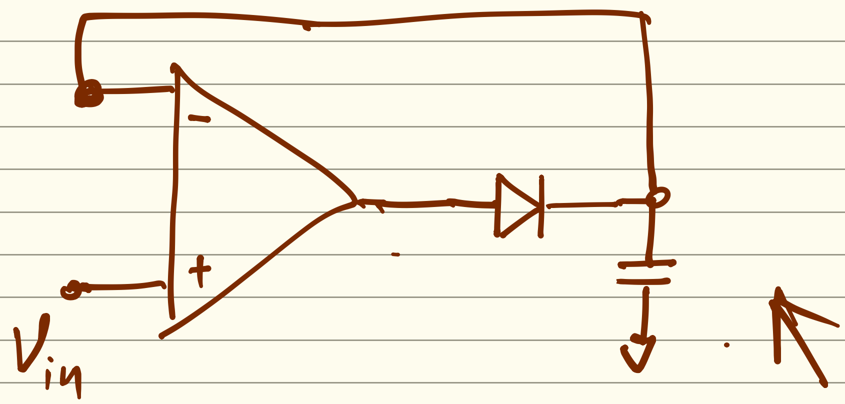






P. H. W. R.

adder



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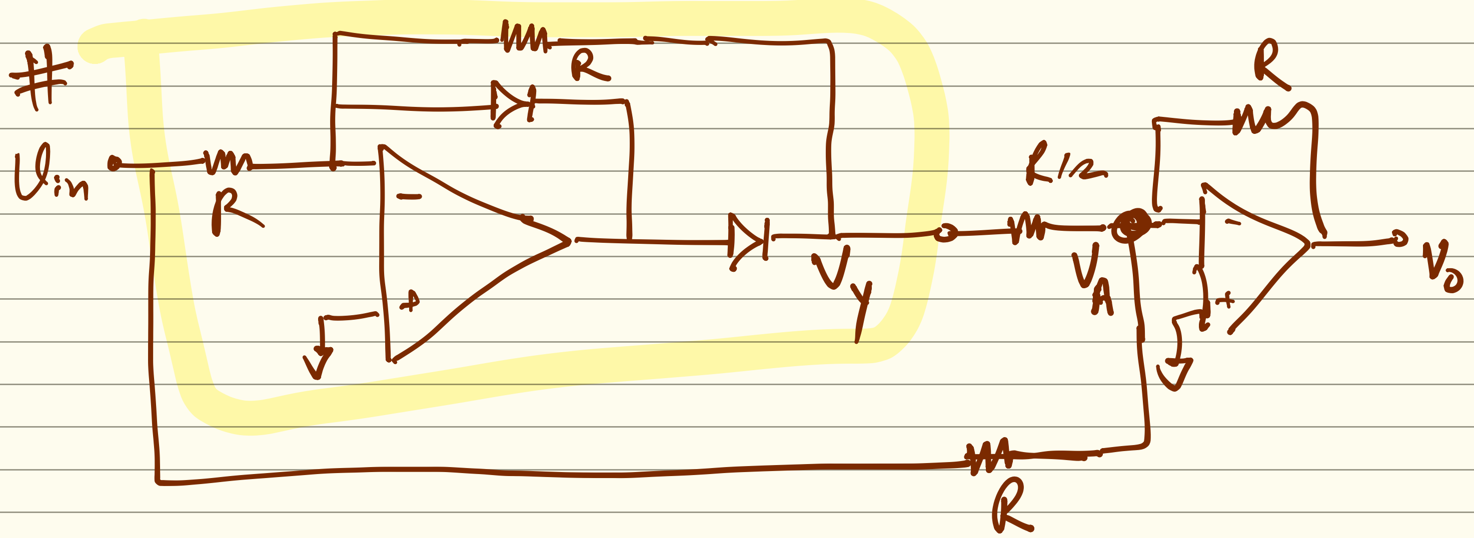
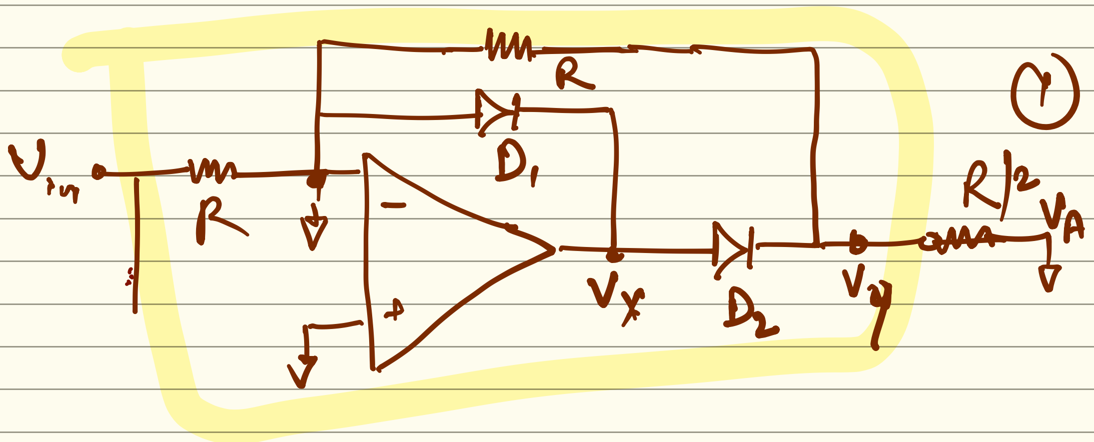




(1) When V_{in} is -ve => V_x will be +ve

$D_2 \to$ F.B

$D_1 \to$ R.B

$$V_y = -\frac{R}{R} \cdot V_{in} = -V_{in}$$

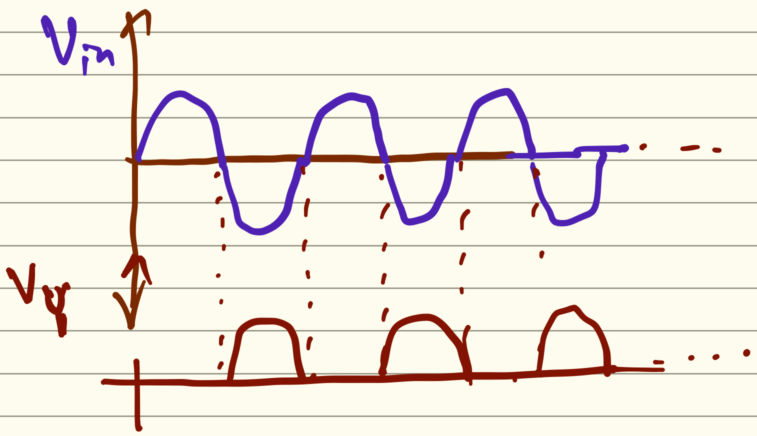
(2) When we have $V_{in} > 0$

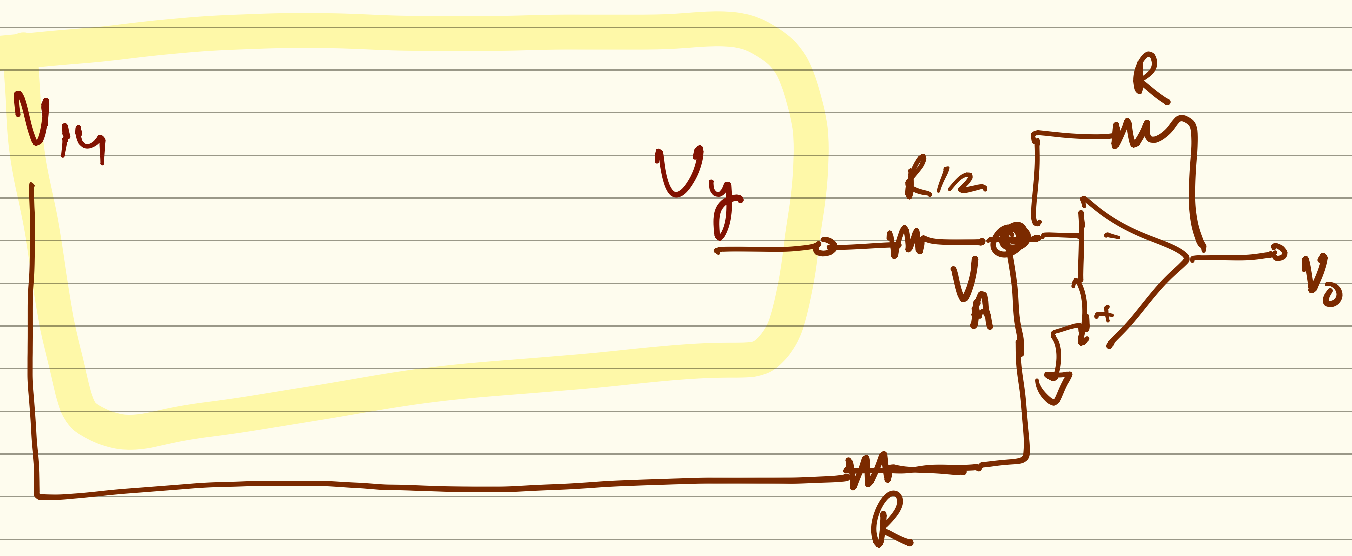
V_x will be -ve => D_2 will be R.B

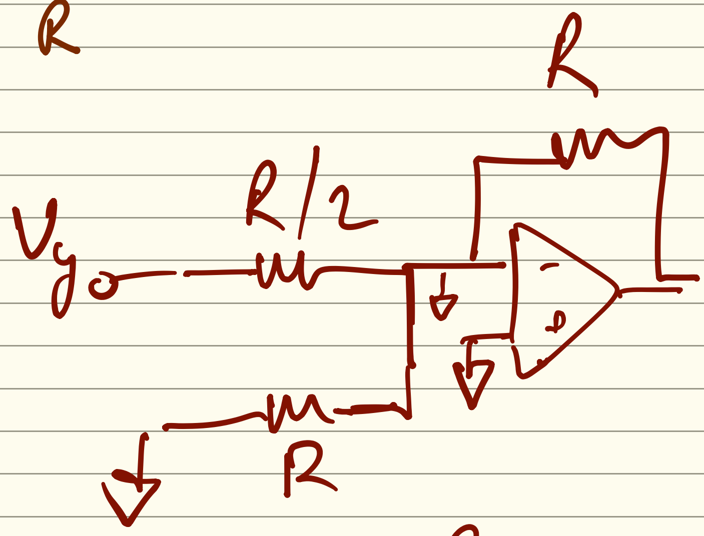
D_1 will be F.B

$$\boxed{V_y = 0}$$

hence we will get inverted -ve half of the input from 1'st part of the circuit



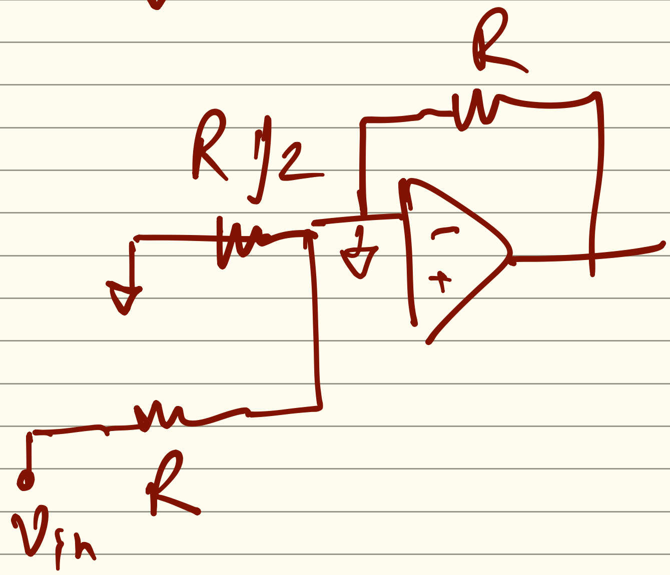


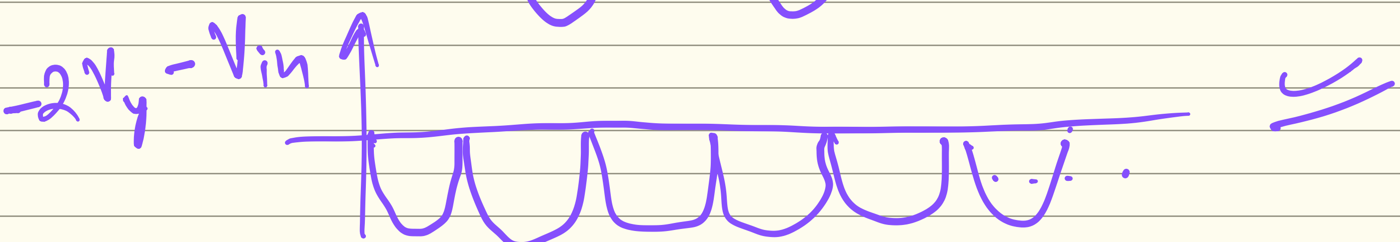


$$V_o =$$

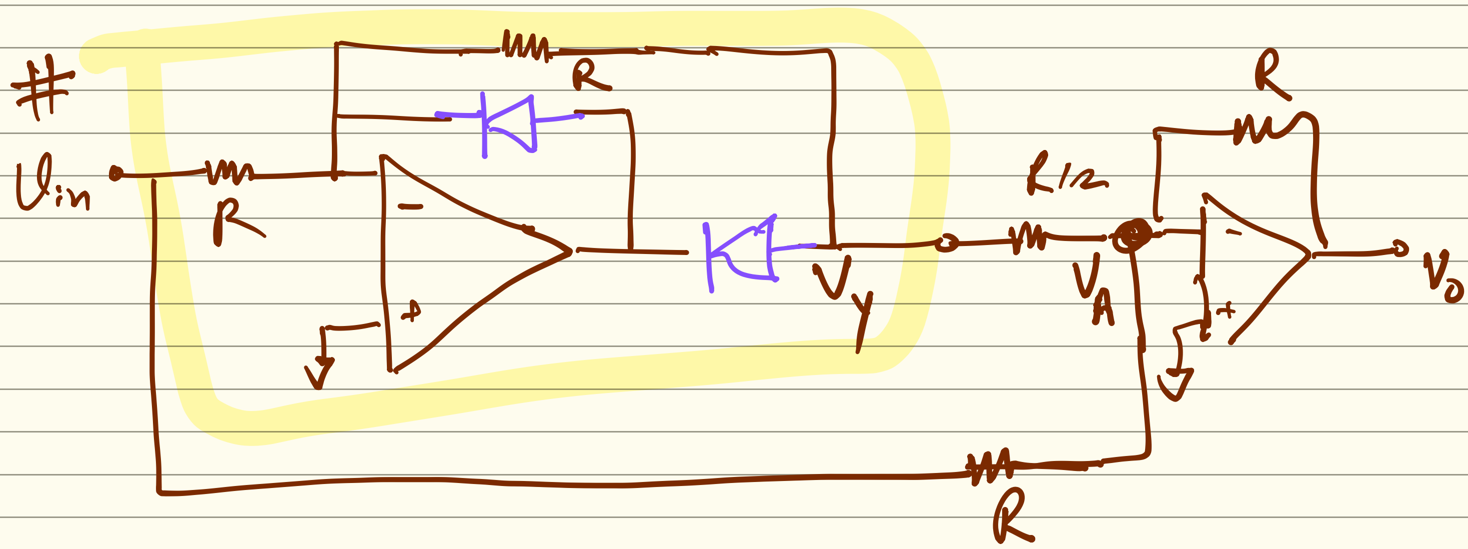
$$= -V_y \cdot \frac{R}{R/2} - V_{in} \frac{\cancel{R}}{\cancel{R}}$$

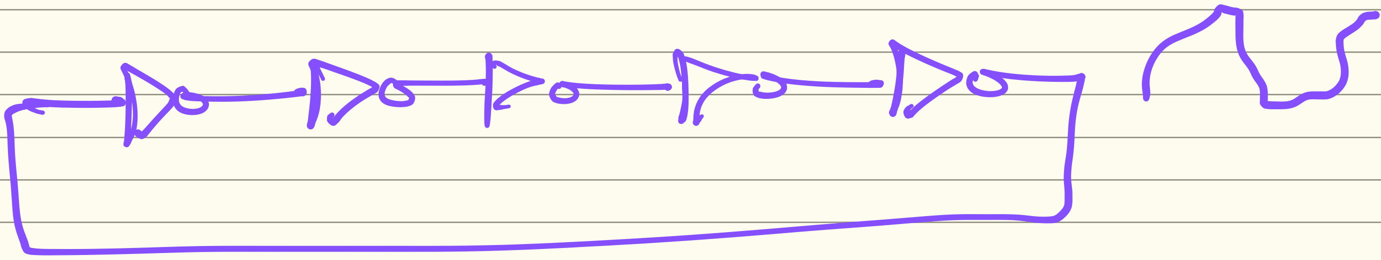
$$= -2V_y - V_{in}$$

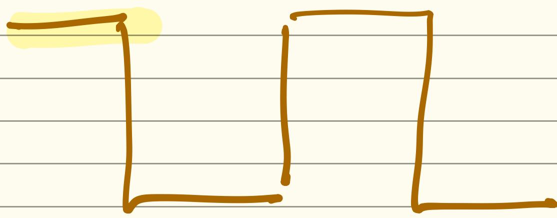


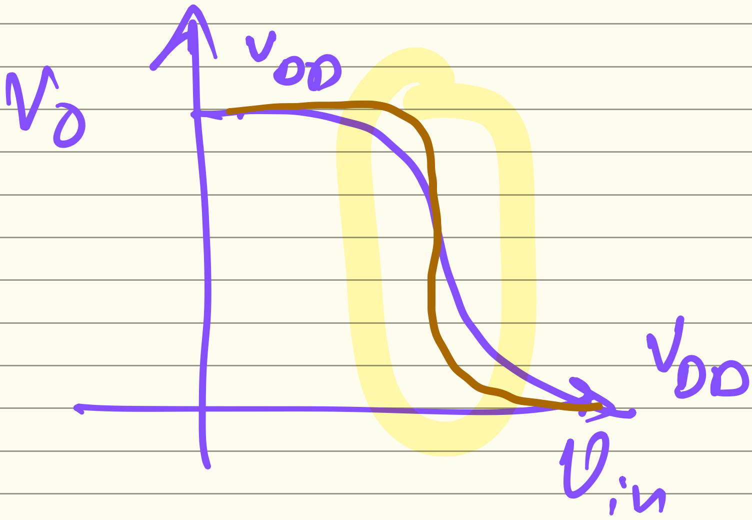


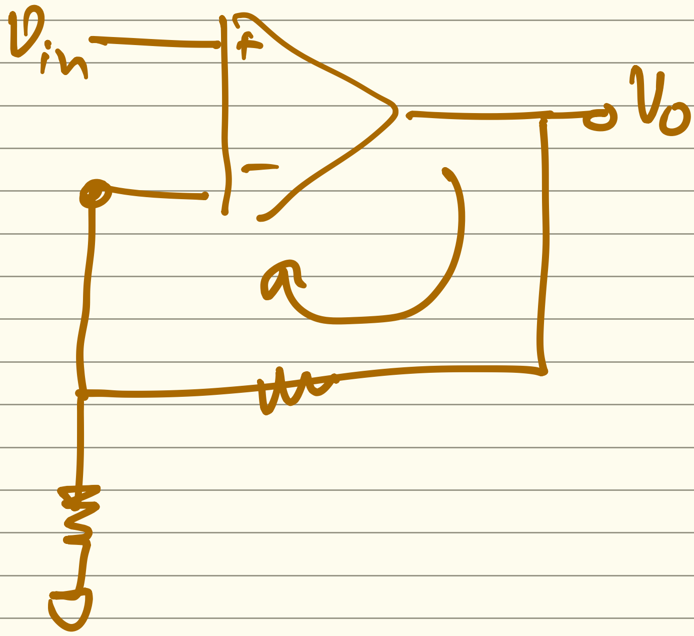
Try This →



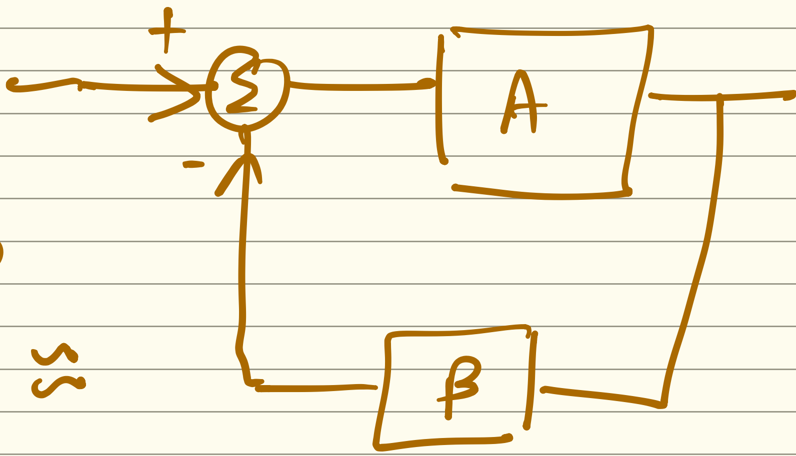






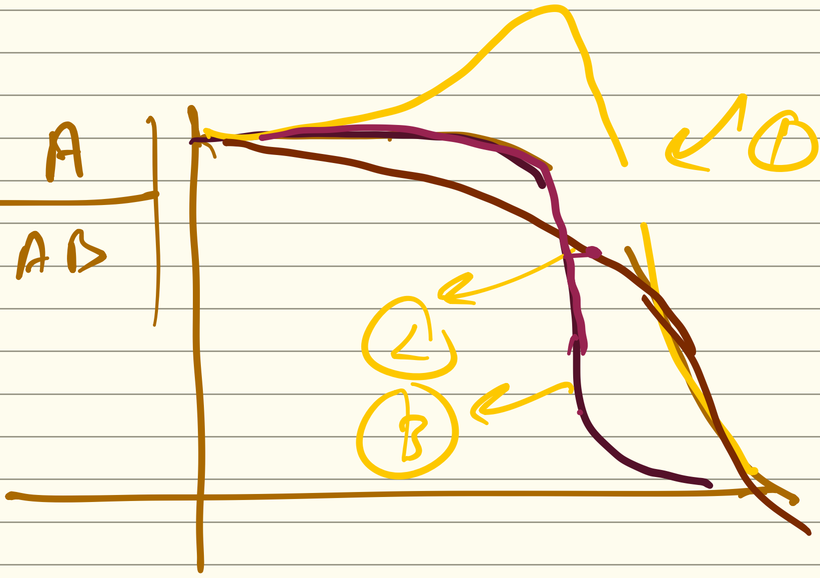


$\approx$



$$= \frac{A}{1 + A\beta}$$

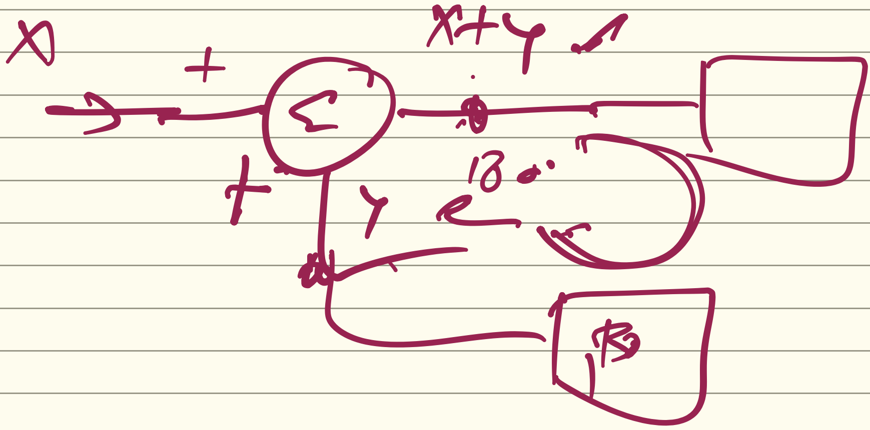
$$\log \left| \frac{A}{1+AB} \right|$$



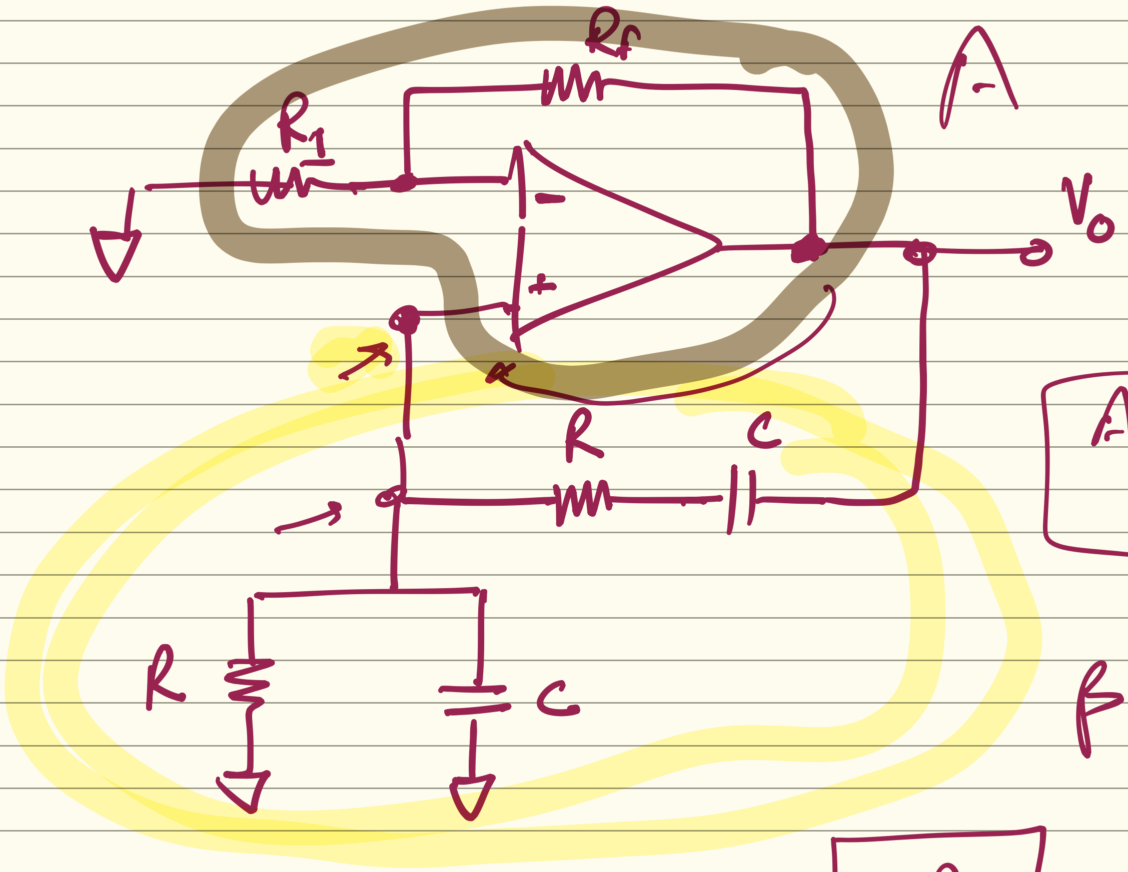
Condition: for oscillation

$\angle AB = \pm 180°$ } → when the f/b is there

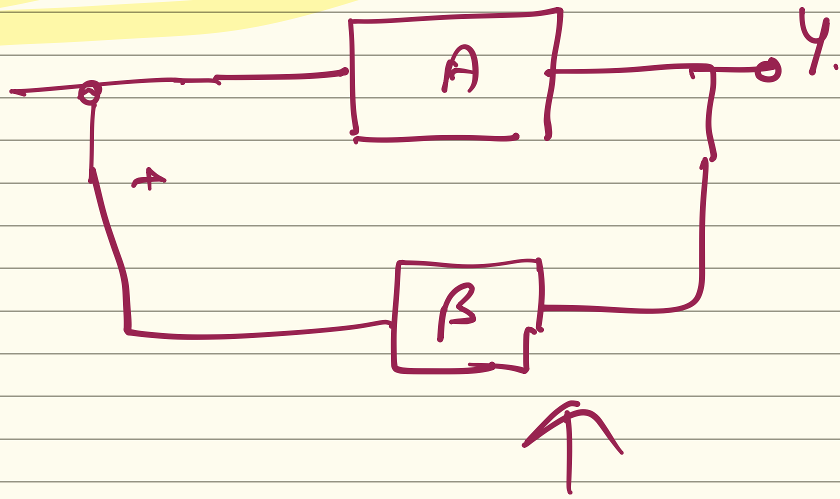
otherwise $\angle AB = 0°$ or $360°$ } = when the f/b is there



Wein Bridge Oscillator



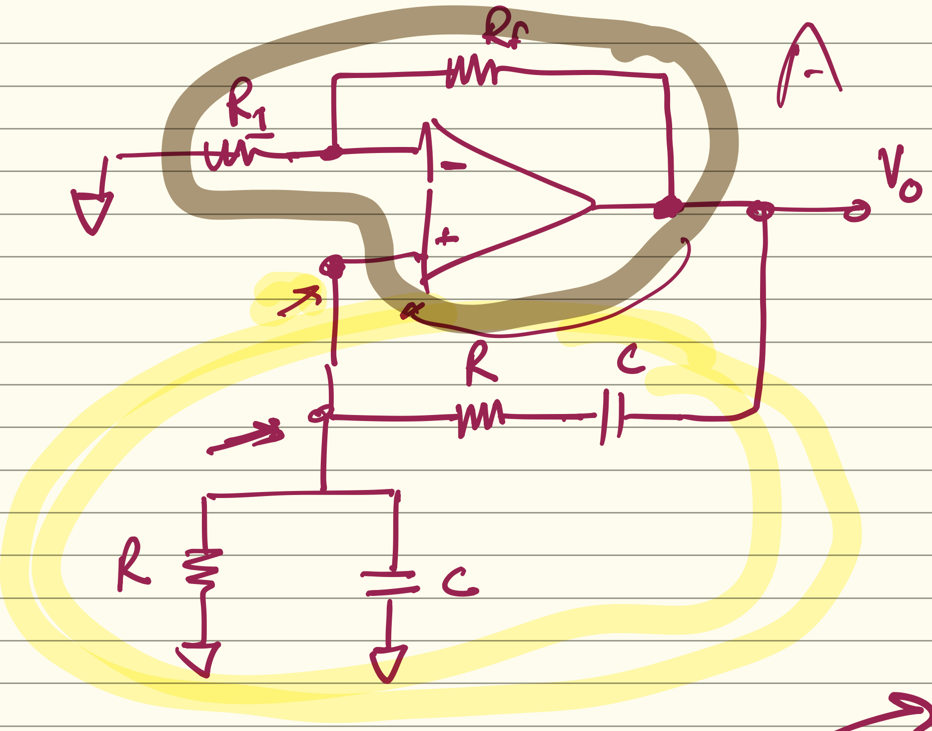
$$A = 1 + \frac{R_f}{R_1}$$



$$\frac{A}{1 - A\beta}$$

$|A\beta| = 1$

$\angle A\beta = 0°$

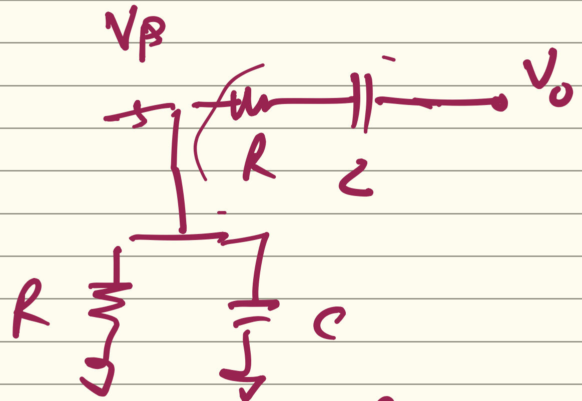


$$A \cdot \beta = 1$$

$$\angle A\beta = 0^\circ$$

$$\Rightarrow \quad A(\omega)\cdot\beta = 1 + 0\cdot j$$

$$\beta = \frac{\dfrac{V_o \cdot R}{(RsC+1)}}{\dfrac{R}{(RsC+1)} + \dfrac{sCR+1}{sC}}$$



$$= \frac{V_o \; R\cdot sC}{RsC + (RsC+1)^2} = \frac{V_o \; RsC}{RsC + 2RsC + R^2C^2s^2 + 1}$$

$$\beta = \frac{RsC}{RsC + 2RsC + R^2C^2s^2 + 1}$$

$$\underset{\sim}{A\beta} = \left(1 + \frac{R_f}{R_1}\right)\left\{\frac{RsC}{3RsC + R^2C^2s^2 + 1}\right\}$$

$$1 + 0j = \left(1 + \frac{R_f}{R_1}\right)\left\{\frac{j\omega RC}{3j\omega RC + 1 - R^2C^2\omega^2}\right\}$$

$$\underbrace{3j\omega RC}_{Im} + \underbrace{1 - \omega^2R^2C^2}_{R} = \underbrace{\left(1 + \frac{R_f}{R_1}\right) j\omega RC}_{Im}$$

$$1 - \omega^2R^2C^2 = 0$$

$$\omega = \frac{1}{RC} \quad \Big| \quad \boxed{f = \frac{1}{2\pi RC}}$$

$$\underbrace{\cancel{3}\,\cancel{j}\omega RC}_{Im} = \underbrace{\left(1+\frac{R_f}{R_1}\right)\cancel{j}\omega RC}_{Im}$$

$$\underline{3\omega RC} = \left(1+\frac{R_f}{R_1}\right)\omega RC$$

$$3 = \left(1+\frac{R_f}{R_1}\right)\cdot 1$$

$$\boxed{\frac{R_f}{R_1} = 2} \Leftarrow$$