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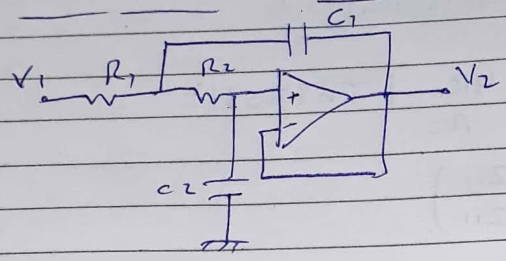
Aun have poles as well as 0's.
Aun(s) & B(s) have same pole.

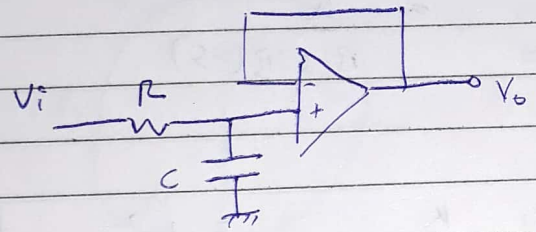
* Butterworth Filter (sallen-key Filter)



$$\frac{V_2}{V_1} = \frac{1/R_1R_2C_1C_2}{s^2 + \left(\frac{1}{R_1C_1} + \frac{1}{R_2C_1}\right)s + \frac{1}{R_1R_2C_1C_2}}$$

2nd order lowpass Filter.

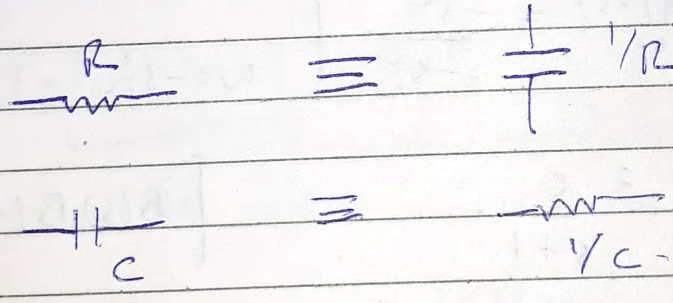
$$= \frac{\omega_0^2}{s^2 + \left(\frac{\omega_1}{\theta}\right)s + \omega_0^2}$$



1st order filter.

$$\frac{V_o}{V_i} = \frac{1}{1+sCR}$$

Now just cascade these to get any order filter.



low pass becomes high Pass.

$s \rightarrow \omega_0'/s$.

lowpass → high pass.

(ω_0' → 3dB frequency)

Impedence Transformation.

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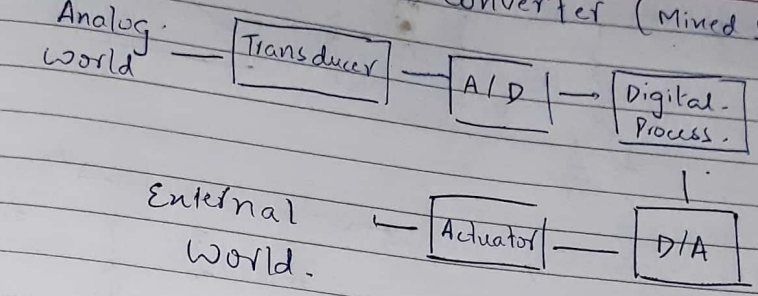
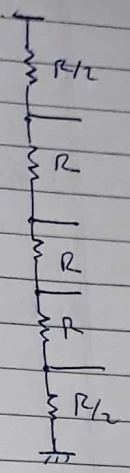
16/4/18

D to A and A/D converter (Mixed Signal Processing).



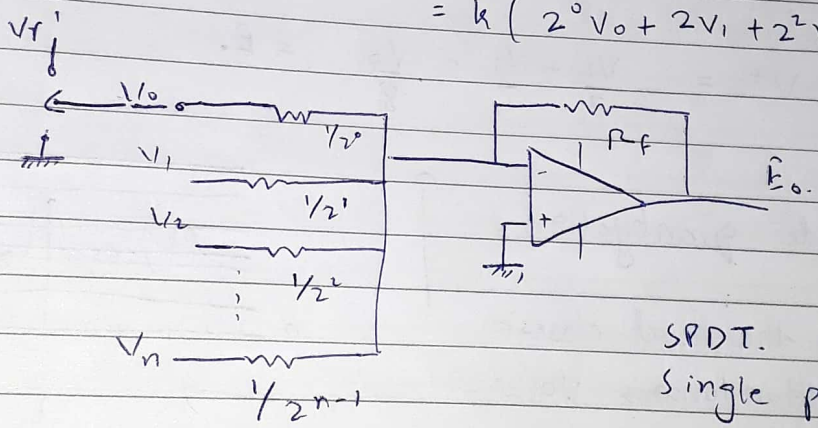


3 bit I/P.

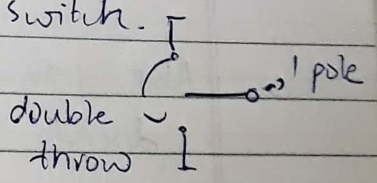
I/P. V_2	V_1	V_0	
0	0	0	$0 \rightarrow 0V$
1	0	1	$1 \rightarrow V_{ref}$
1	0	0	
1	1	1	

$$\vec{E}_o = k \sum_{i=0}^{n-1} V_i 2^i$$

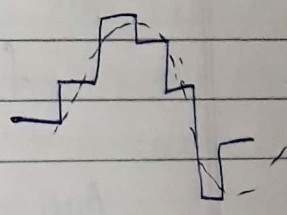
$$= k\left(2^0 V_0 + 2V_1 + 2^2 V_2\right)$$



SPDT.
Single pole double throw switch.



Now pass the output through a filter based on the input or the info abt the signal.



* ⇒ Weighted Resistor D/A converter.

but this depends on resistance values, & which needs to be precise, but resistances are very arbit.

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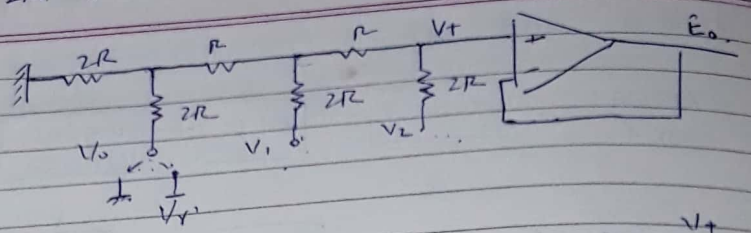
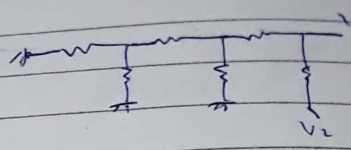
R-2R ladder D/A Converter.

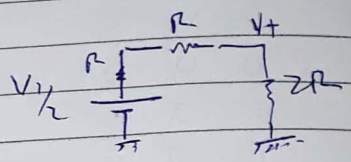


if $V_2 = 1$, $V_0 = V_1 = 0$ →



$\Rightarrow V_+ = \frac{V_2}{2}$

Now, $V_2 = V_0 = 0$, $V_1 = 1$.



$V_+ = \frac{V_1}{4}$

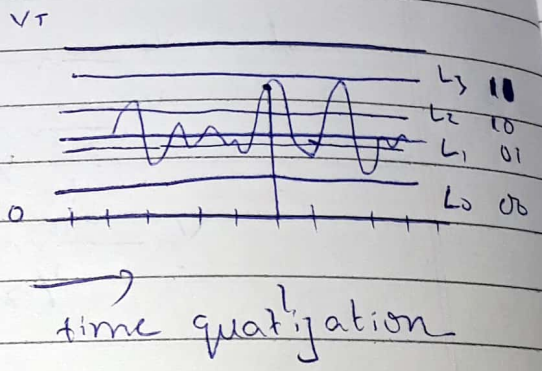
Ully, $V_0 = 1$, $V_1 = V_2 = 0$.

$\Rightarrow V_+ = \frac{V_0}{8}$.

$\Rightarrow V^+ = \frac{V_2}{2} + \frac{V_1}{4} + \frac{V_0}{8} = E_0$

Amplitude quantization -

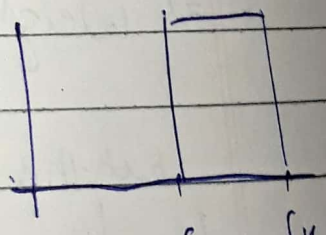
I choose the level closest to instantaneous value.



Also, looking at signal only at discrete time. $f_s = \frac{1}{T_s}$ (sampling frequency)

$f_s > 2f_i$ Nyquist relation

band limited.



Anti-aliasing

if band limited, can do sampling at much lower rate

$f_s > 2(f_H - f_L)$

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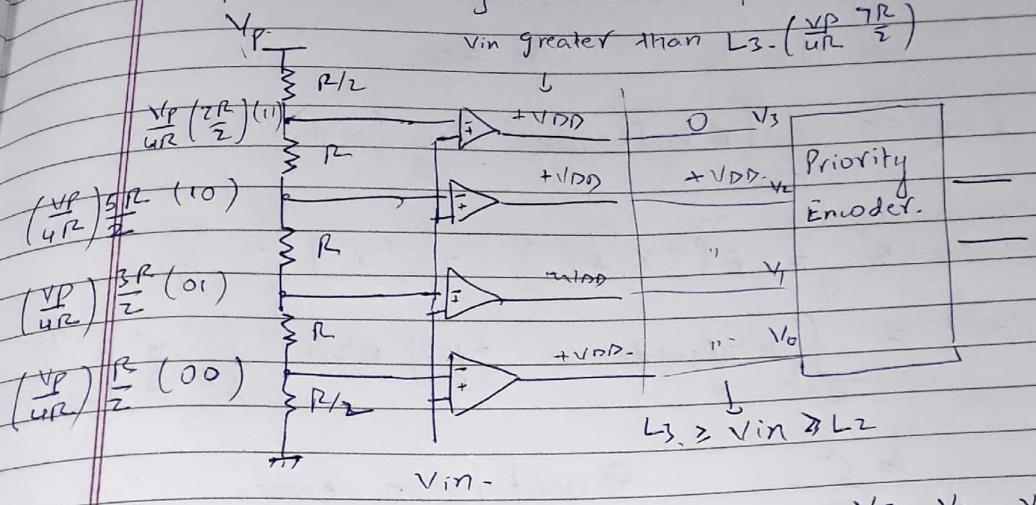
Anti-aliasing filter band pass.

amplitude Quantization loss info. Time Quantiz. does not.



V3	V2	V1	V0	D1	D0
1	x	x	x	1	1
0	1	x	x	1	0
0	0	1	x	0	1
0	0	0	x	0	0

A/D converter (flash ADC)

↙

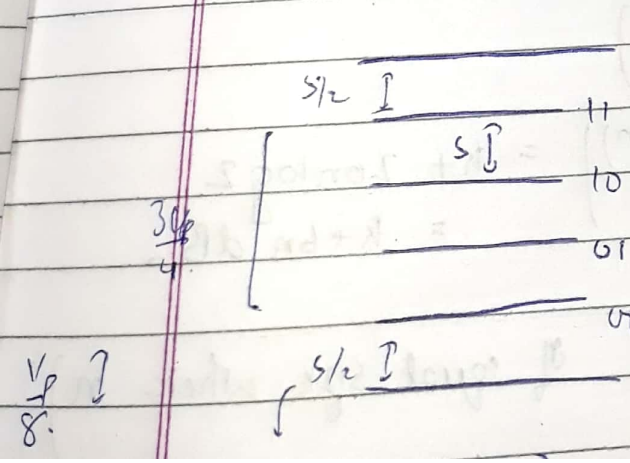
fast. very fast.

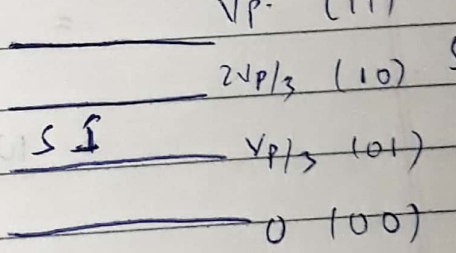
Single slope A/D Converter.

Dual " " "

Successive Approximation ADC.

Σ-Δ ADC (sigma-Delta)





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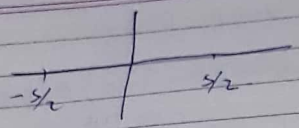
$f(x) = 1/s$



(uniform - distribution)

$\bar{x} = 0$

$E(x) = 0 = \int_{-s/2}^{s/2} x f(x)\,dx = \frac{1}{s}\int_{-s/2}^{s/2} x\,dx = 0$

Variance $(x) = E[(x-\mu)^2] = E[x^2]$

$E(x^2) = \int_{-s/2}^{s/2} x^2 f(x)\,dx = \frac{1}{s}\int x^2\,dx = \frac{1}{s}\frac{x^3}{3}\Big|_{-s/2}^{+s/2}$

$= \frac{s^2}{12}$ - Quantization error.

→ to make sure we have equal space.

R, R/2 -

D/A ↔ A/D $\quad N = \frac{s^2}{12}$, $E = \frac{v^2}{2}$ (Energy of signal) $\quad v_p$

SNR (Signal to noise ratio) $= 10\log_{10}\left(\frac{E}{N}\right)$

$= 10\log_{10}\left(\frac{v^2}{2}\,\frac{12}{s^2}\right)$

$= 10\log_{10}\left(\frac{6}{4}\frac{v^2}{v^2}(2^{2n})\right) = k + 20n\log 2$

$= k + 6n$ dB.

$s = \frac{2v}{2^n}$ (2v divided in 2^n levels of equal size, where n is n-bit decoder)

Assump. → uniform distribution of levels. signal is pure sin.

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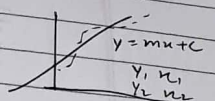
Noise is coming by quantization error.

Error $= \frac{1}{n} \Sigma (Y - Y_i)^2$

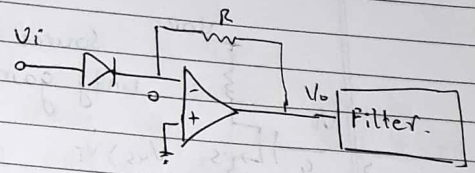


minize this. We take the variance, as we don't care abt the sign of error.

every bit we increase, we get an improvement of 6 dB.

$$i = I_0 e^{V_i/\eta_{kT}}$$

$$= -\frac{V_0}{R}$$

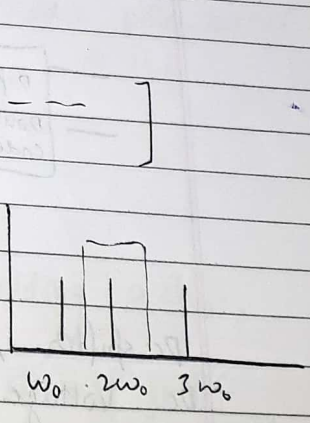


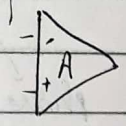
$$V_0 = -I_0 R e^{V_i/\eta_{kT}}$$

$$= -I_0 R \left[1 + \frac{V_i}{\eta_{kT}} + \frac{V_i^2}{2\eta^2 k^2 T^2} + \cdots \right]$$

$V_i = V_M \sin \omega t$

How to introduce a phase shift.





If assume gain to be A, still get $V_0 = f(A, R_1, R_2)$

$A \to \infty$ gives same result.

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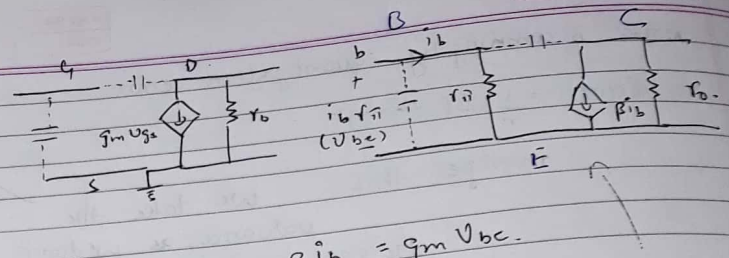
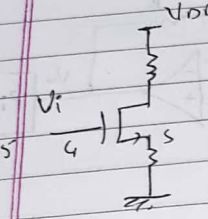


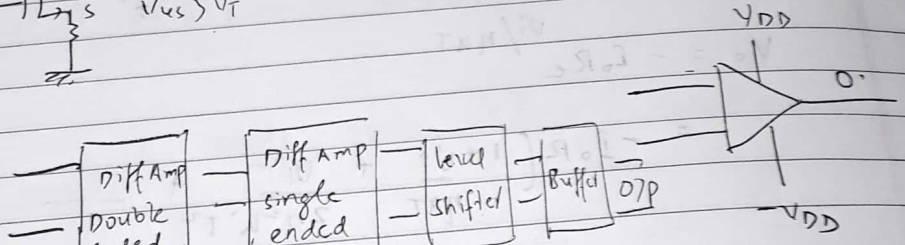
$\frac{\beta}{r_\pi} = g_m$. $\beta i_b = g_m V_{bc}$.

depletion capacitance
diffusion capacitance.



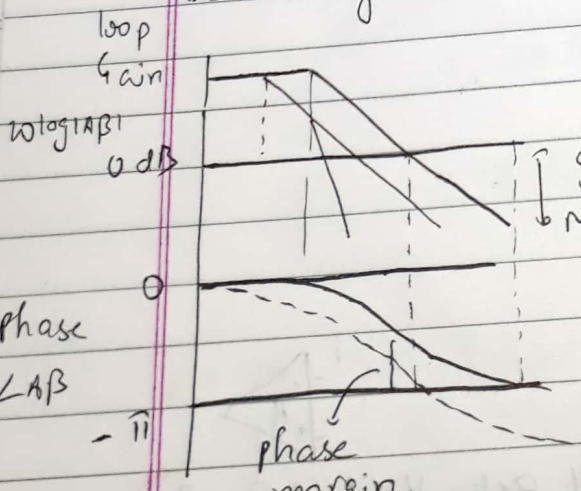
Source follower. Dc shift also, V_T or more.
unity gain

$V_{GS} > V_T$



if input 0, we expect output to be 0. if bipolar.

Dc shifter, can make Dc voltage 0 at the output.



$A\beta = 1$.

$\frac{1 - j\omega RC}{1 + j\omega RC}$.

⇓

All pass filter with phase shift.

gain 1, phase should be π.

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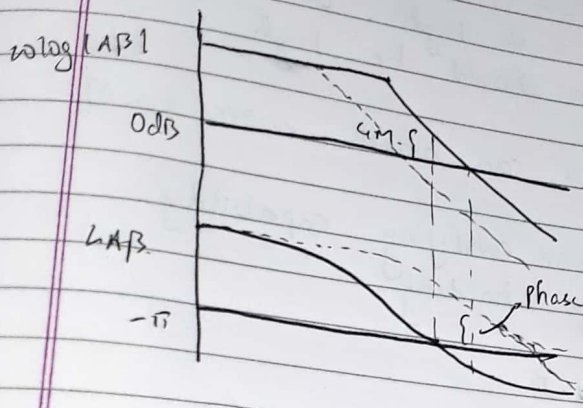
GIC. generalized Impedence converter

$\frac{Z}{(s+a)}$ $\quad Z_{11} = \frac{Z_1 Z_3 Z_5}{Z_2 Z_4}$

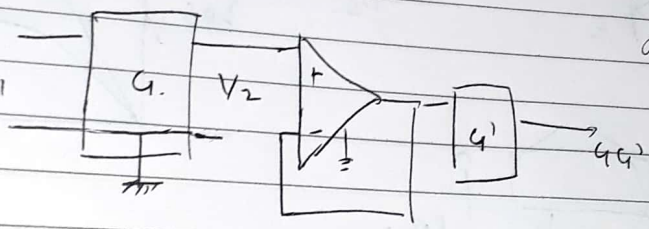


This is not stable, chances of oscillation at $-\pi, |A\beta| > 1$

$G'' = GG'$.

add a tranfer func, to reduce the gain, but it will also add a phase shift

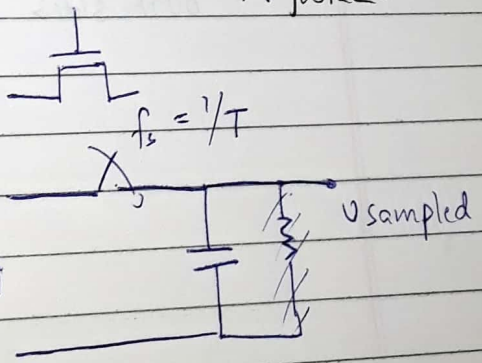
add a pole earlier to it.



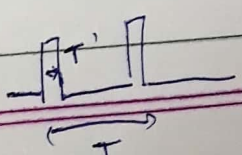
Can change the phase plot, by adding a shift, all pass filter, mag. plot doesn't change.

$G' = \frac{1 - j\omega RC}{1 + j\omega RC}$

{ Gain Comp
{ Pole Comp.



Can't keep t' small, as then associated energy with particular sample is very low, can't drive next circuit.



Can't be large, as value is

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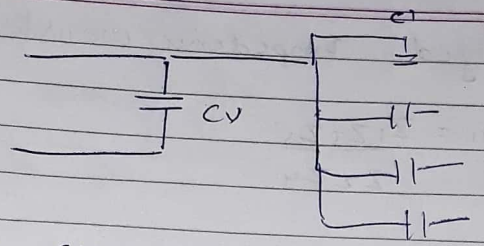


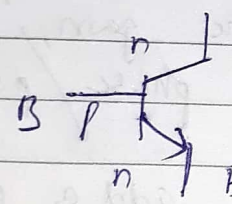
fan out max. no. of inputs connected to output of another circuit.

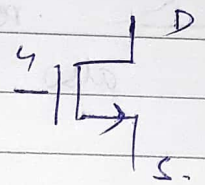
We want CV high, ∴ C high. CR high, takes time to charge. ∴ T' should be high.

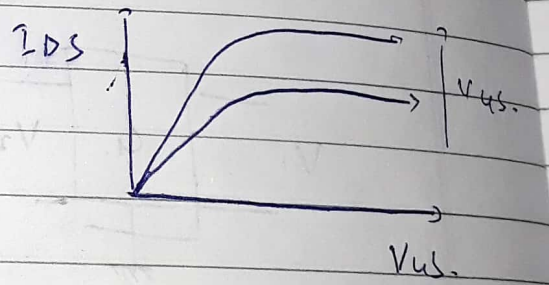
C' should be ~~high~~ low, ∴ can attach more no. of ~~out~~ inputs.

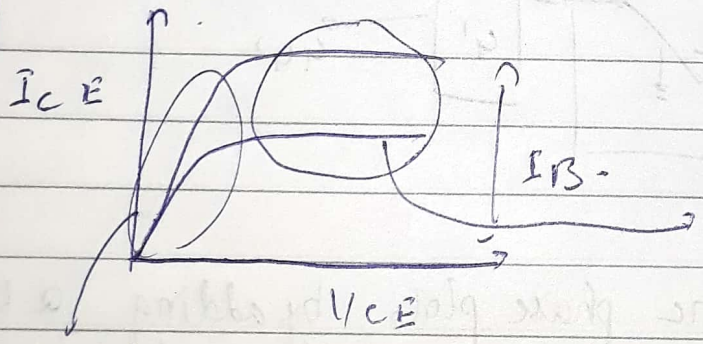
limit on fan in → current carrying capability.

" " " out → charge holding " .









Active Region.

Saturation Region. , Base is saturated with charge, both sides

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