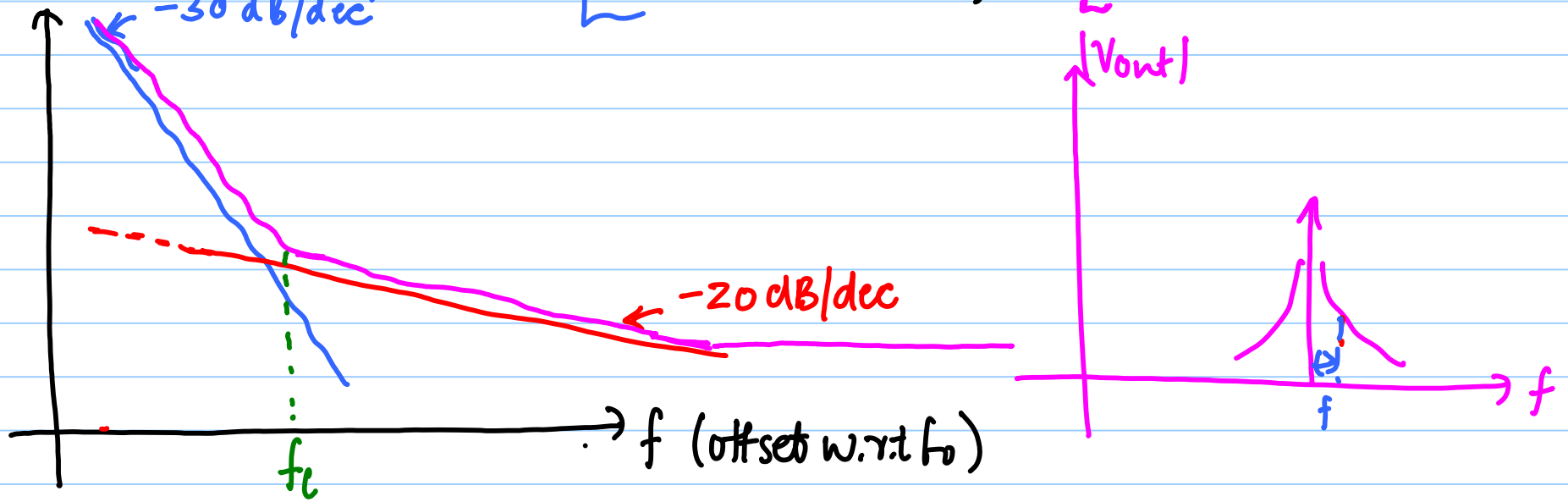
Lecture # 28

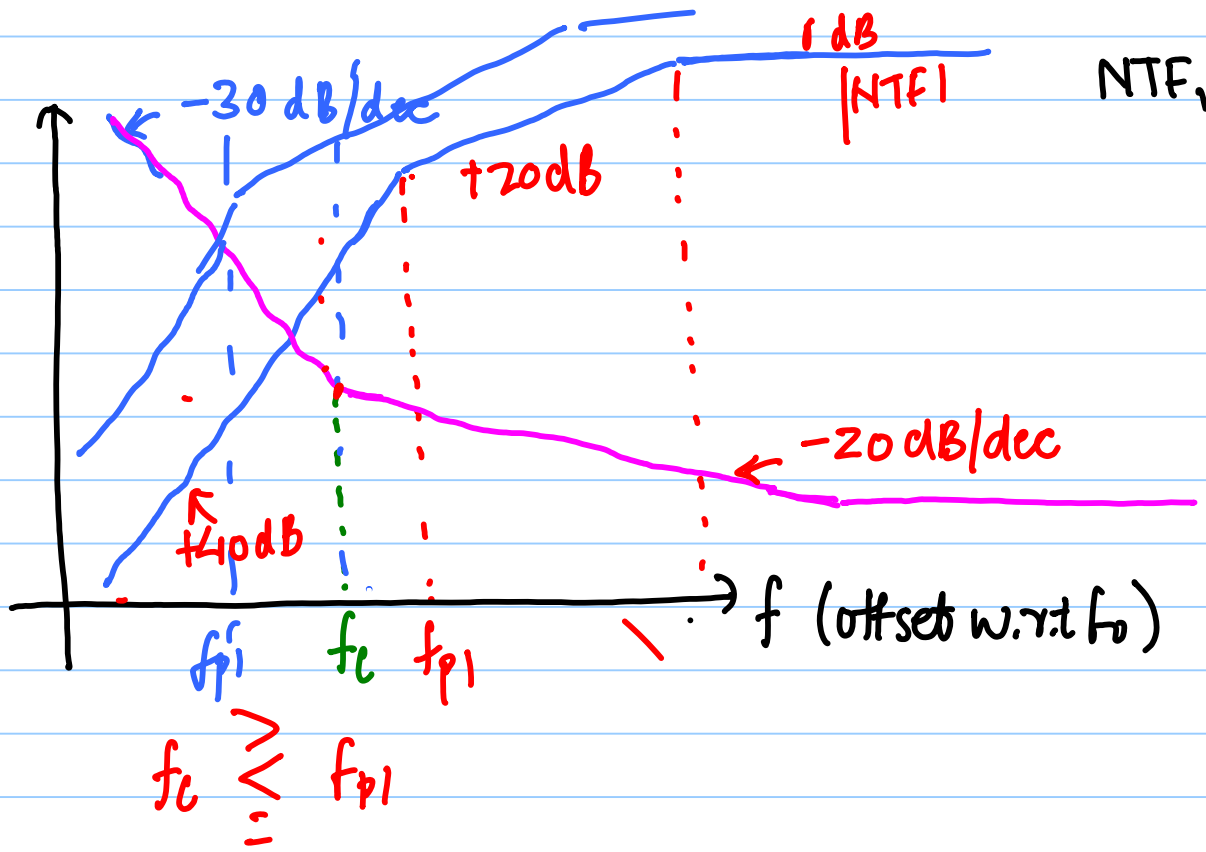
Note Title 30-07-2020

Phase Noise in Ring Osc.

$$\mathcal{L}(f) = \frac{2\pi c T}{I}\left(\frac{1}{V_{dd}-V_t}(\gamma_N+\gamma_P)+\frac{1}{V_{dd}}\right)\left(\frac{f_0}{f}\right)^2$$

$$+\frac{C_{ox}}{8MI}\left(\frac{\mu_N K_{fn}}{L_N^2}+\frac{\mu_P K_{fp}}{L_P^2}\right)\left(\frac{f_0}{f}\right)^3$$





$$NTF_{VCO} = \frac{1}{1+LH}$$

$$= \frac{1}{1 + \frac{I_{cp}}{2\pi}\frac{2\pi K_{VCO}}{sN}\frac{(1+sRC_1)}{\left(1+sRC_1\frac{C_2}{C_1+C_2}\right)}}$$

$$\approx \frac{1}{s(C_1+C_2)}$$

$$= \frac{s^2 N (C_1+C_2)\left(1+sRC_1\frac{C_2}{C_1+C_2}\right)}{(C_1+C_2)s^2 N\left(1+sRC_1\frac{C_2}{C_1+C_2}\right) + I_{cp}K_{VCO}(1+sRC_1)}$$

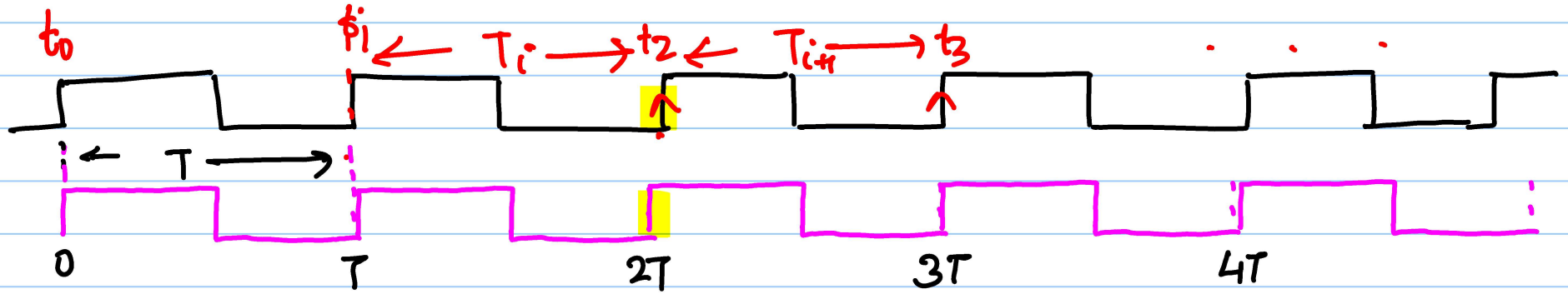
$$\approx \frac{s^2 NC_1}{s^2 NC_1 + I_{cp}K_{VCO}(1+sRC_1)}$$

Period Jitter, $\sigma_T^2 = \int_0^\infty S_T(f)\,df = \int_0^\infty S_\phi(f)\,\frac{\sin^2(\pi f/f_0)}{(\pi f_0)^2}\,df$ ✓

N ⇒ avg. Time period (T)

Time period $T_i = t_{i+1} - t_i$

$$E[(T_i - T)^2] = \sigma_E^2$$



$\Delta t_i = t_i - i.T$ (TIE: time interval error)

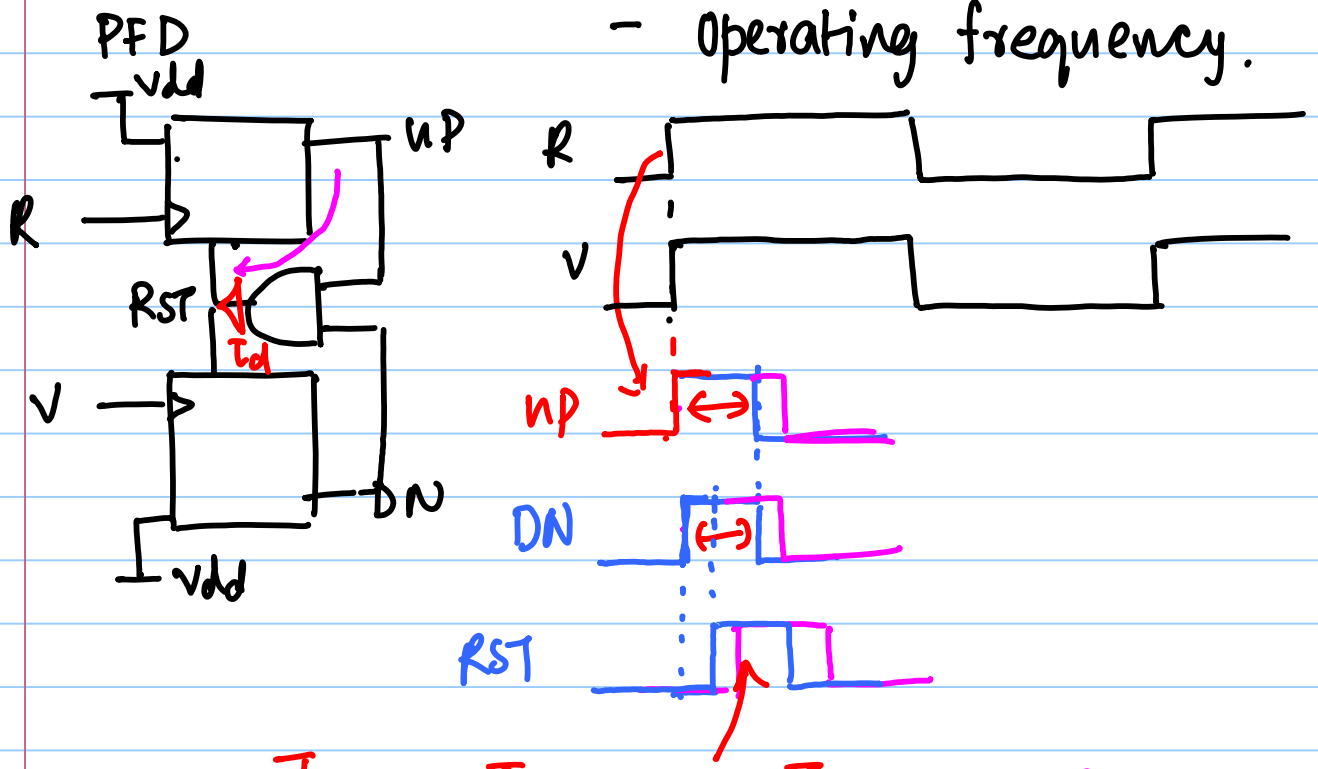
$\sigma^2 = E[\Delta t_i^2] = \int_0^\infty \mathcal{L}(f)\, df$ (long-term absolute jitter or accumulated jitter)

Cycle-to-cycle Period Jitter = $E[\Delta t_i^2]$

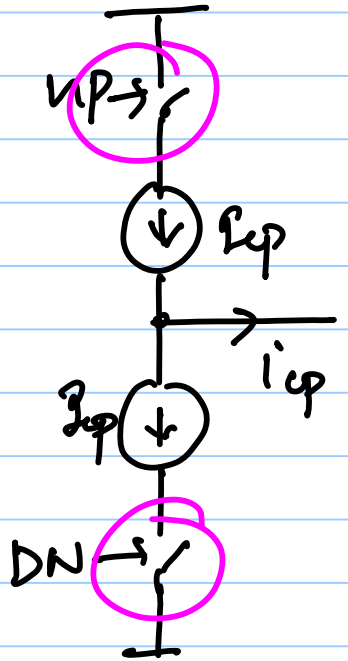
$\Delta t_{i,c \to i+1,c} = T_{i+1} - T_i$

# Sample size.	σ	Error $\sigma_n / \sqrt{2N}$
10	± 1.282	
10^4	± 3.719	
10^{12}	± 7.035	

Building Blocks of PLL

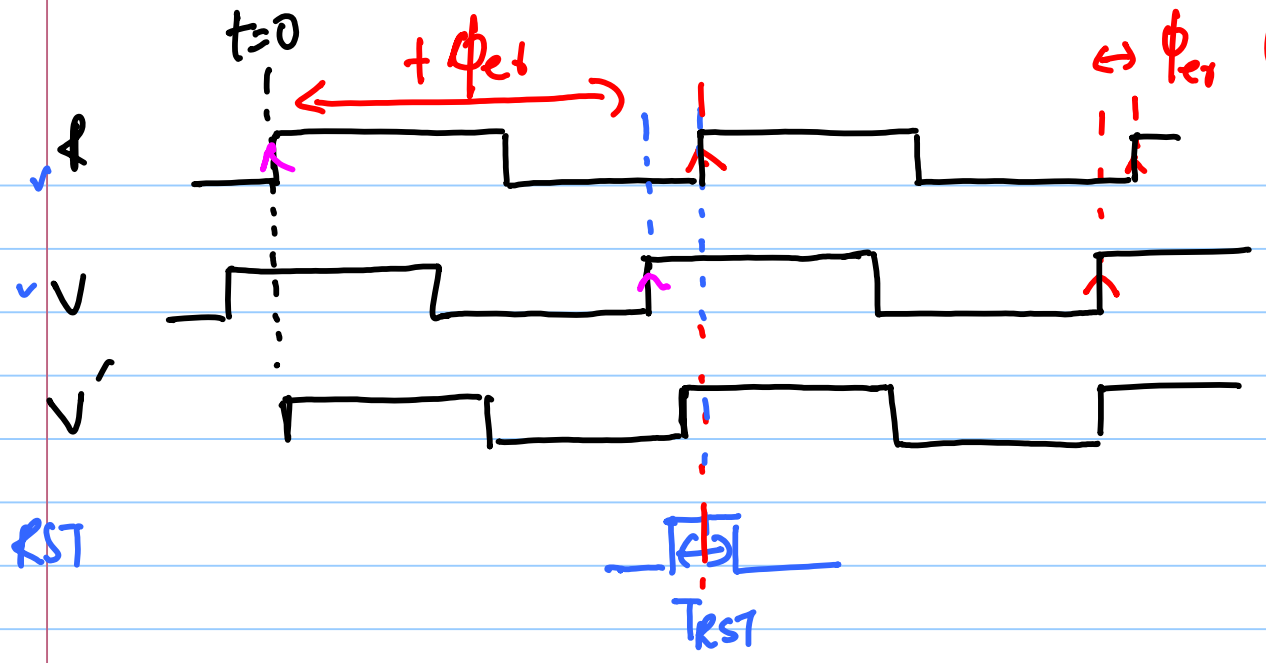


- Operating frequency.

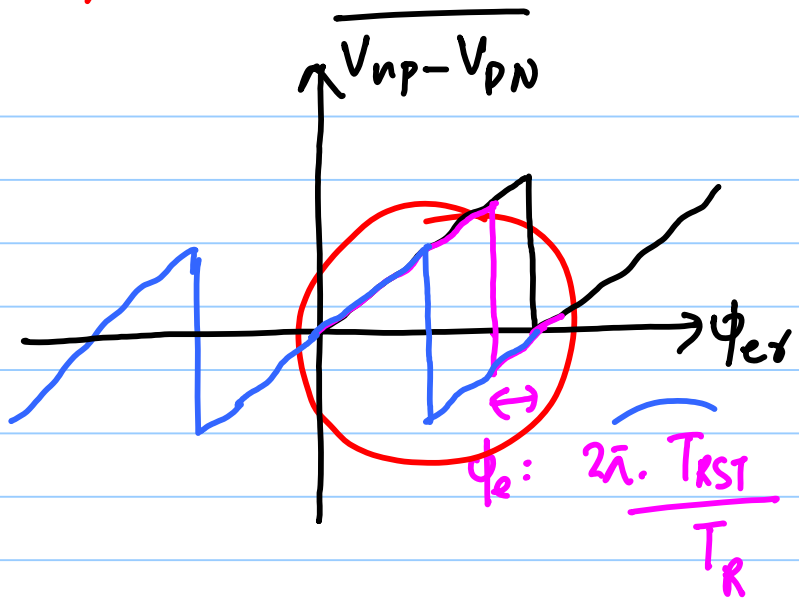


$$T_{RST} = T_{nand2} + T_{RST-Q} + T_d$$

$$T_{ov} = T_d + T_{nand2} + T_{RST-Q} \geq T_{min}$$



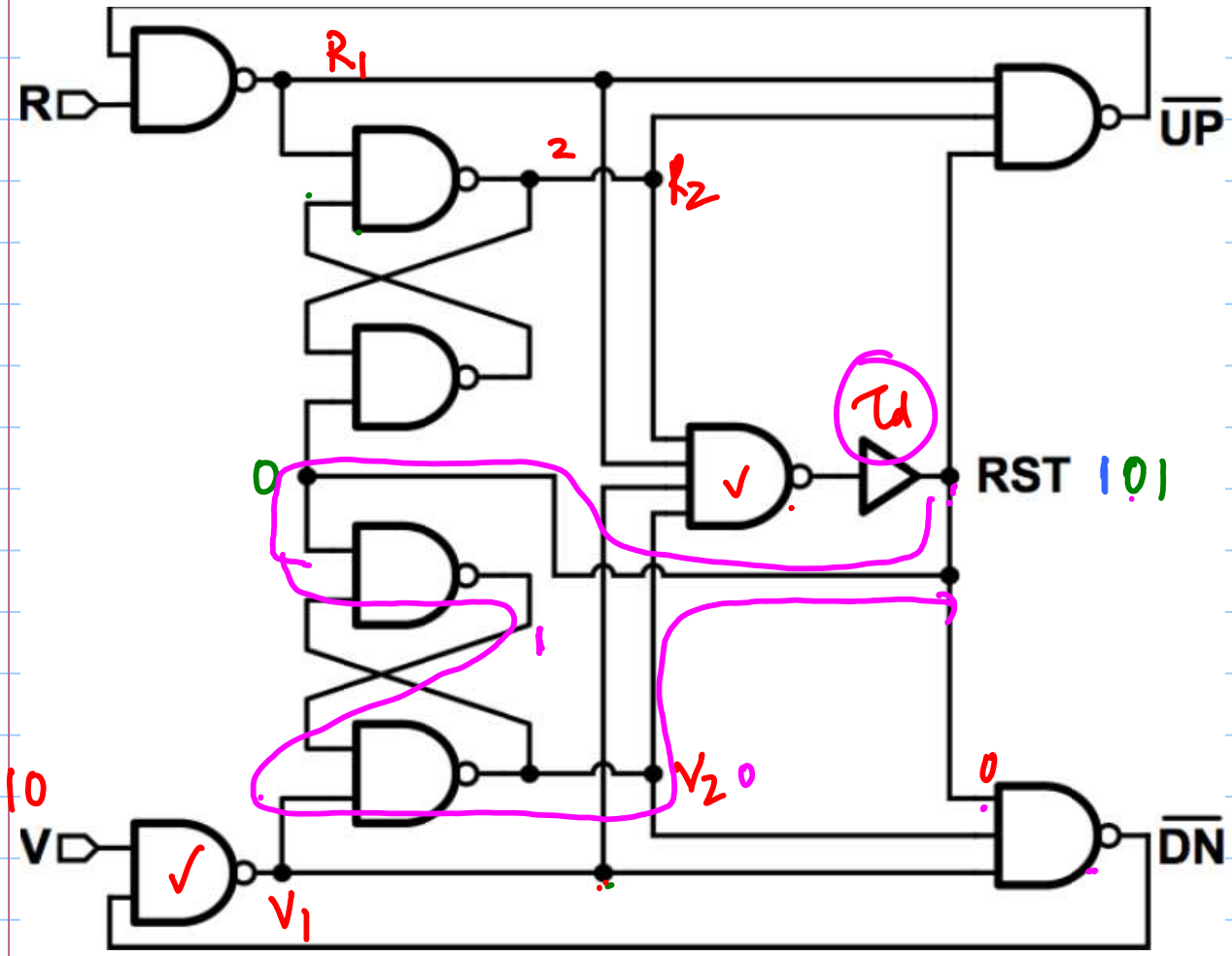
X transistion

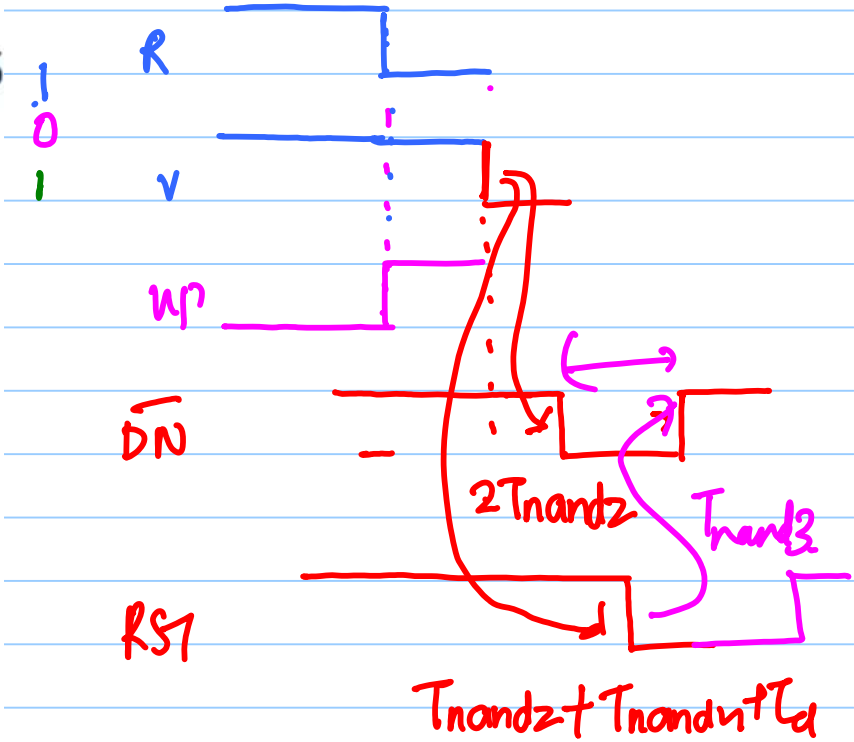


$$\varphi_e = 2\pi \cdot \frac{T_{RST}}{T_R}$$

$$T_{RST} < T_R/2$$

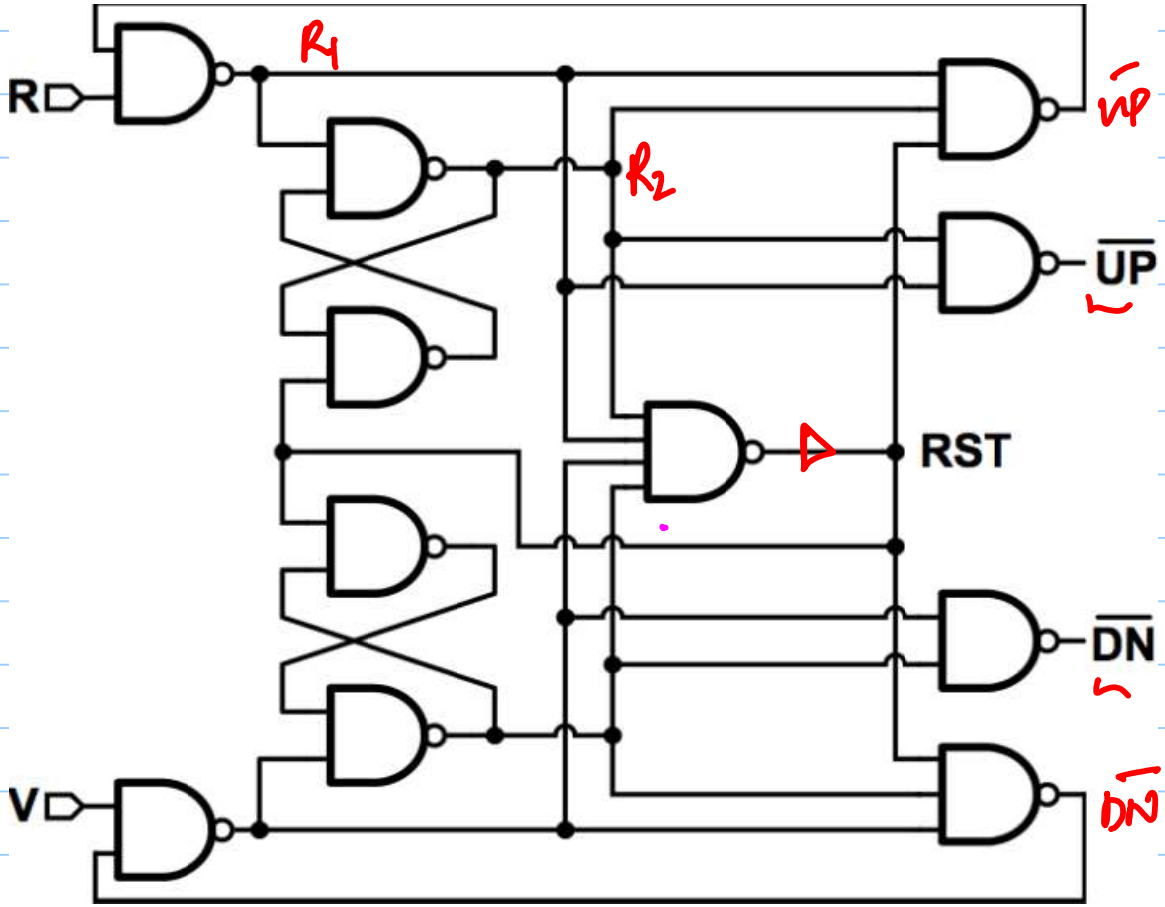
$$\Rightarrow f_R < \frac{1}{2T_{RST}}$$





T_{ov} = $T_{nand1} + T_d$

$T_{RST} = 2T_{nand2} + T_{nand1} + T_d$



$T_{OV} = 2T_{nand2} + T_{nand4}$

$T_{RST} = 2T_{nand2} + T_{nand4}$