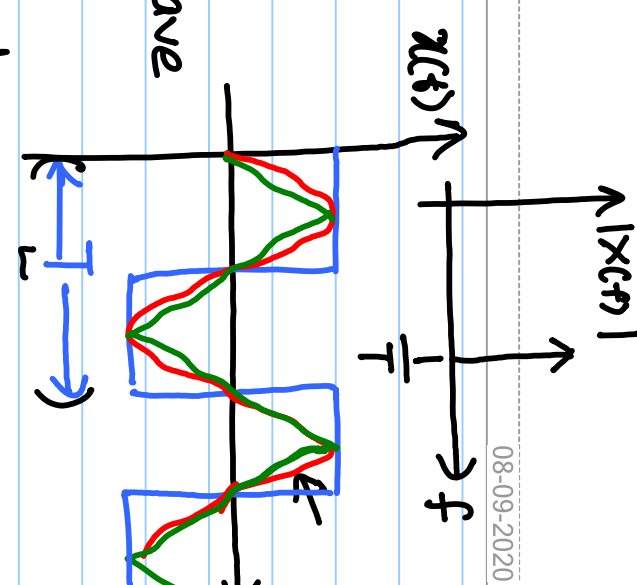
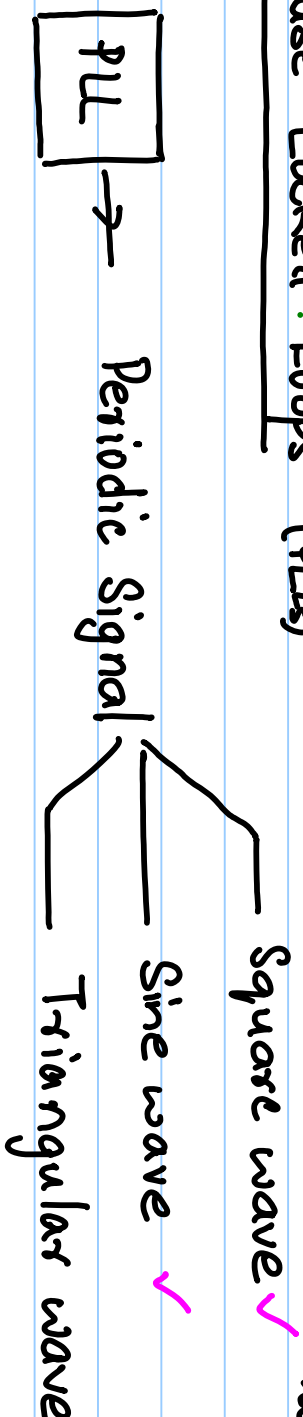


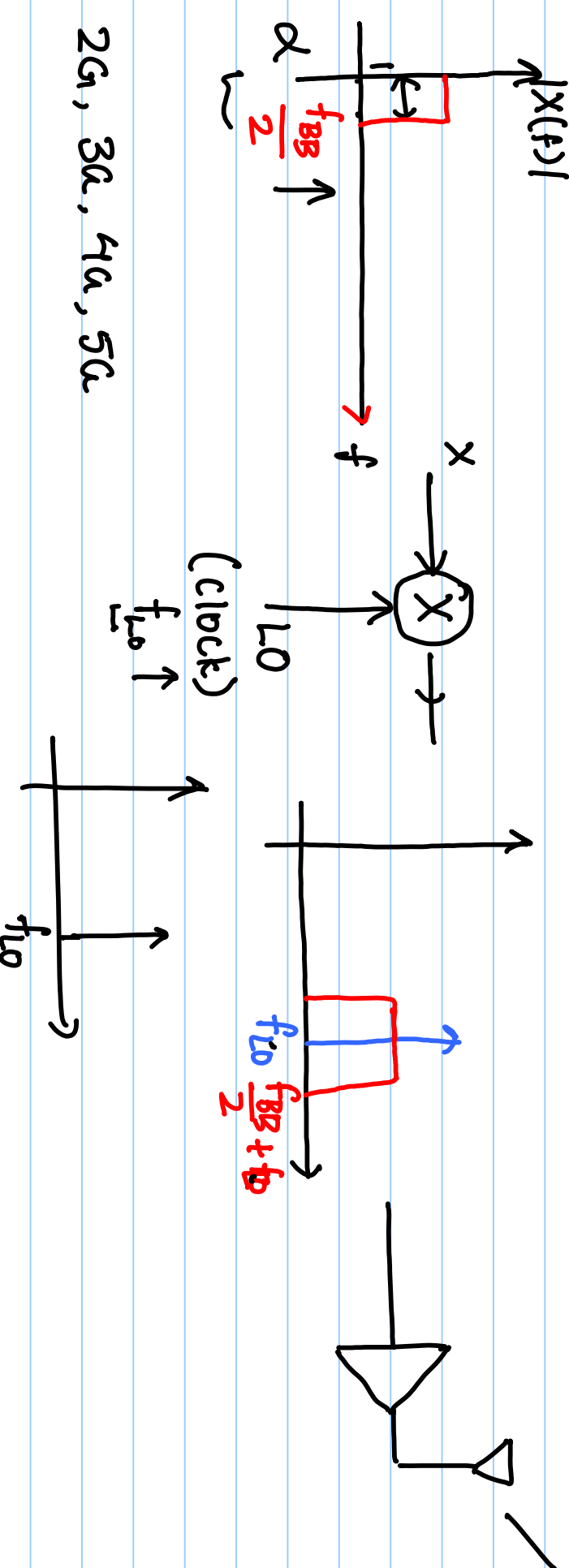
Lecture # 1

Phase-Locked Loops (PLL)

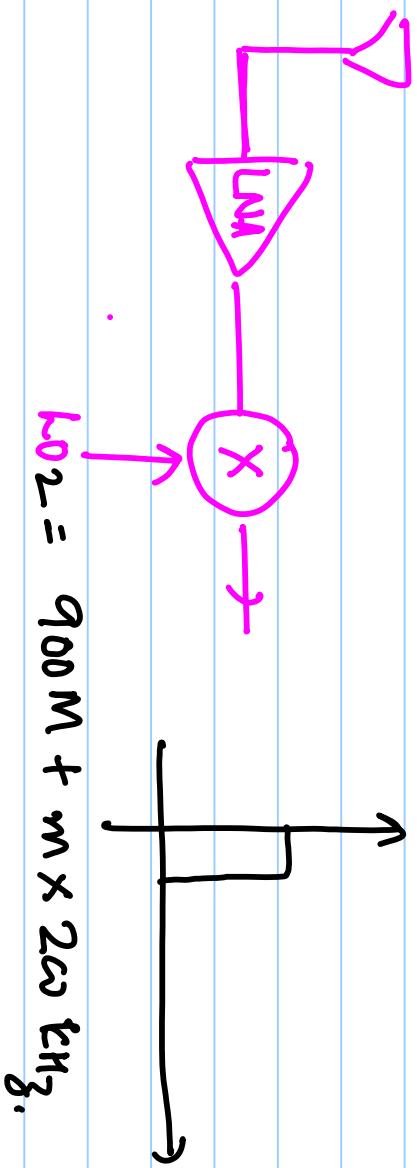
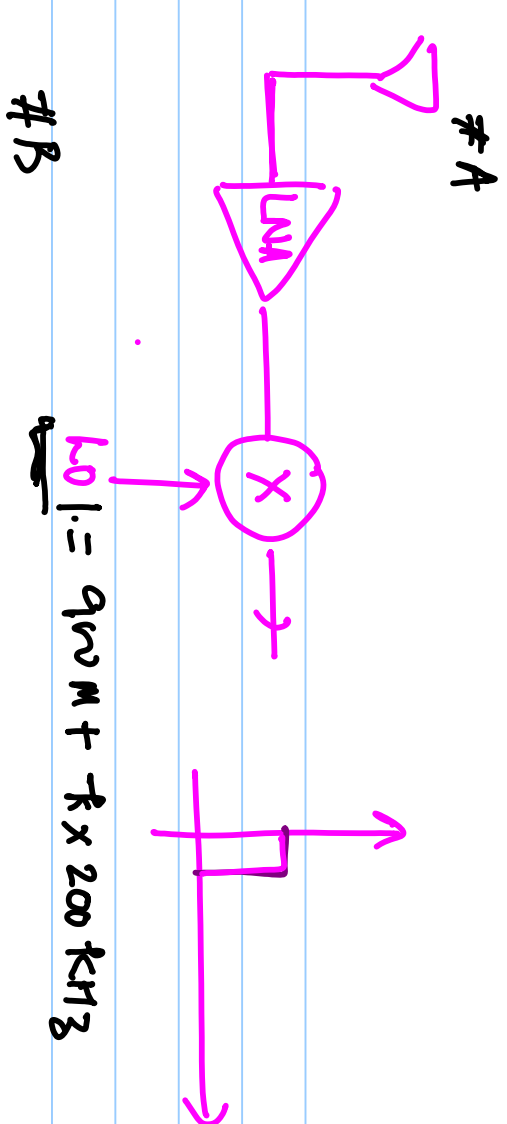
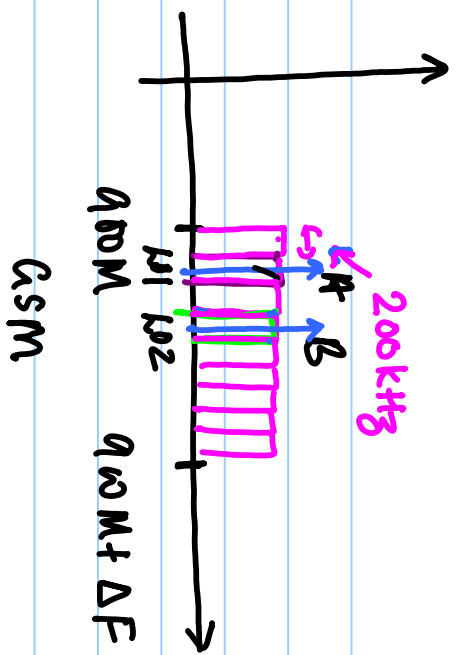


T: time period

Wireless Application



2G, 3G, 4G, 5G



$$w(t) = a_m \sin(\omega_m t)$$

$$x_{L0}(t) = 1 \cos(\omega_{L0} t)$$

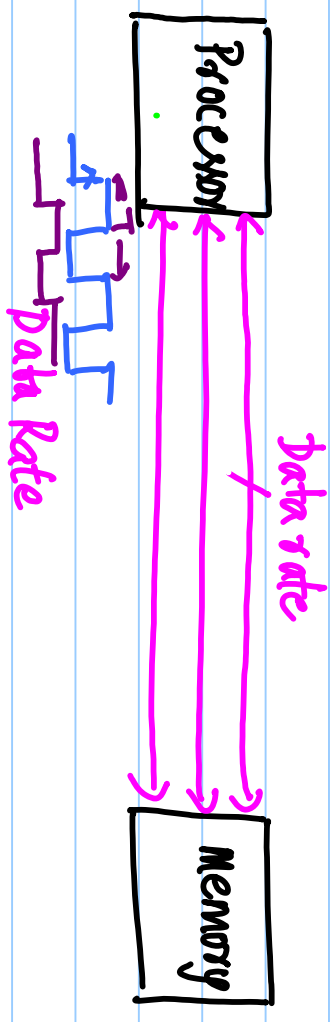
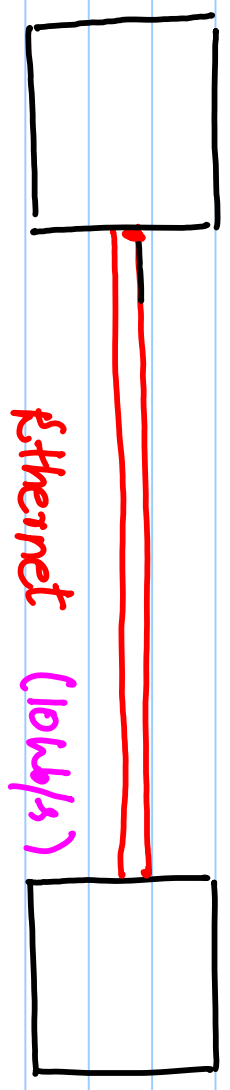
$$w(t) \times x_{L0}(t) = a_m \sin(\omega_m t) \cos(\omega_{L0} t)$$

$$= \frac{a_m}{2} \left[\sin(\overline{\omega_{L0} + \omega_m} t) + \sin(\overline{\omega_{L0} - \omega_m} t) \right]$$

Wireline Communication

Location #1

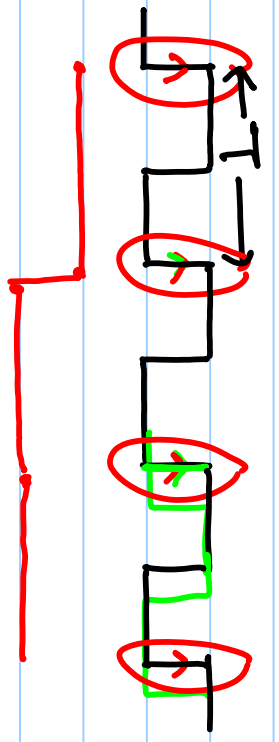
Location #2



Mbps - Gbps

Data rate := # of bits transferred.

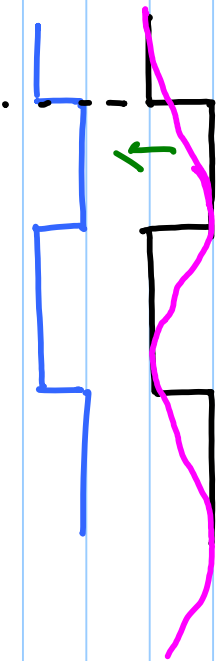
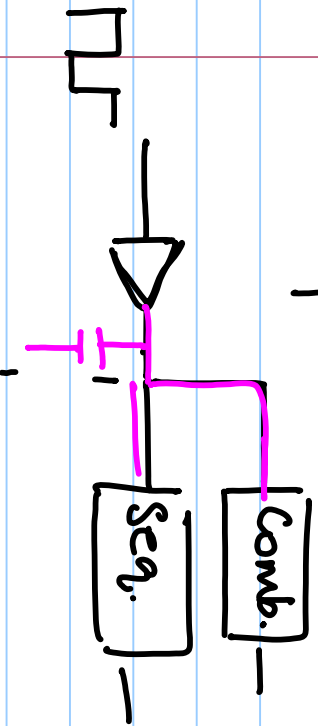
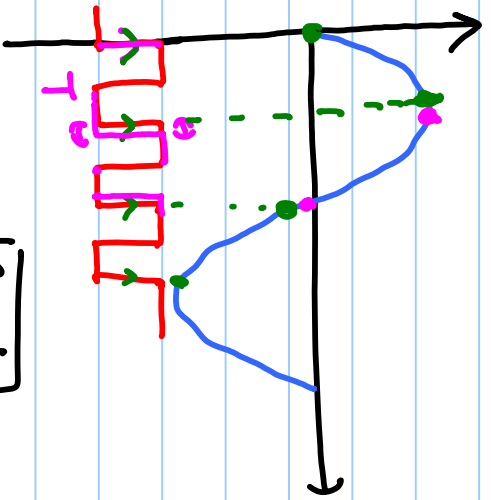
Total time taken.



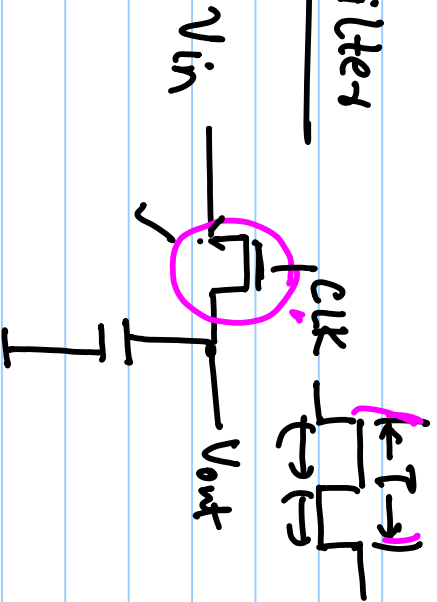
$$\text{@ } 10 \text{ Gbps} \Rightarrow T = \frac{1}{10 \times 10^9} = (100 \text{ ps})$$

Bit error rate (BER) < 10^{-12}

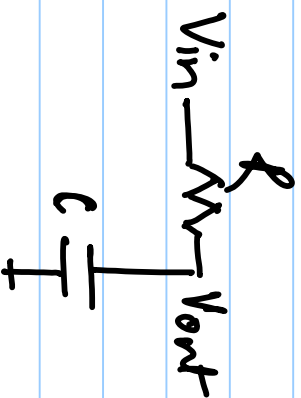
Analog to Digital Converter (ADC)



Tunable filters

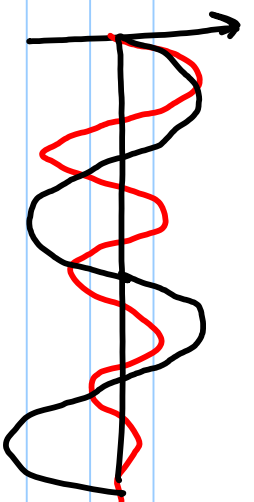


$$\frac{V_{out}}{V_{in}} = \frac{1}{(1 + s/kp)}$$



Quartz - crystal :

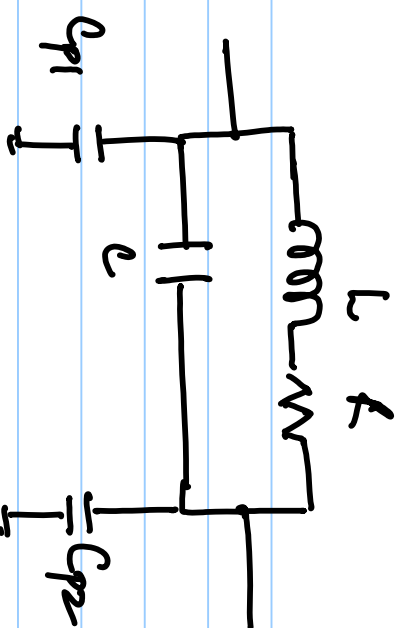
Piezo-electric



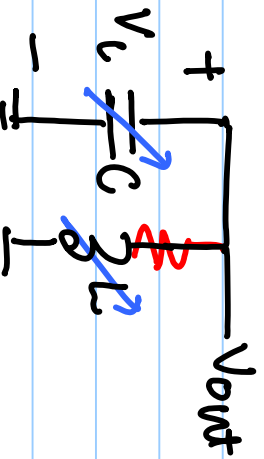
- Frequency is low X

- Not tunable X

- Variation in clock period is least ✓



$$\omega_{osc} \propto \frac{1}{\sqrt{LC}}$$



$$V_{out} = \sin(\omega_0 t)$$

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

at $t=0$, $V_c(0) = V_0$