ECE 518 - Lecture 8

HW is posted

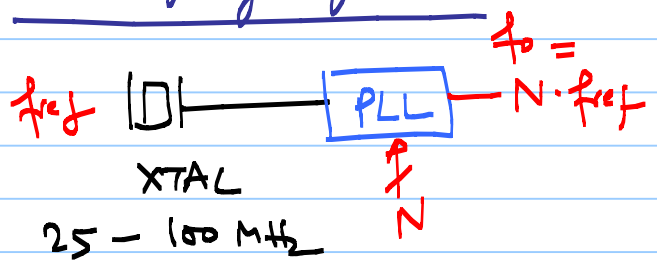
Note Title 2/14/2013

Phase Locked Loops (PLLs)

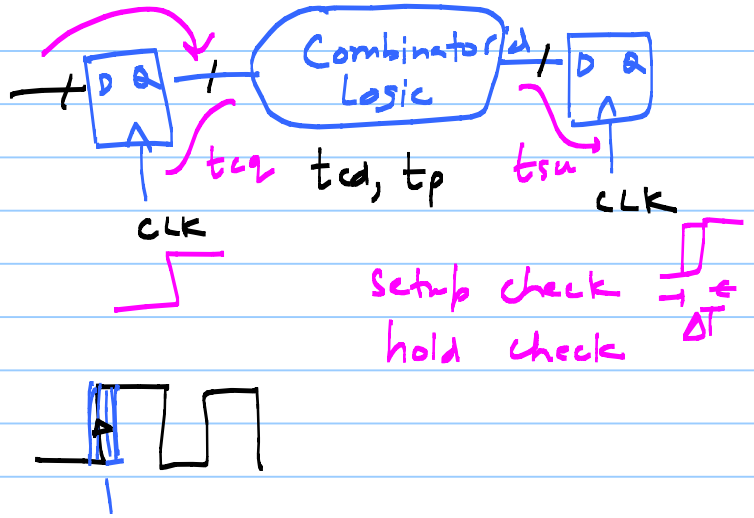
→ memories, µPs, FPGAs, HDDs, RF, wireline & fiber optic TRx, Cell phones, XBOX, Displays.

Applications:

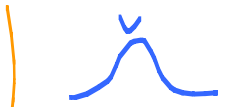
① Frequency Synthesis



N ⇒ integer

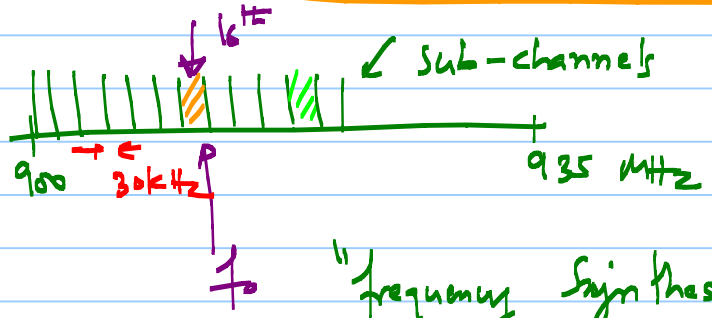


$N \rightarrow \text{fraclim} = \frac{n}{m}, \; n, m \in I$



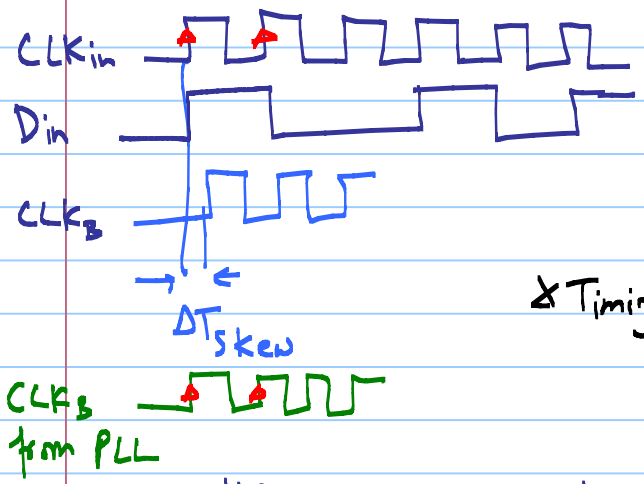
"STA"
↳ Asic Design

Cell phone → GSM



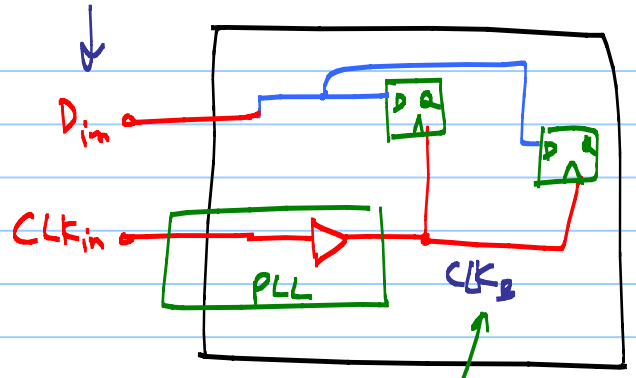
"frequency synthesizer"

② Skew Reduction



"Phase alignment"

Digital chip



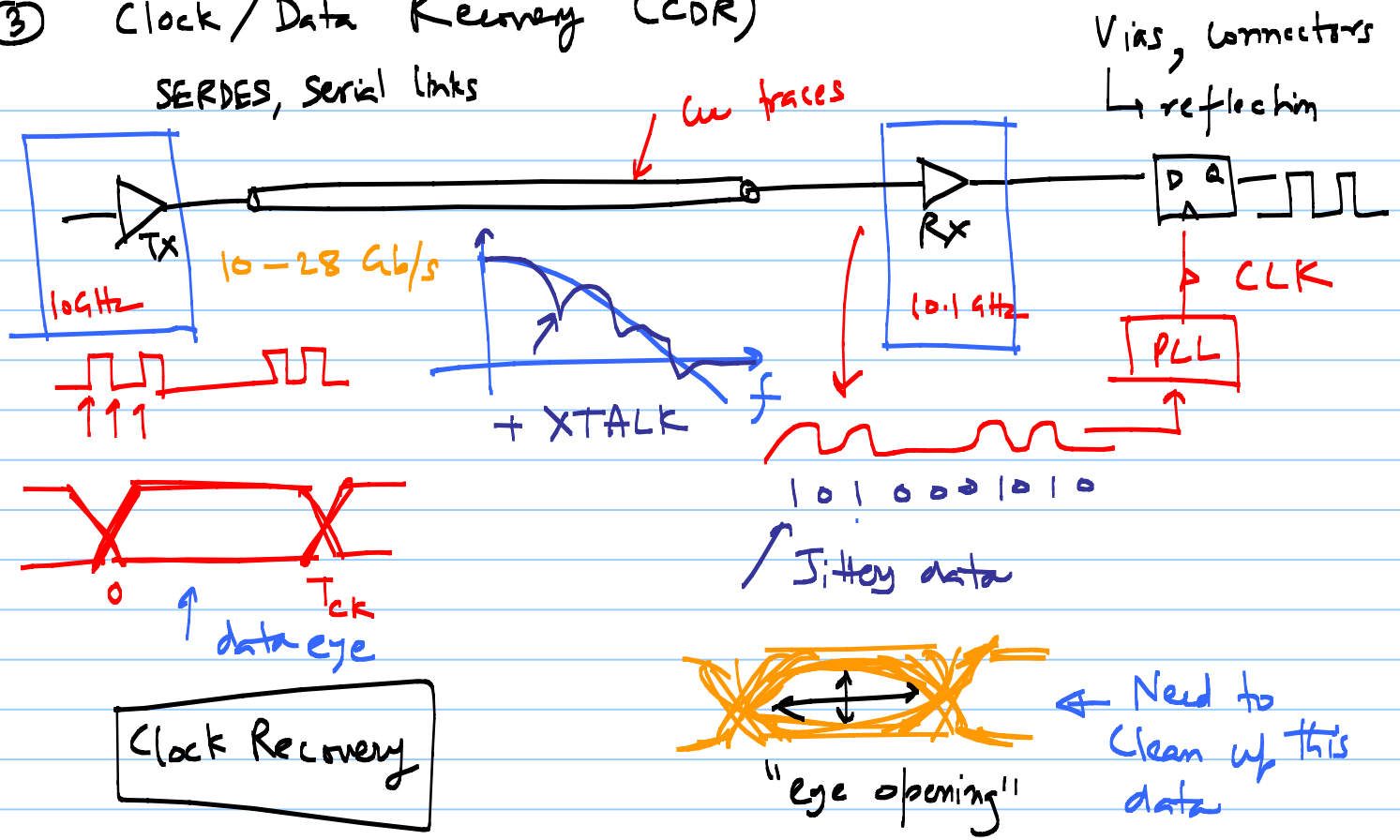
& Timing errors

is aligned to CLKin

Clock Tree to route the clocks

③ Clock / Data Recovery (CDR)

SERDES, Serial links

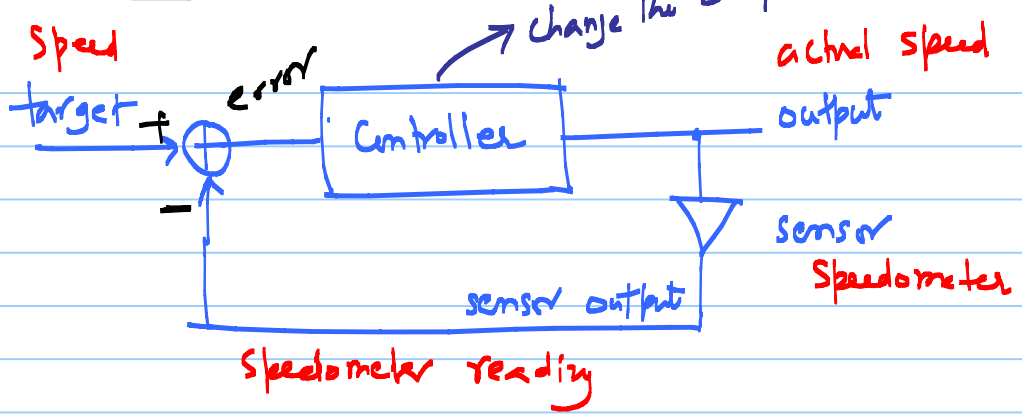


jittery clock N=1 jitter is attenuated

④ Modulation & Demodulation
↳ FM radio reciever

"DLL" → skew reduction → adjust delays
↳ simpler → application is limited
no freq multiplication

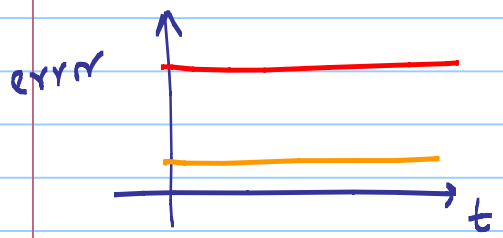
Negative feedback Systems

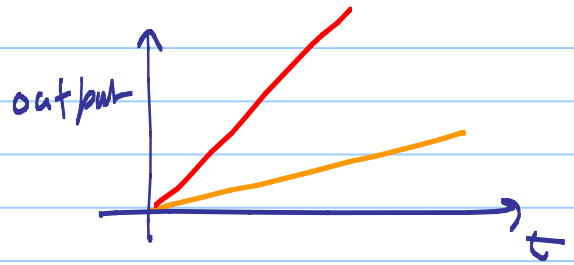


* Continuously adjusting the o/p until the desired output is achieved.

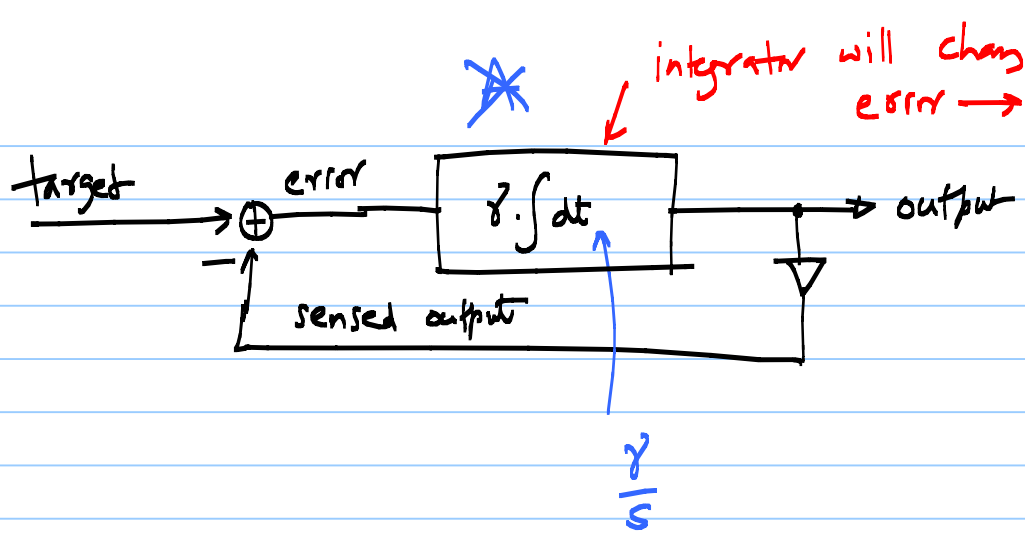
* Can't set the o/p to the correct value instantaneously.

* What is the nature of the controller?

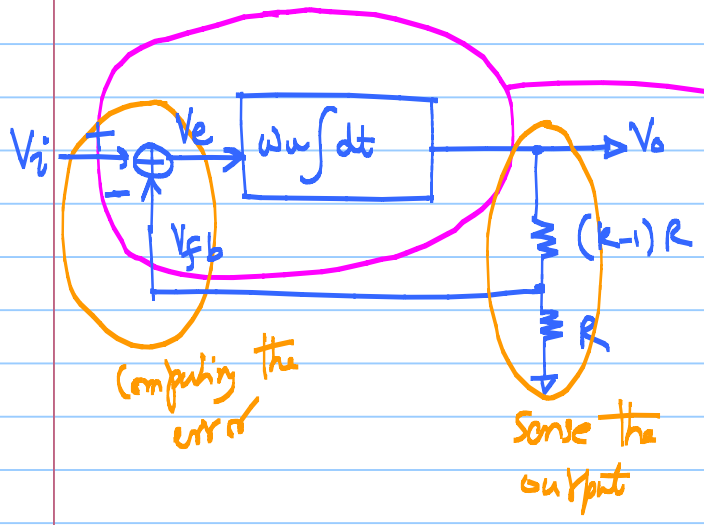




* an integrator is used as the controller.

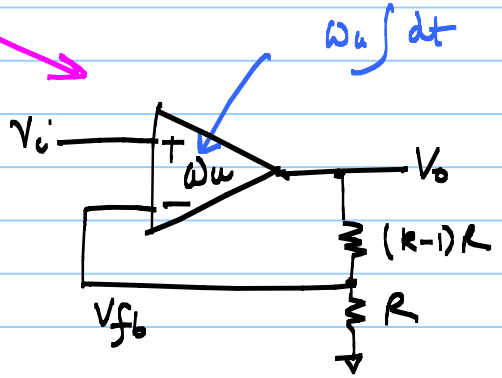

integrator will change the o/p until
error → 0
target
error
$\gamma \cdot \int dt$
output
sensed output
$\frac{\gamma}{s}$

Example: Negative feedback Amplifier



Desired output

$V_o = kV_i$



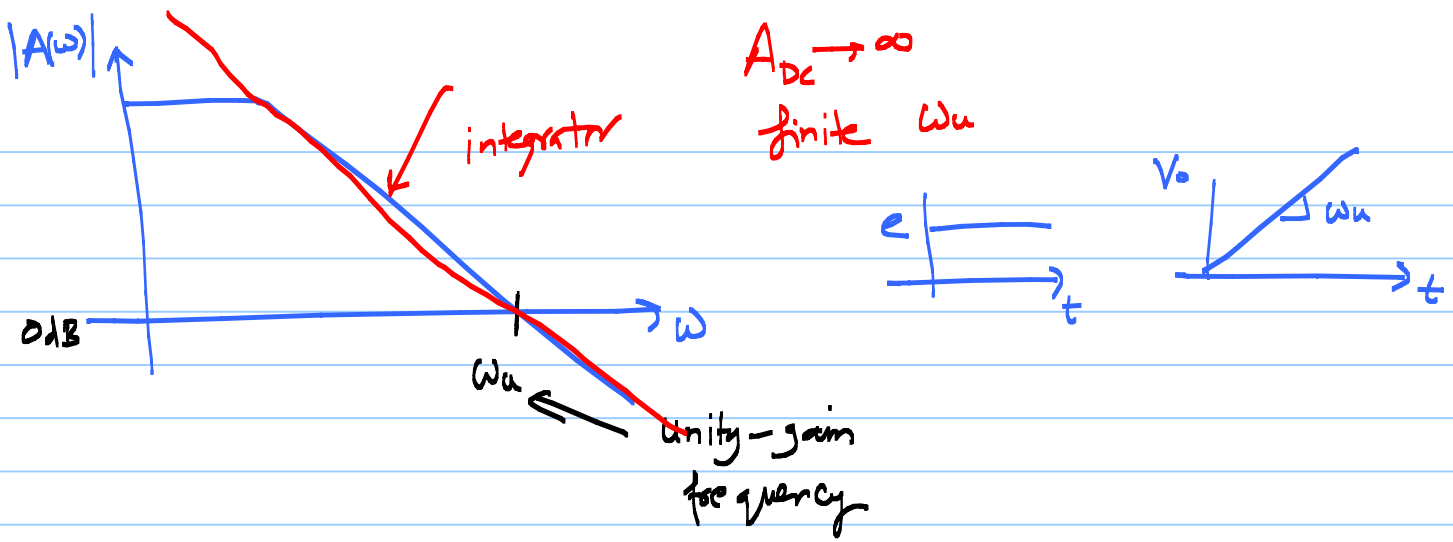
target $\rightarrow V_i$

Sensed output $= \frac{V_o}{k}$

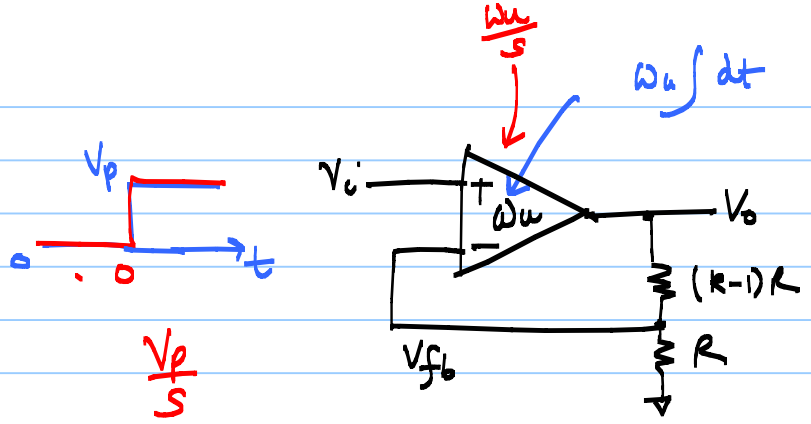
error: $V_e = V_i - \frac{V_o}{k}$

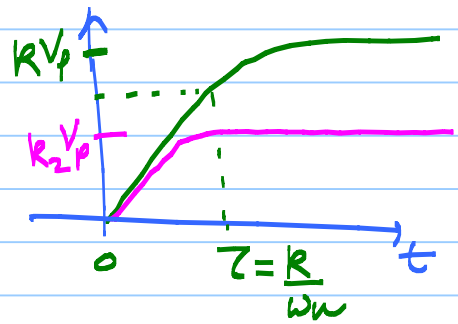
* in steady-state

$V_e \rightarrow 0 \Rightarrow V_o = k \cdot V_i$


|A(ω)|
integrator
$A_{DC} \to \infty$
finite ω_u
0dB
ω
ω_u
unity-gain
frequency
e
t
V_o
ω_u
t

$\frac{k}{1+s\tau}$





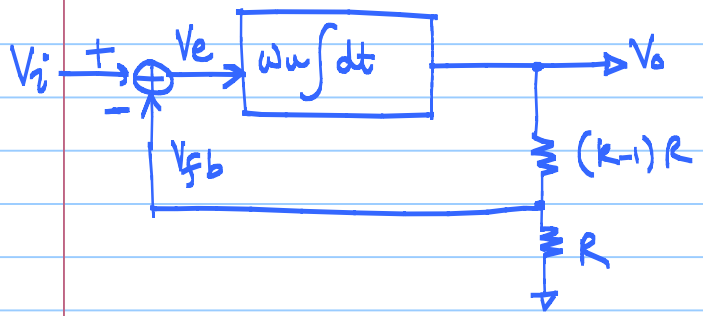
$$\frac{V_o}{V_i}(s) = \frac{k}{1 + \frac{s}{(\omega_u/k)}}$$

time constant $\tau = \frac{k}{\omega_u}$

for large 'k' $\Rightarrow$ τ is larger

$$V_{out}(s) = \frac{V_p}{s} \cdot \frac{k}{1 + \frac{s}{\omega_u/k}} \xrightarrow{\mathcal{L}^{-1}} kV_p\left[1 - e^{-t\omega_u/k}\right] u(t)$$

f_{in} ← input generate $f_o = N \cdot f_i$ "k=N"



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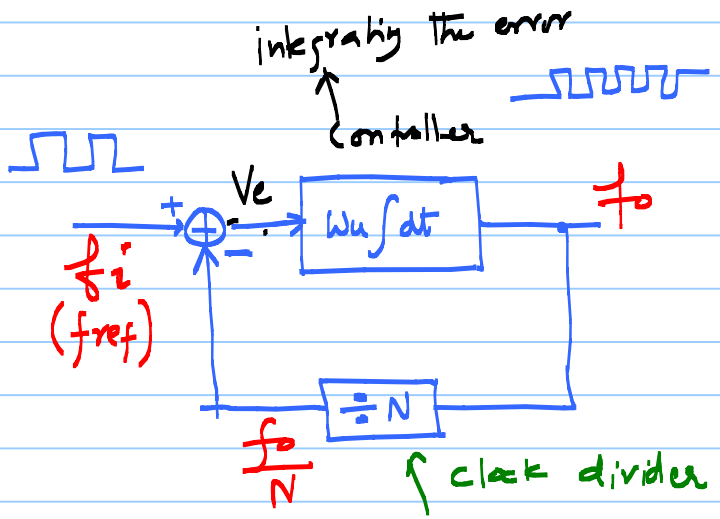

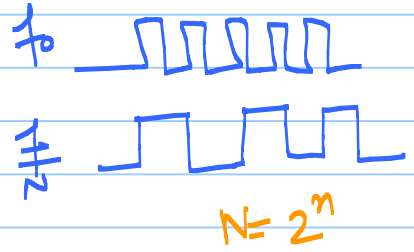

in steady-state ⇒ $f_o = N f_{ref}$

- we need a controlled frequency source
  - Vary the frequency of oscillation using an electrical signal
    - VCO