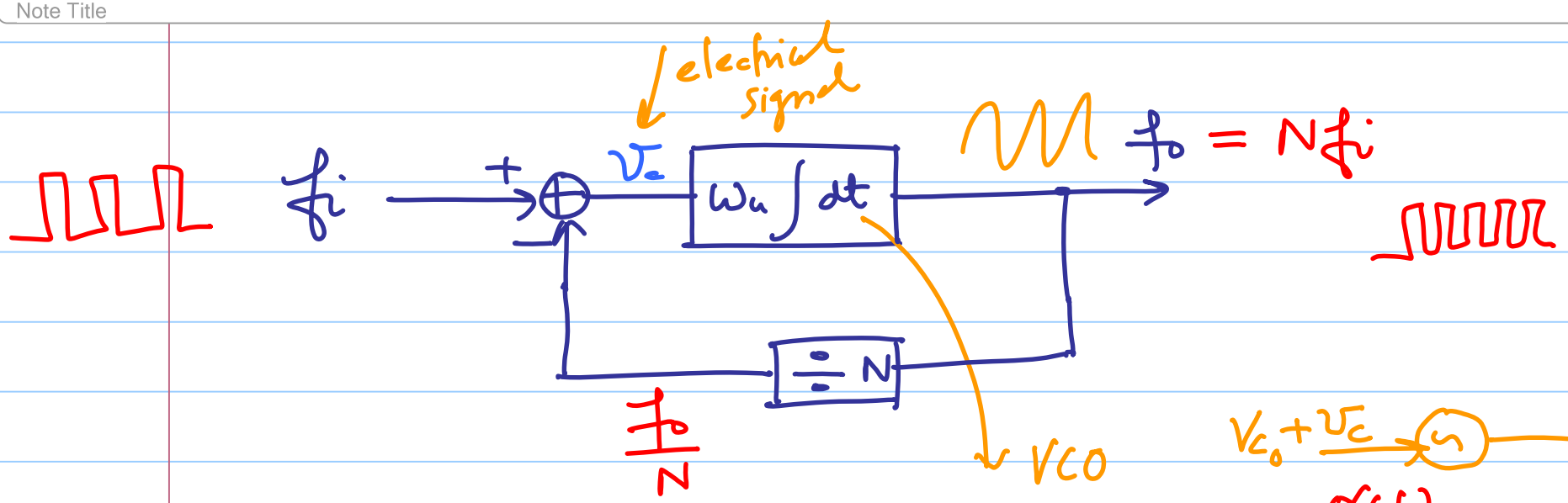
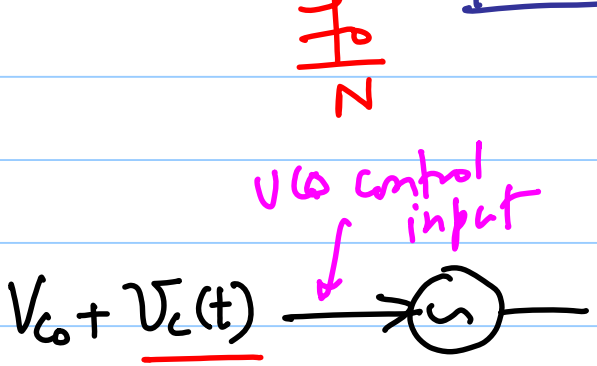
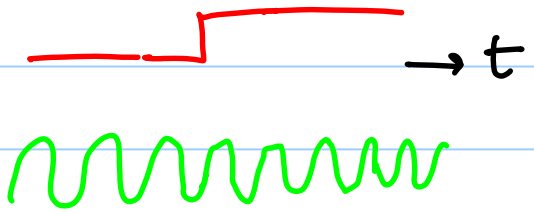
ECE 518 - Lecture 2

Note Title 1/15/2015







$$\phi(t)$$

$$A\cos\left(2\pi f_o t + 2\pi K_{VCO}\int_{-\infty}^{t} v_c(t)\,dt\right)$$

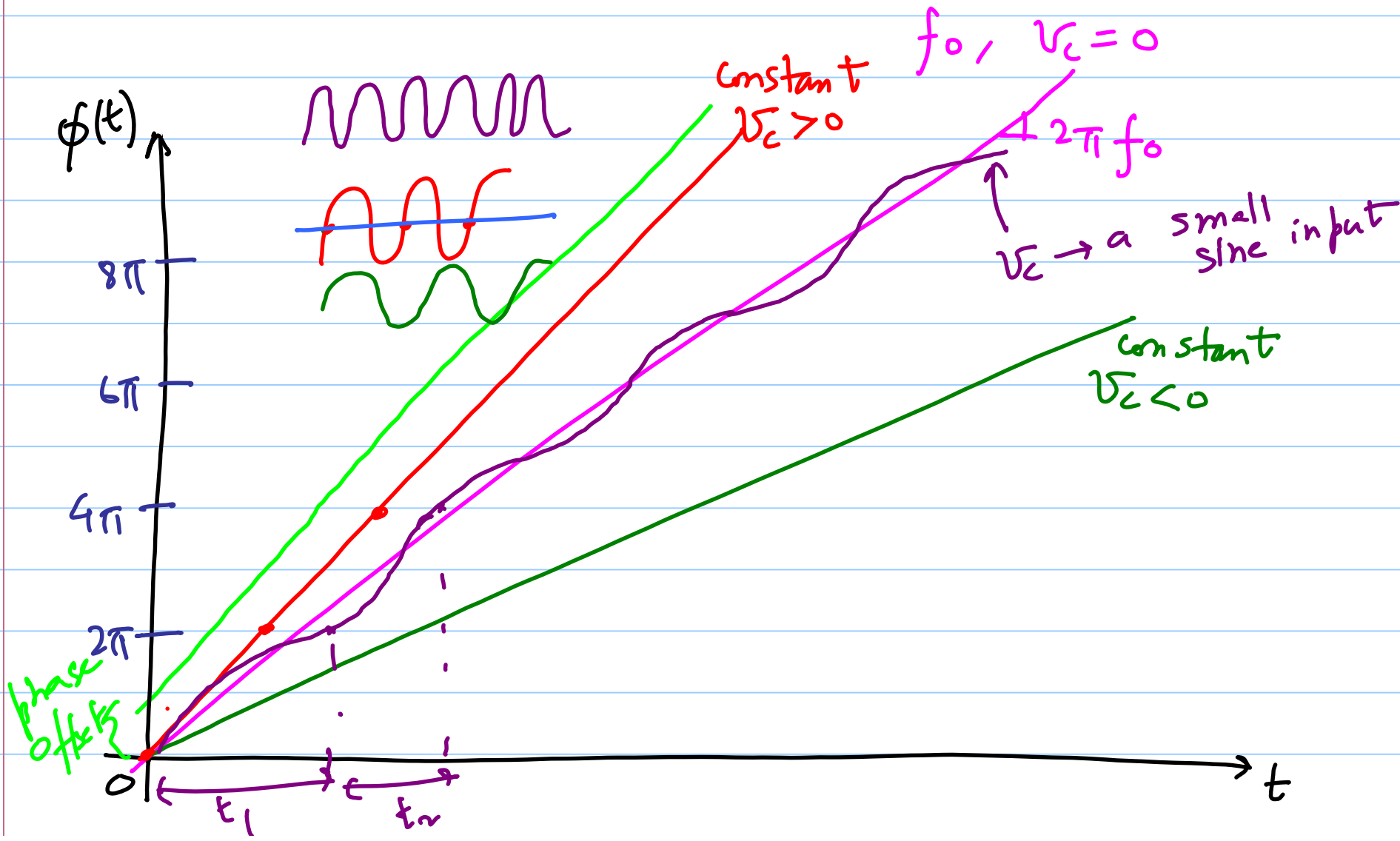
phase

free running

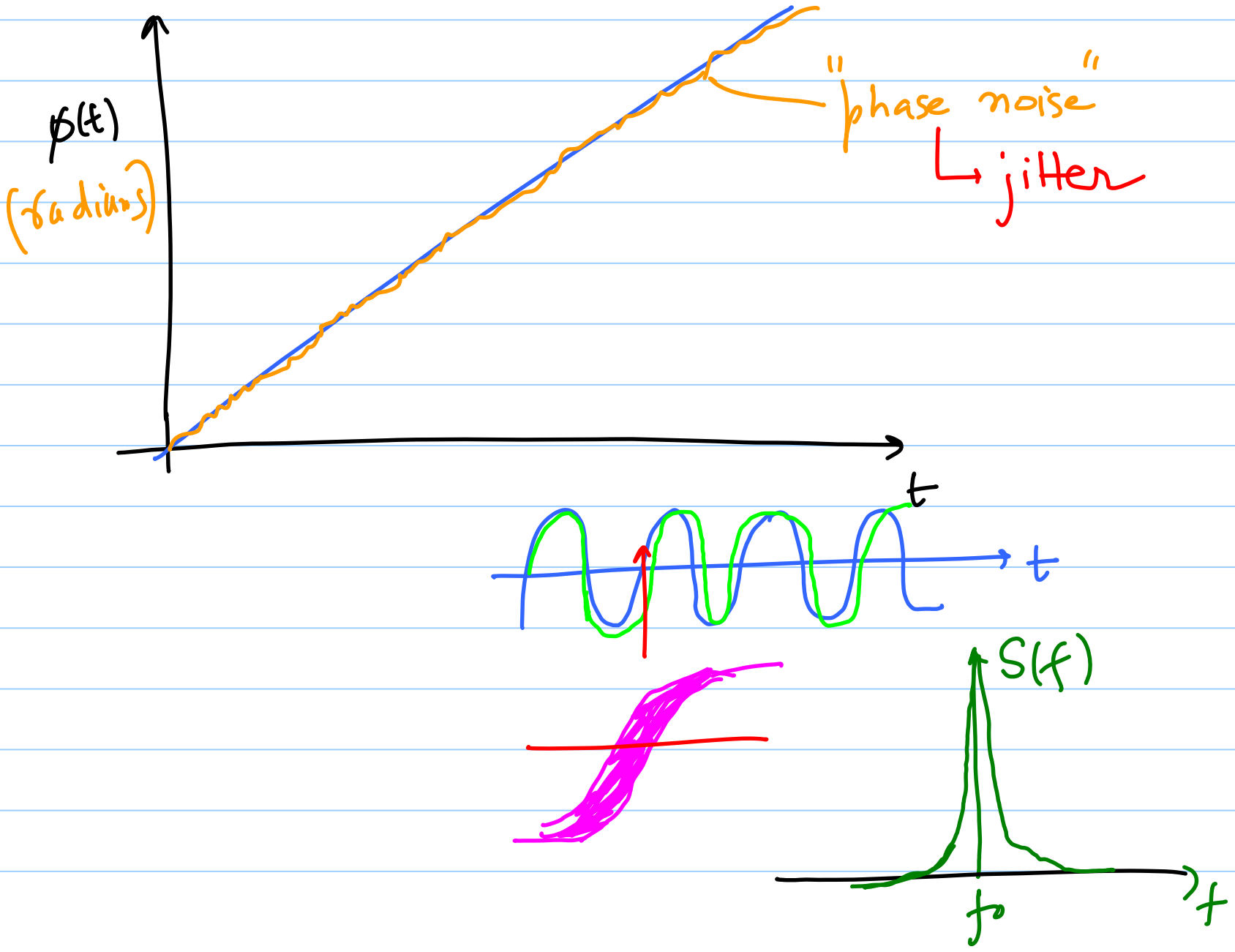
incremental part

phase of the VCO output, $\phi(t)$

↳ output is periodic with period 2π



VCO → NLTV → "phase noise"

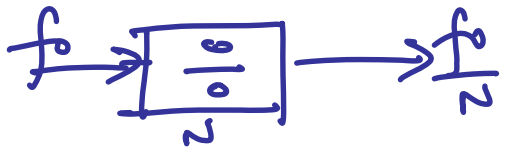


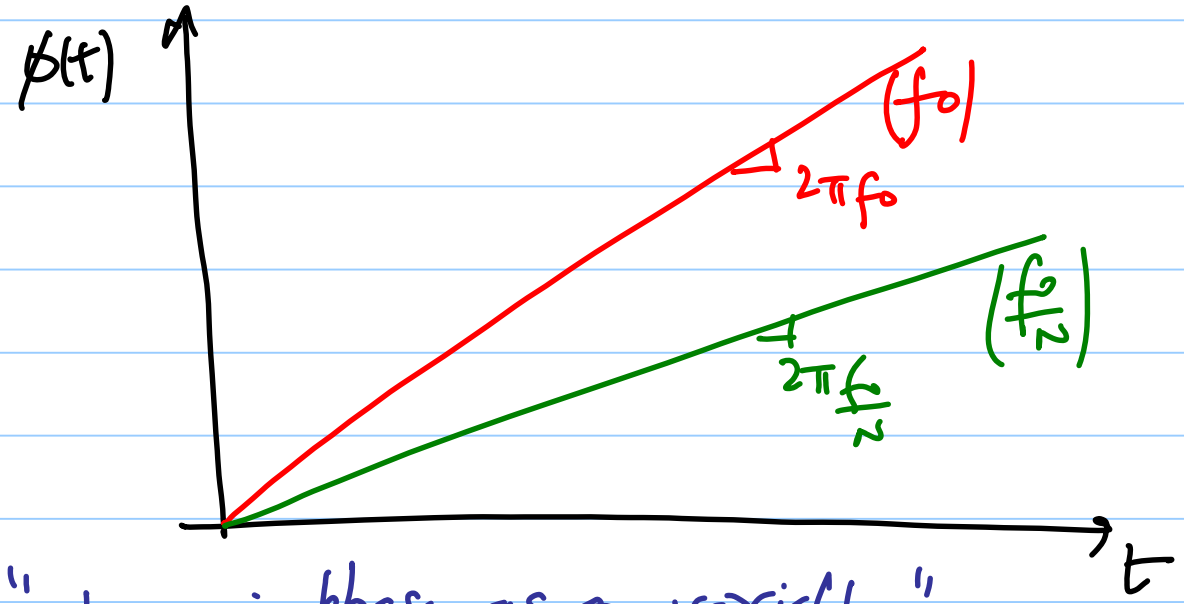
* We choose phase $\phi(t)$ as the basic variable in PLL design.

↳ instantaneous frequency

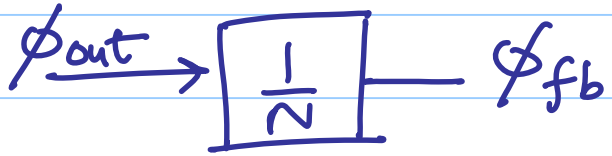
$$f_i(t) = \frac{1}{2\pi} \cdot \frac{d\phi(t)}{dt} \quad \text{Hz}$$

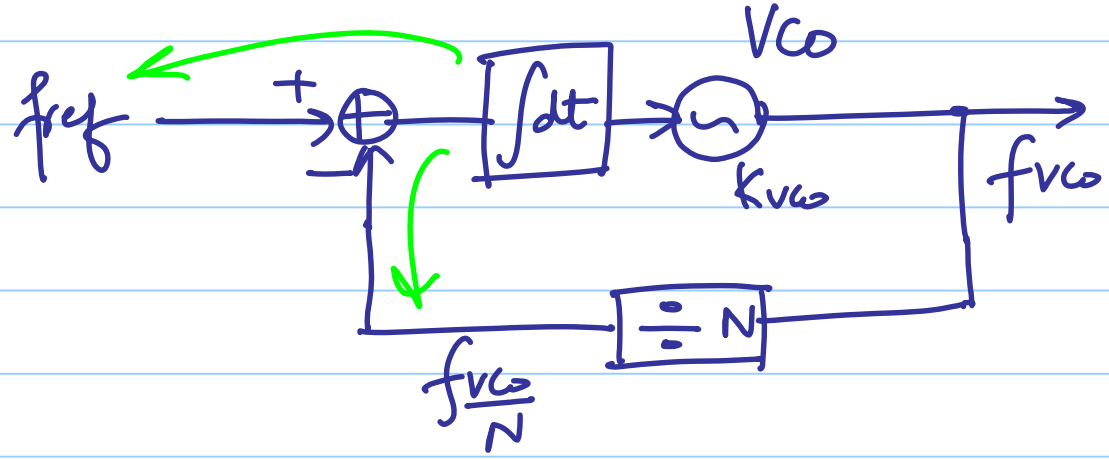
radians

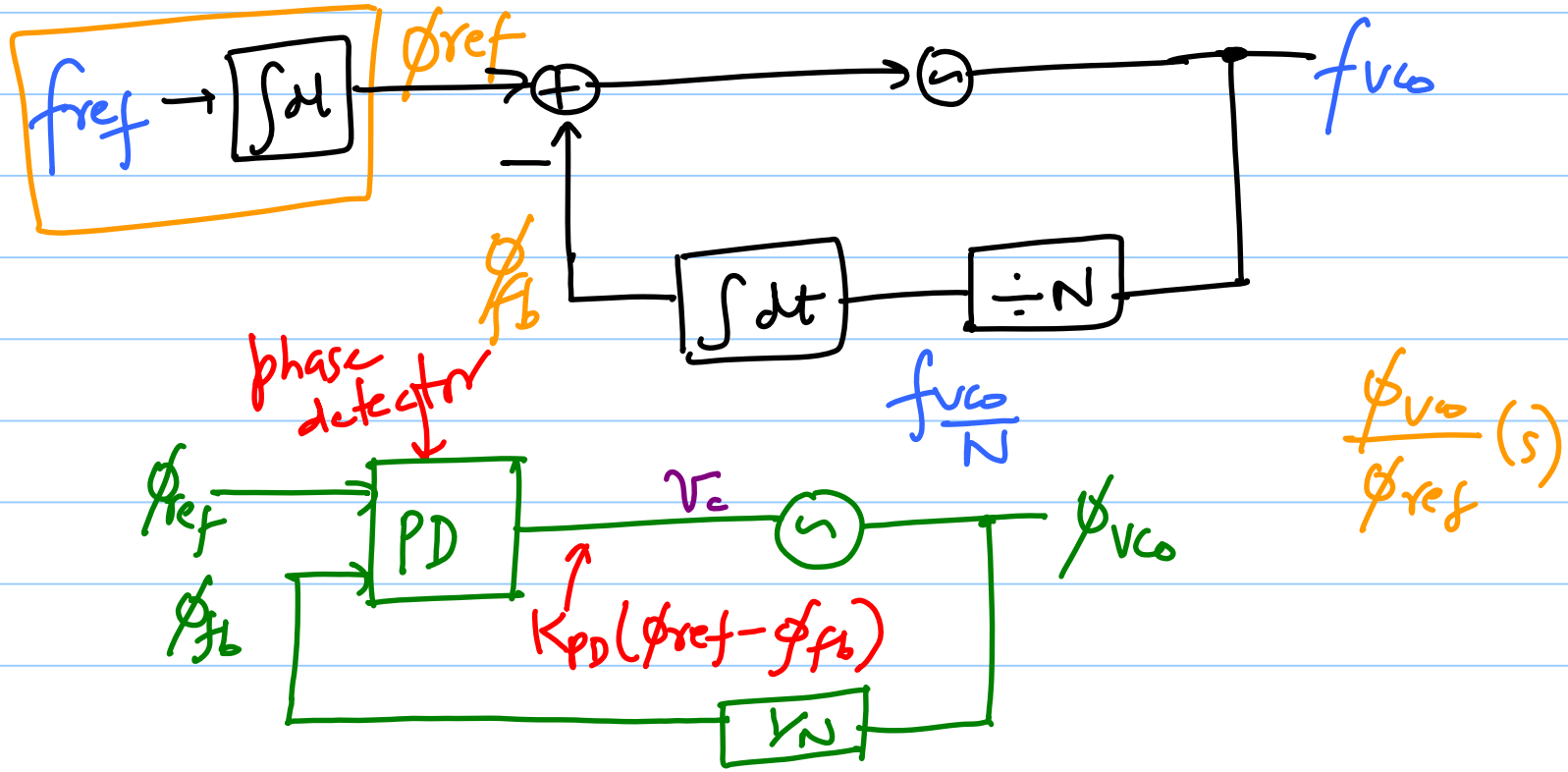




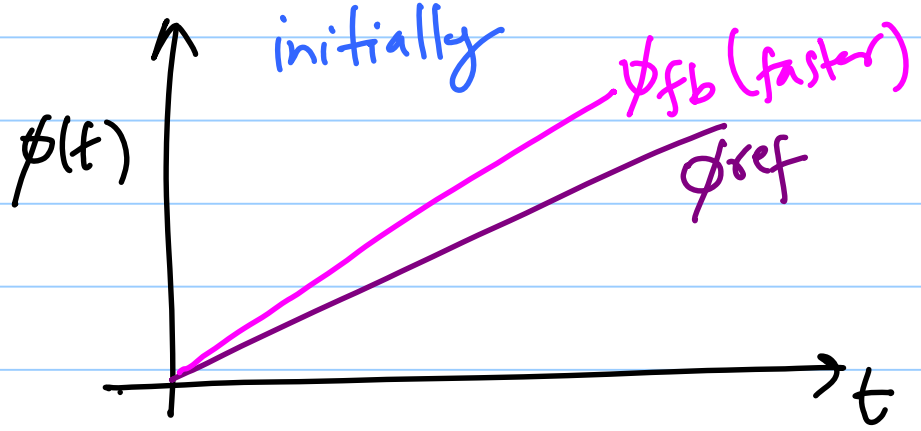
"when using phase as a variable"

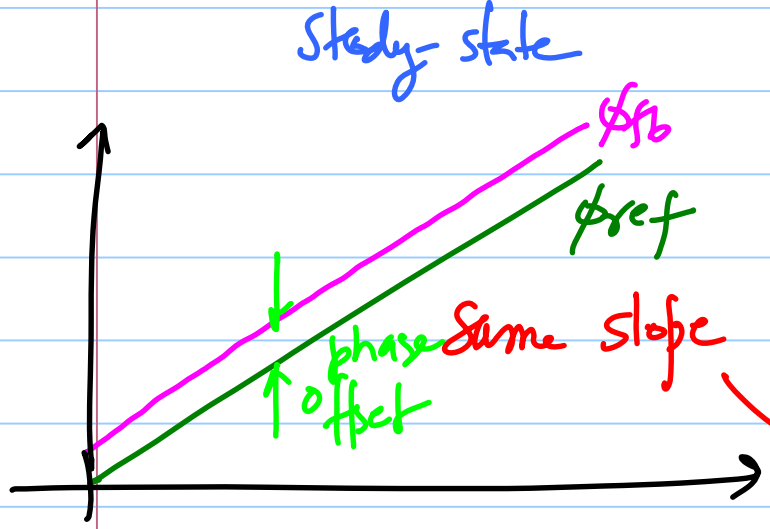


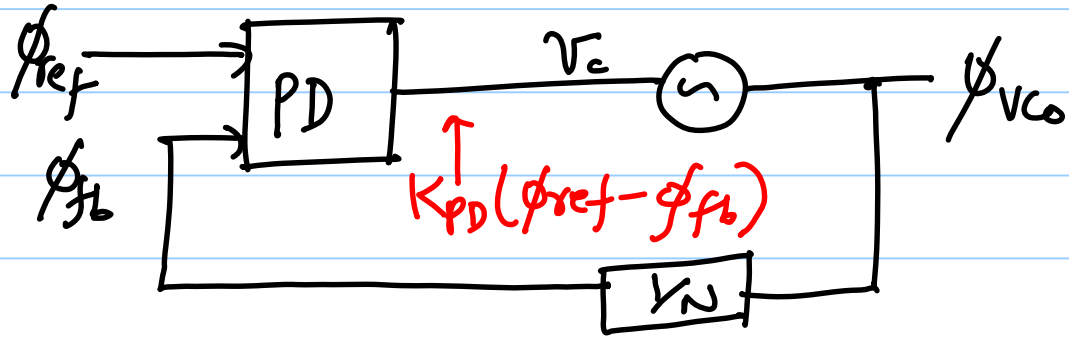

fref
+
∫dt
VCO
KVCO
fVCO
÷ N
fVCO / N


fref
∫dt
Øref
fVCO
−
∫dt
÷N
Øfb
phase detector
fVCO / N
Øref
PD
Vc
ØVCO
Øfb
KPD(Øref − Øfb)
÷N
ØVCO / Øref (s)

phase detector (PD) ⇒
detects the difference between the ref & the feedback phases.







$f_{ref} = \frac{f_{VCO}}{N}$ or $f_{VCO} = N f_{ref}$

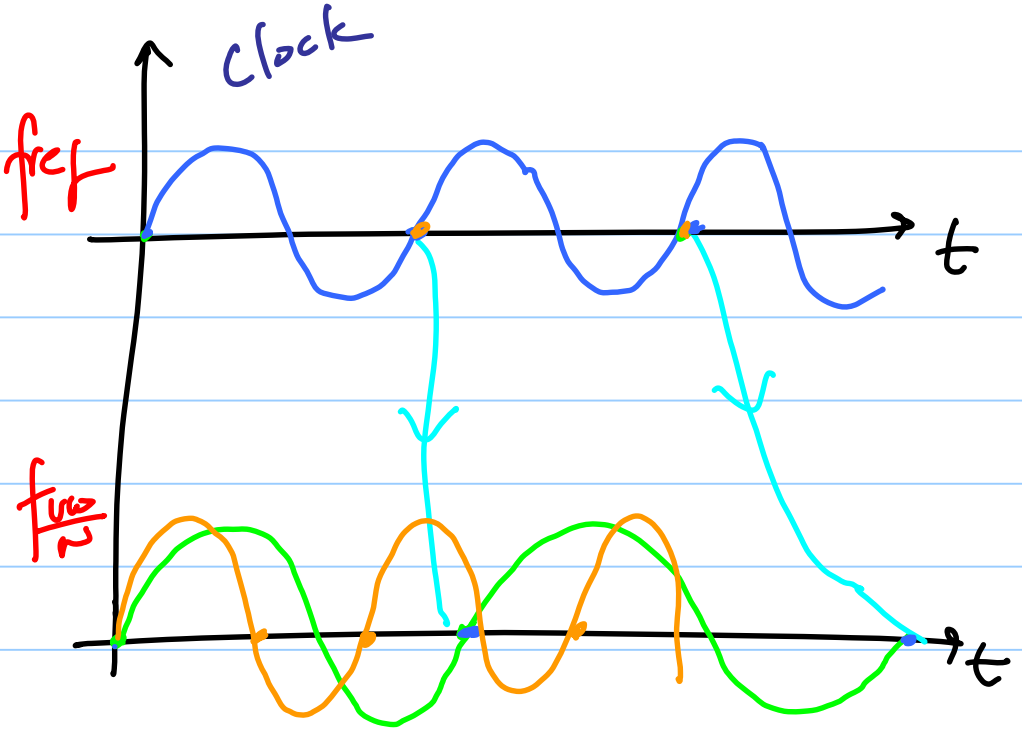
In steady-state,

V_c becomes constant

when both ϕ_{ref} & ϕ_{fb} have the same slope

↳ $f_{VCO} = N f_{ref}$

↳ can have a phase offset



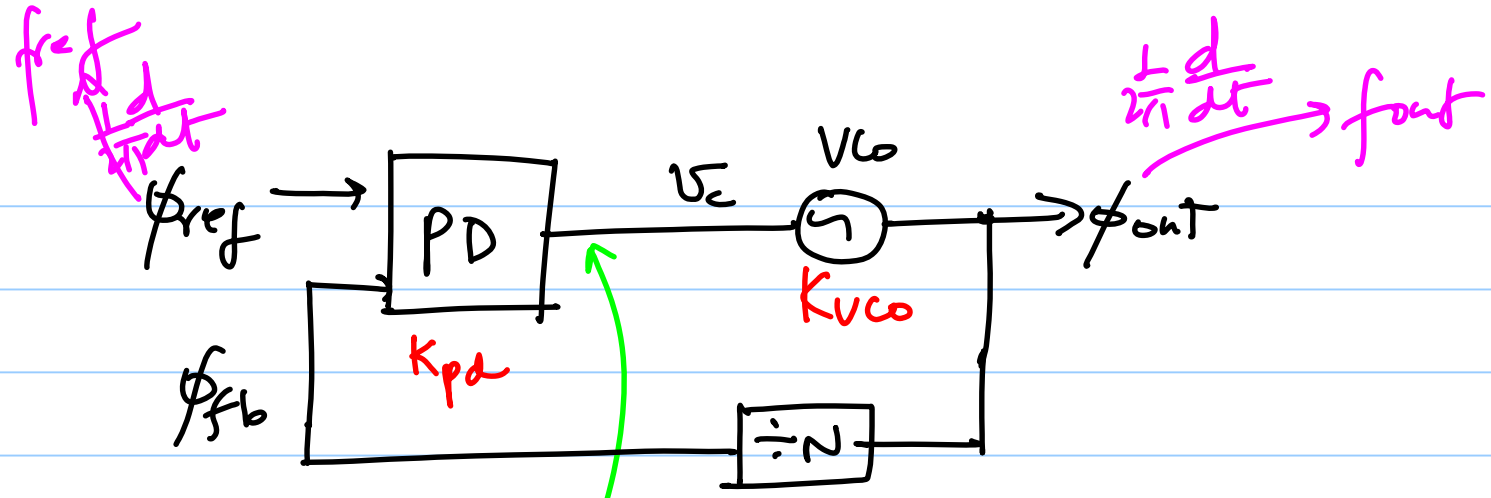
the phase difference will grow

* we are using the phase difference to control the frequency of the VCO
  ↳ phase-locked loop

↳ In steady-state $f_{out} = N f_{ref}$

and the phase difference is a constant value

↳ but not necessarily zero.



$K_{pd}(\phi_{ref} - \phi_{fb})$

$$f_{out} = f_0 + K_{VCO} \cdot v_c$$

f_0: free running frequency

in steady-state

$$v_c = \frac{N \cdot f_{ref} - f_0}{K_{VCO}} \longrightarrow (1)$$

$$\phi_{ref} - \phi_{fb} = \frac{N f_{ref} - f_0}{K_{VCO} \cdot K_{PD}} \longrightarrow (2)$$