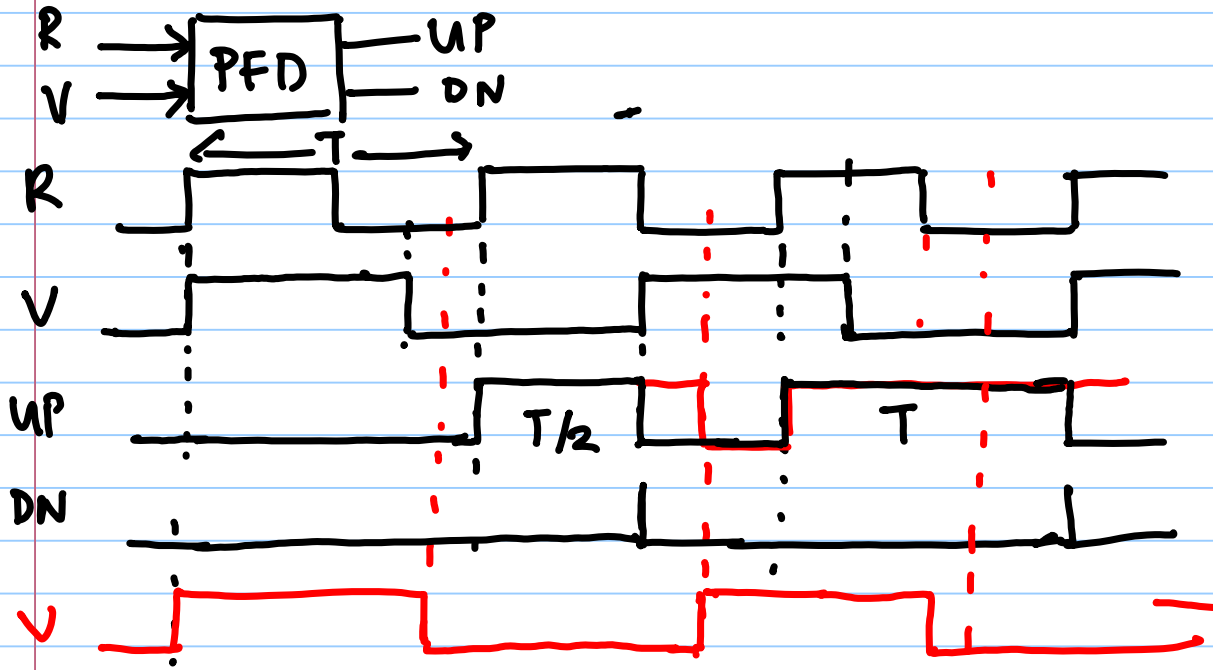
Lecture #15

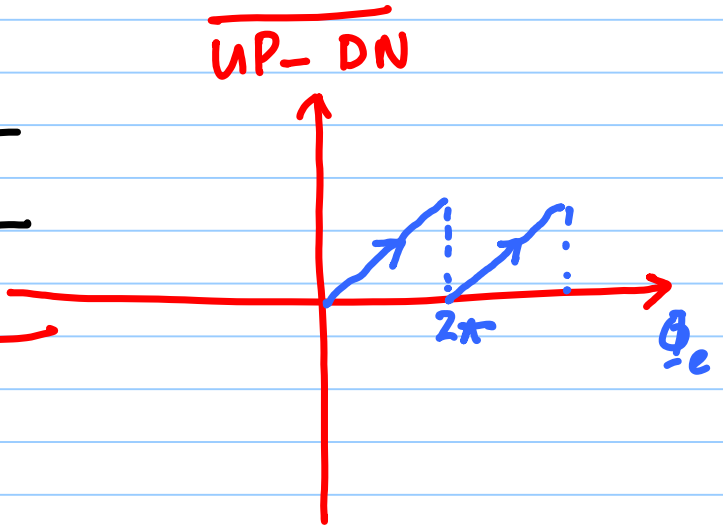
Note Title 24-08-2017

Phase Frequency Detector (PFD)



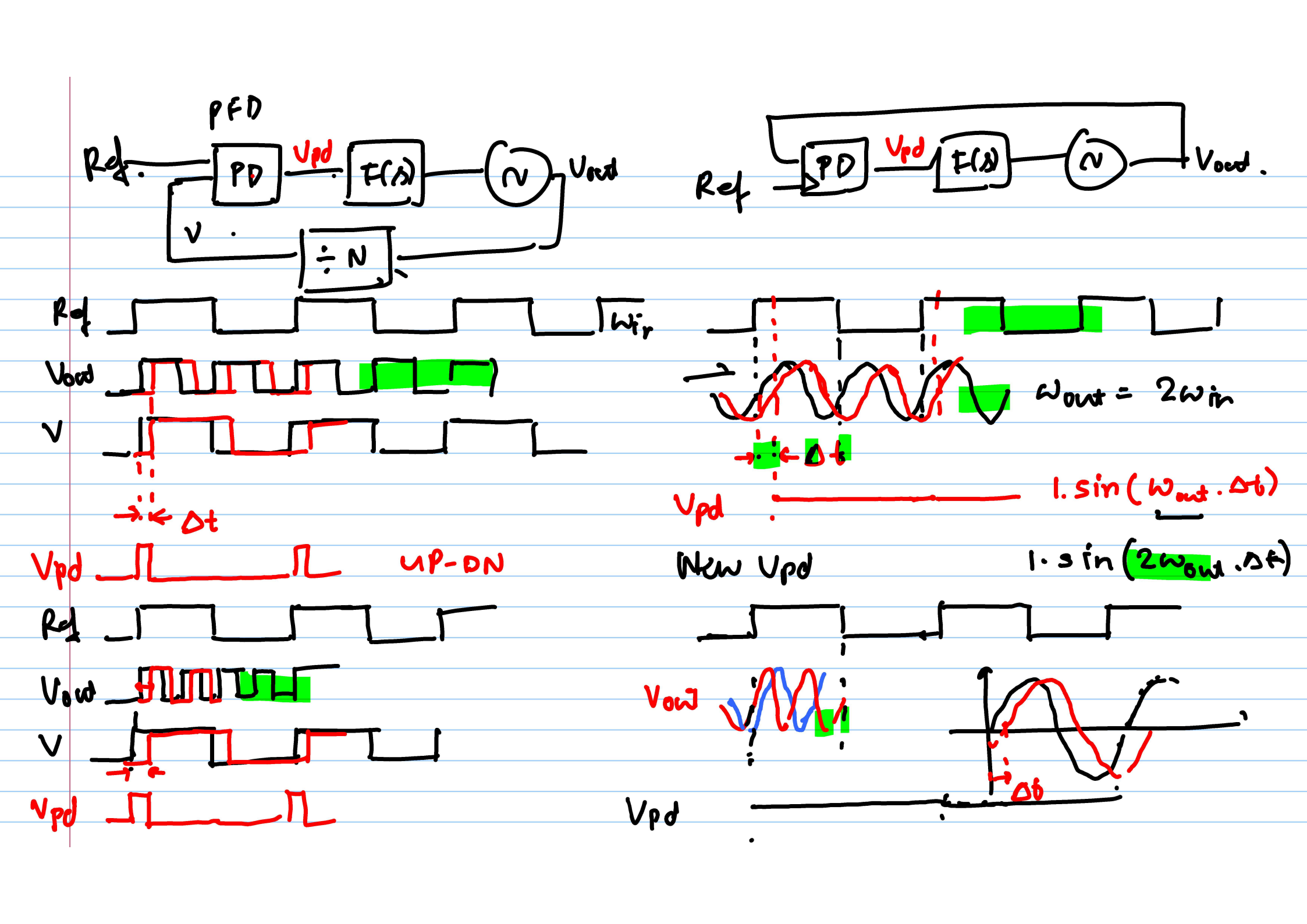
$\phi_e = \Delta\omega \cdot t$

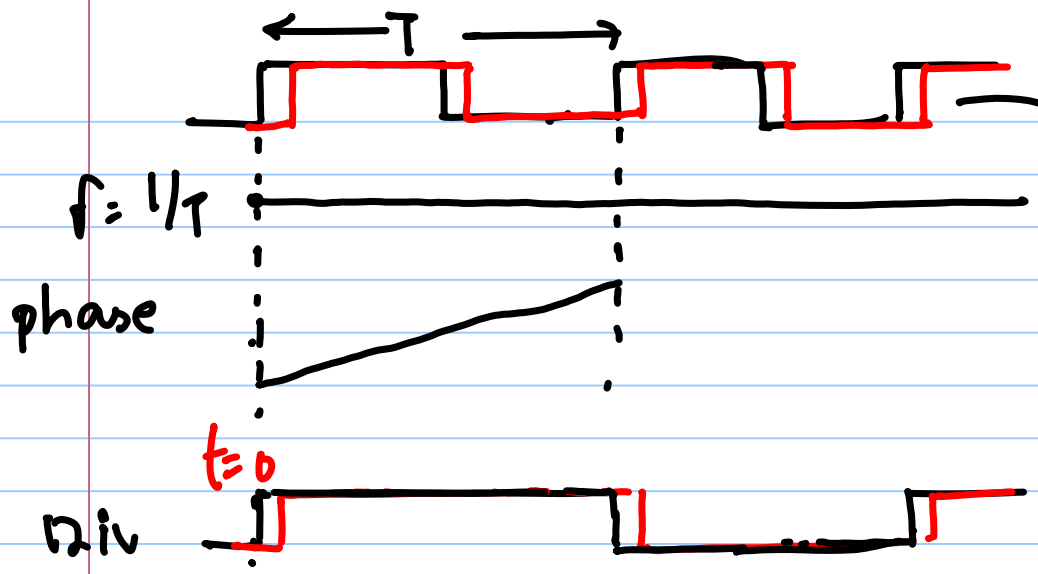
$= (\omega_i - \omega_o)\, t$



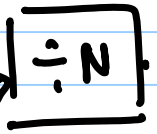
F_R (i/p freq.)

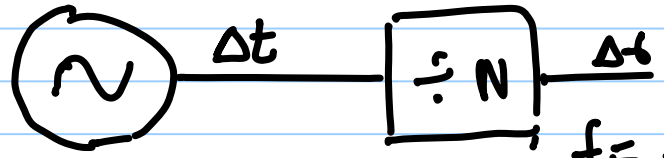
- F_o o/p. $\longrightarrow (F_i - f_o)\, t$
- $2F_o$ o/p $\longrightarrow (F_i - 2F_o)\, t$


PFD
Ref
PD
Vpd
F(s)
VCO
Vout
V
÷ N
Ref
Vout
V
Δt
Vpd
UP-DN
Ref
Vout
V
Vpd
Ref
PD
Vpd
F(s)
VCO
Vout
Ref
Vout
ωout = 2ωin
Δt
Vpd
1. sin(ωout . Δt)
New Vpd
1. sin(2ωout . Δt)
Vout
Δt
Vpd



Δt shift in o/p clock.





$f = \frac{f}{NT}$

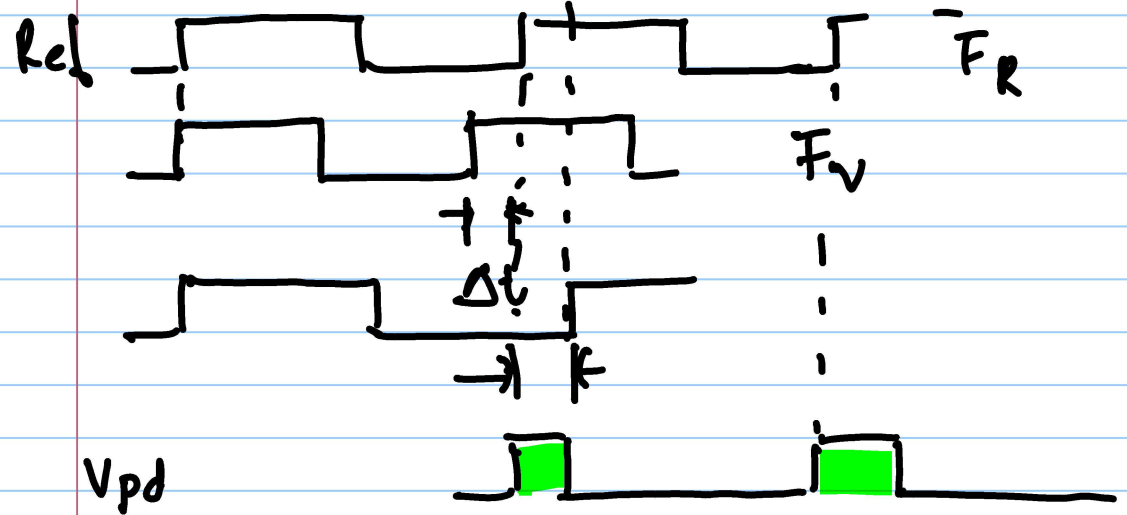
$\phi_{in} = \frac{2\pi}{T} \Delta t$

T is VCO period

$\phi_{out} = \frac{2\pi \cdot \Delta t}{NT}$

$= \frac{\phi_{in}}{N}$

PFD as frequency detector



F_R : Ref. clock freq. $F_R = 1/T_R$

F_V : O/p clock freq. $F_V = 1/T_V$

$\Delta t = T_V - T_R$; $F_R > F_V$

$$\frac{F_R}{F_V} = \frac{5}{4} \Rightarrow \frac{T_V}{T_R} = \frac{5}{4}$$

$$4T_V = 5T_R$$

For 1st Ref. cycle,

$$\Delta t(1) = T_V - T_R = \frac{5}{4}T_R - T_R = \frac{T_R}{4}$$

$$\Delta t(2) = 2T_V - 2T_R = \frac{T_R}{2}$$

$$\overline{V_{pd}} = \frac{1}{N.T}\left(\Delta t + 2.\Delta t + \cdots + N(\Delta t)\right)$$

$$N(\Delta t) = T$$

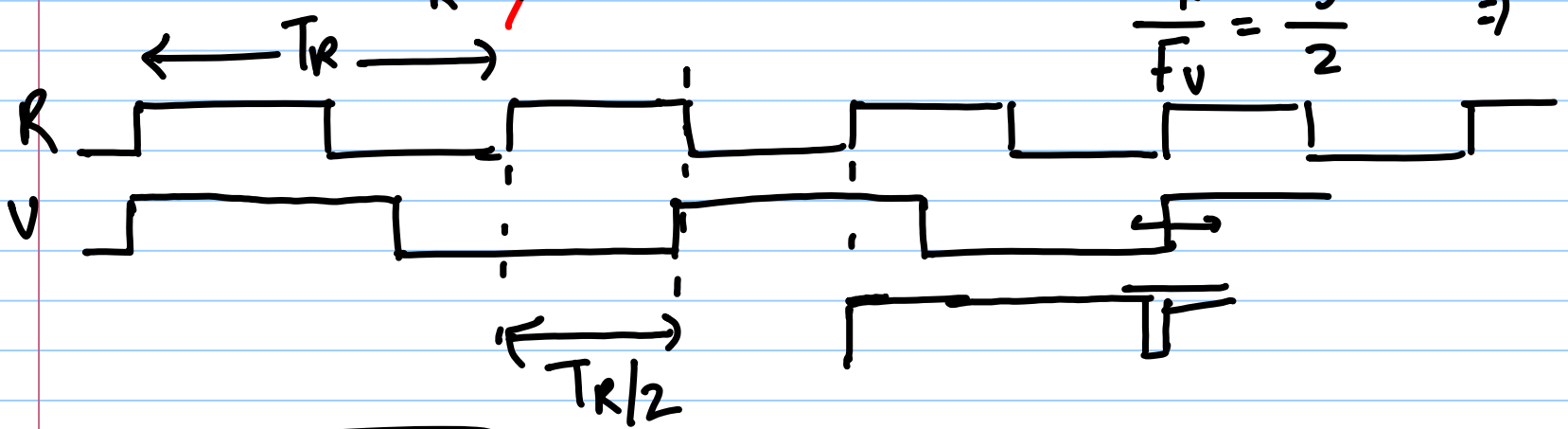
$$\overline{V_{pd}} = \frac{1}{N.T}\,\Delta t\,\frac{N(N+1)}{2}$$

$$\overline{V_{pd}} = \frac{\Delta t}{T}\,\frac{1}{N}\,\frac{N(N+1)}{2} \qquad \Delta t = T_V - T_R \;;\; F_R > F_V$$

$$= \frac{\Delta t}{T_R}\,\frac{1}{N}\,0.5N(N+1) \sim$$

$$\frac{F_R}{F_V} = \frac{3}{2} \Rightarrow \frac{T_V}{T_R} = \frac{3}{2}$$

$$2T_V = 3T_R$$



$$\boxed{\Delta t \cdot N = T_R}$$

$$V_{pd} = 0.5\left(\frac{N+1}{N}\right) = 0.5\left(1 + \frac{\Delta t}{T_R}\right)$$

$$= 0.5 + 0.5\,\frac{(T_V - T_R)}{T_V} =$$