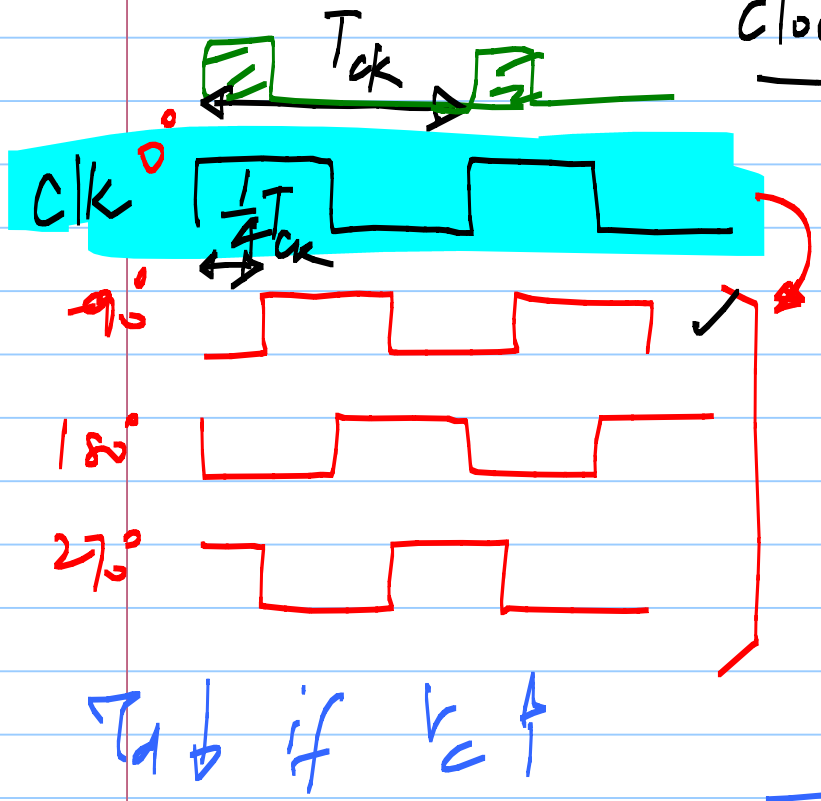
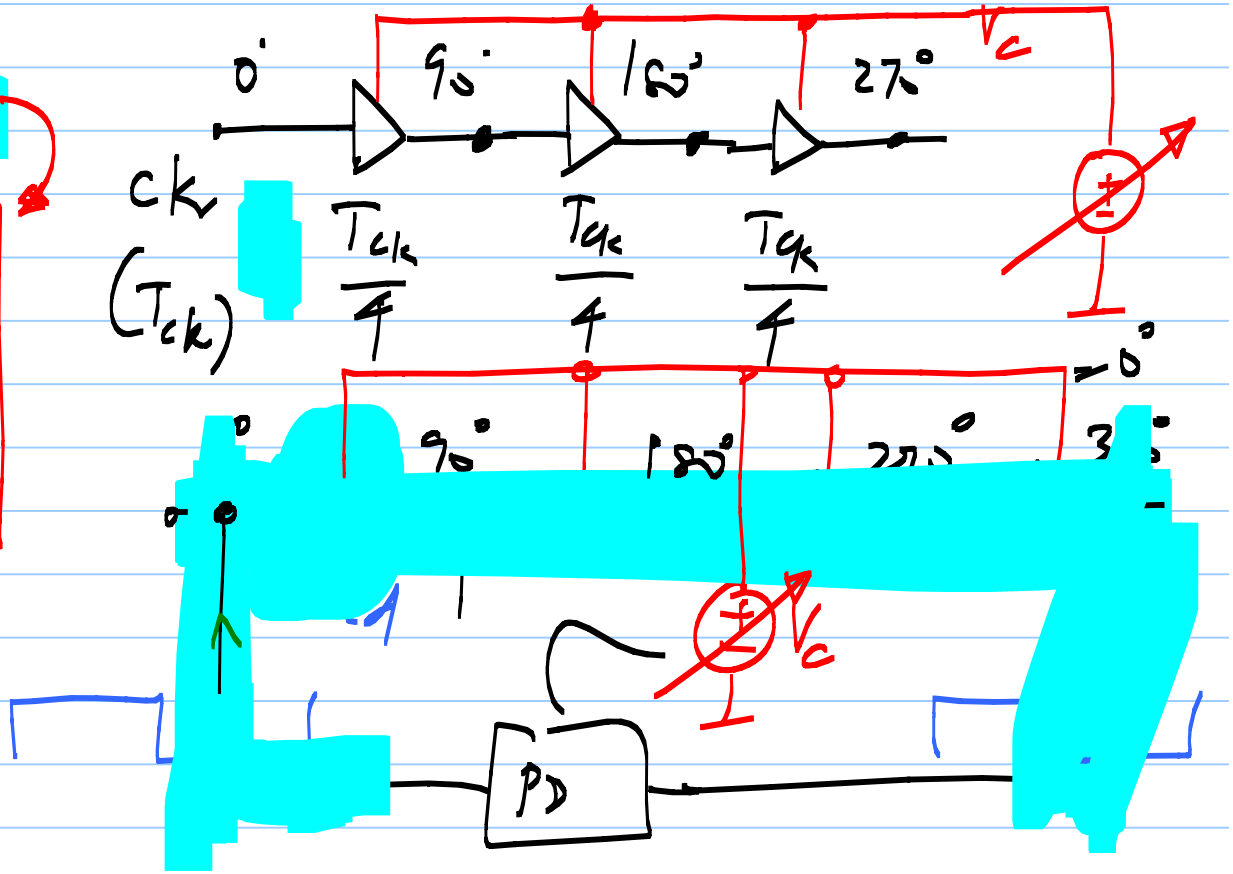
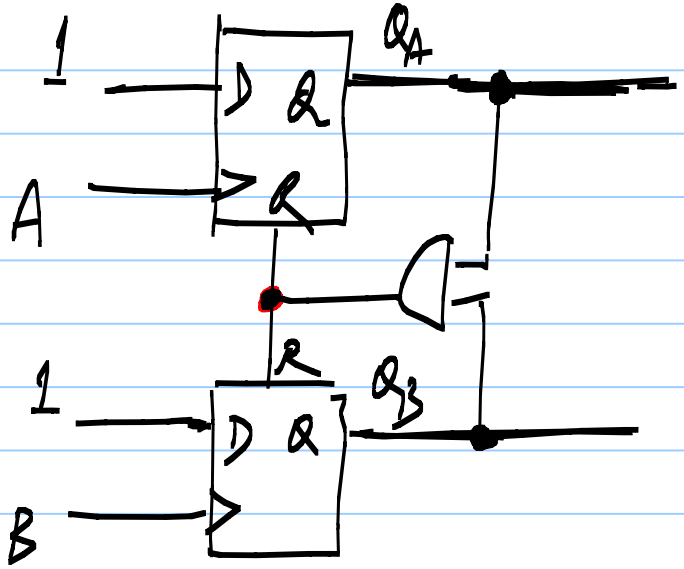
Lecture 11

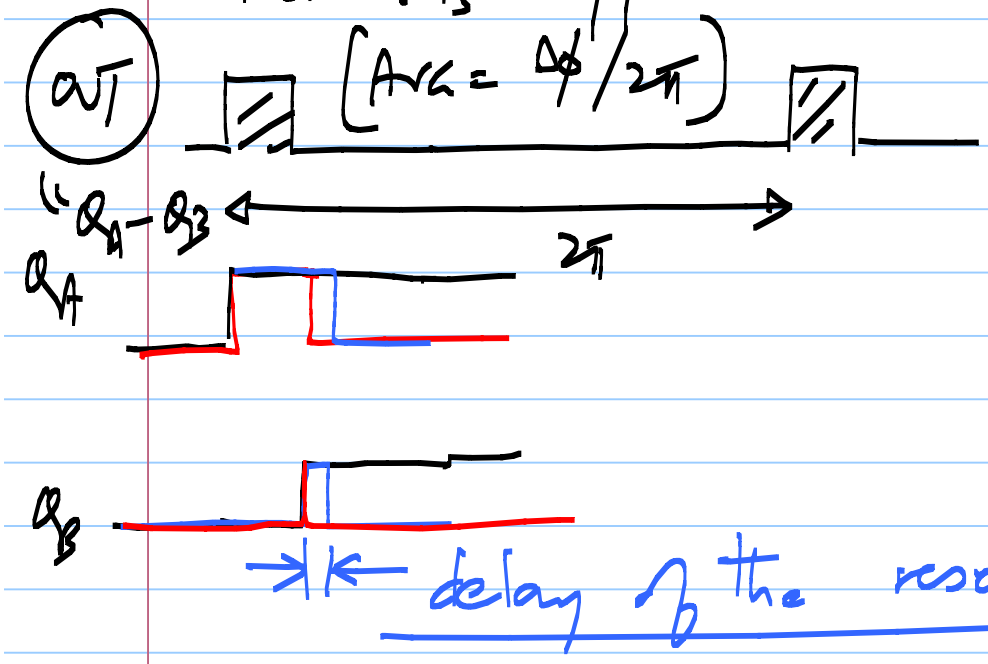
Generate multiple phases of a given clock waveform



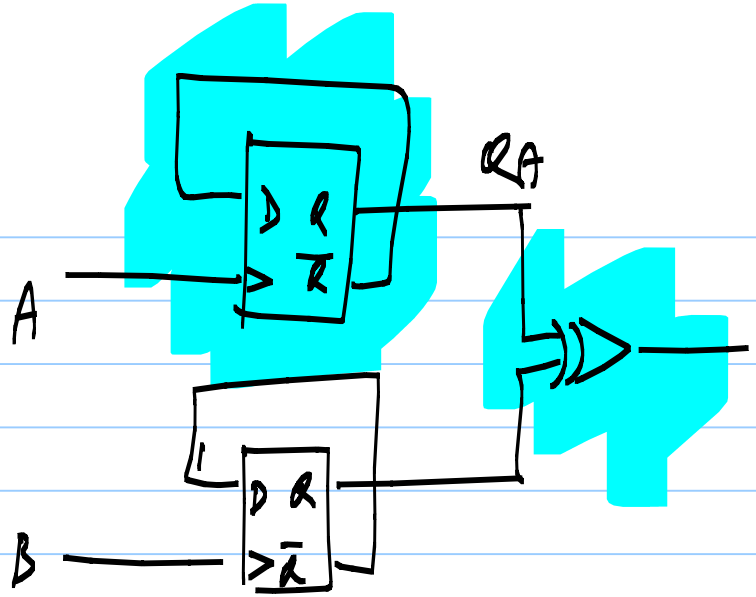


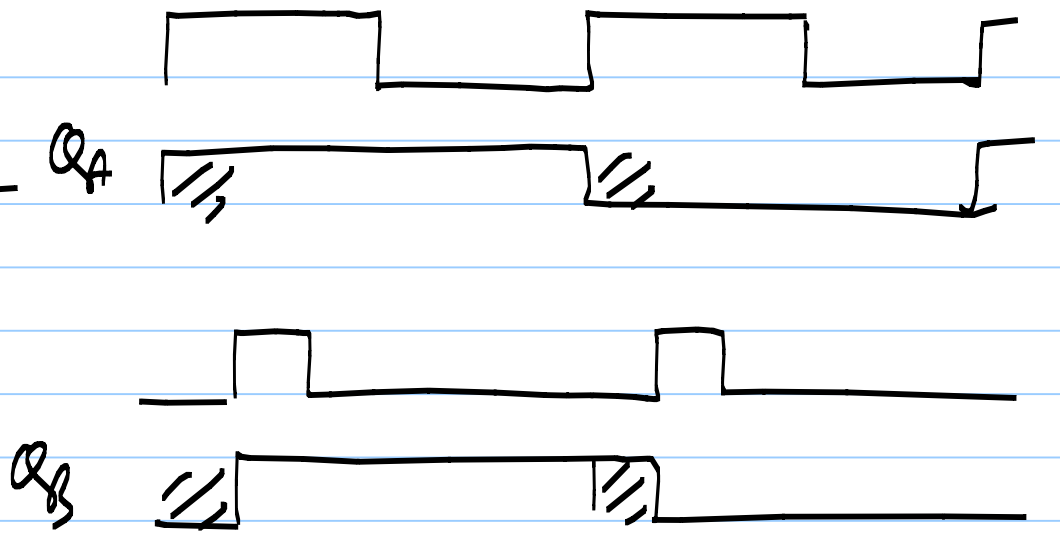

Δϕ
A
B
1
Detect this difference

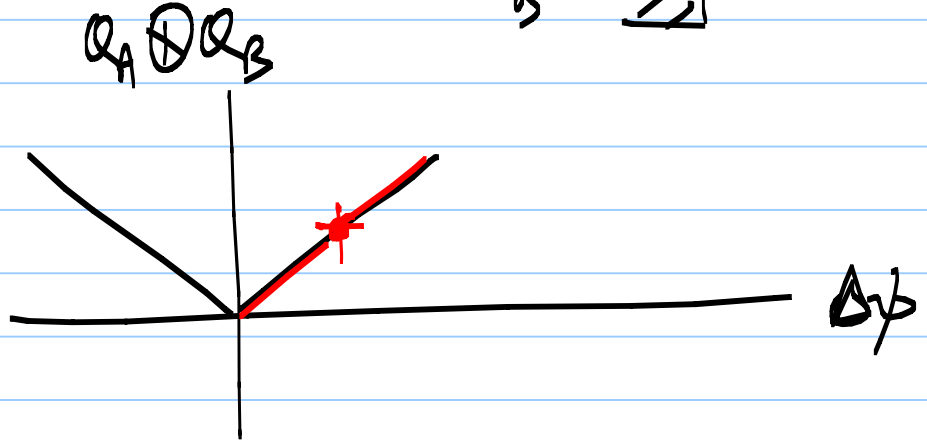

1
D
Q
Q_A
A
R
1
D
Q
Q_B
B

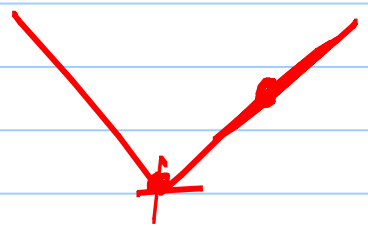

OUT
(Avg = Δϕ/2π)
"$Q_A - Q_B$"
2π
Q_A
Q_B
delay of the reset path

$OUT = Avg(Q_A - Q_B)$

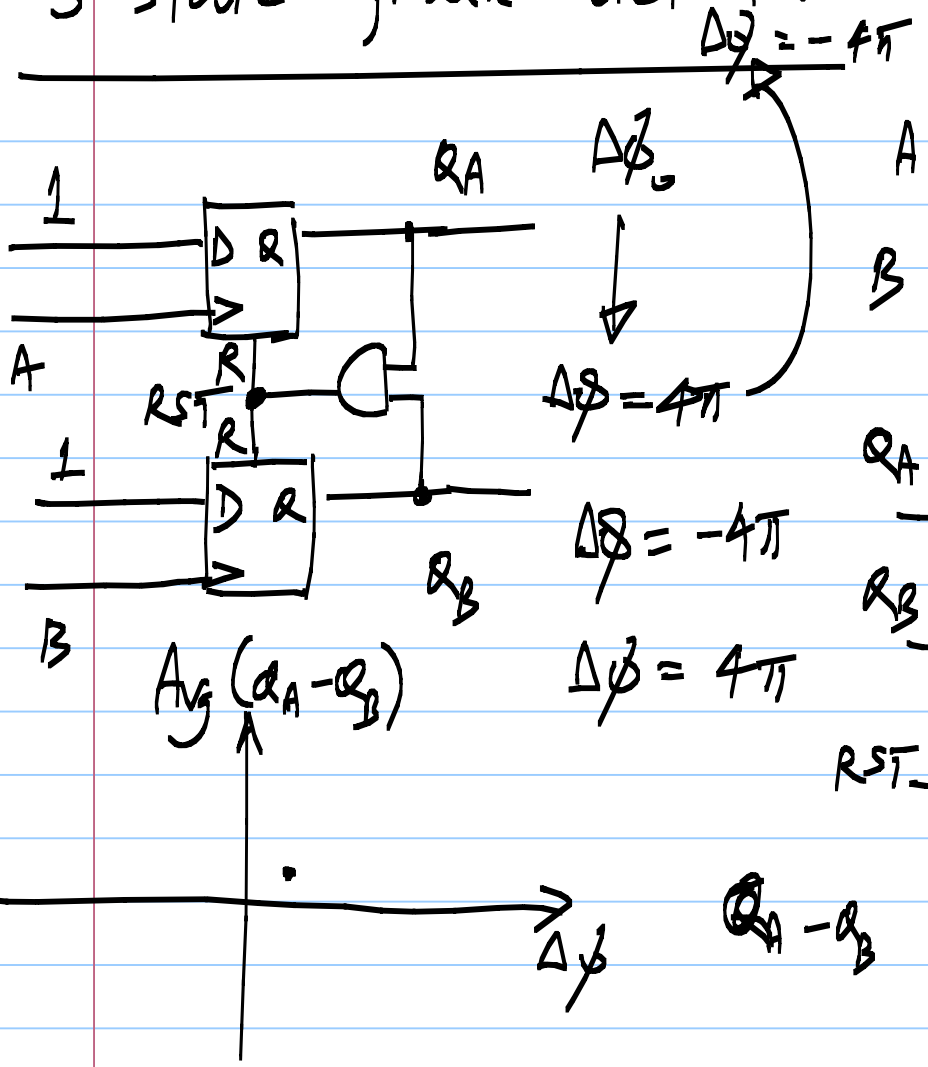

A
B
D
R
$\bar{R}$
Q_A


Q_A
Q_B

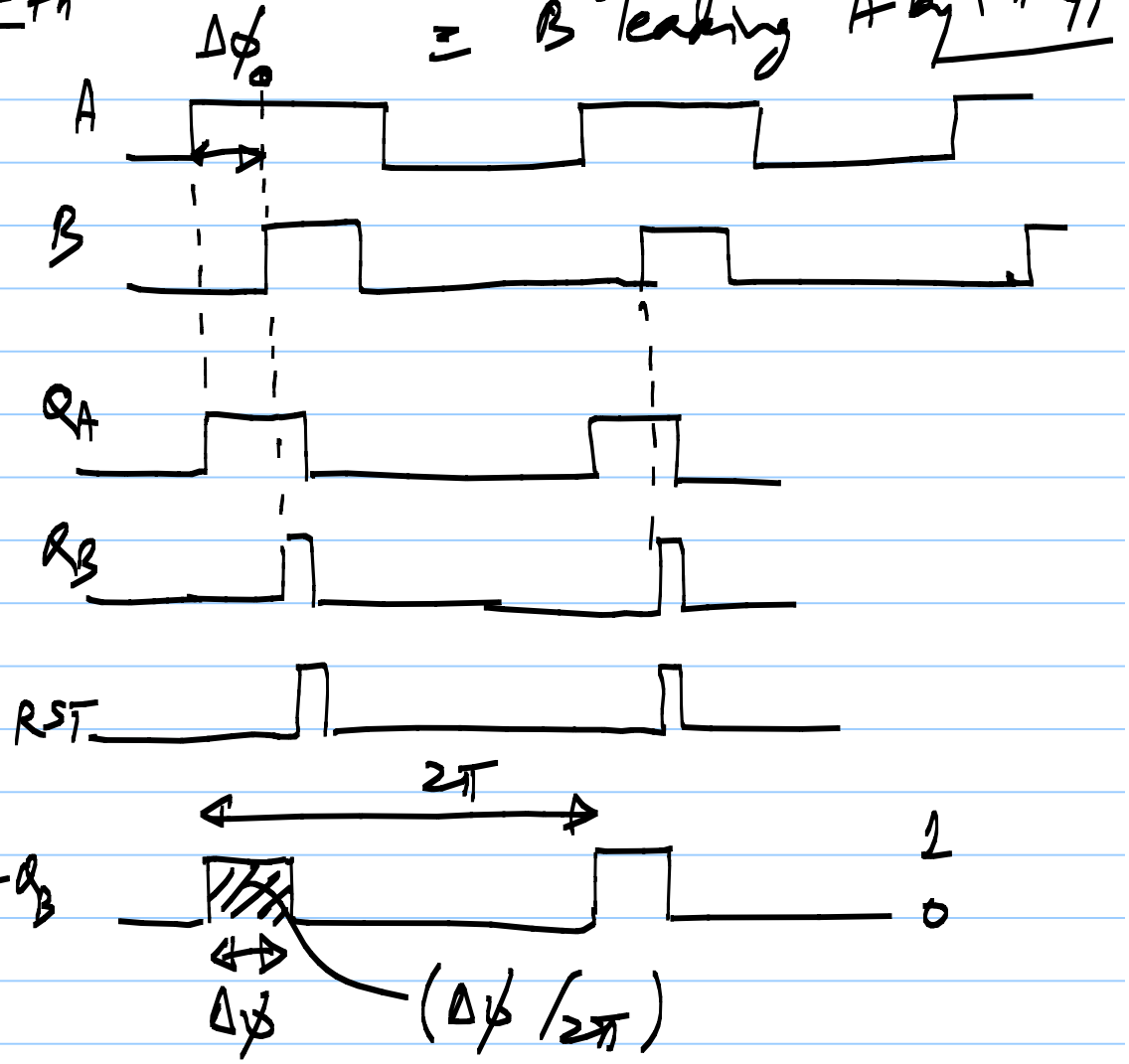

$Q_A \oplus Q_B$
$\Delta\varphi$

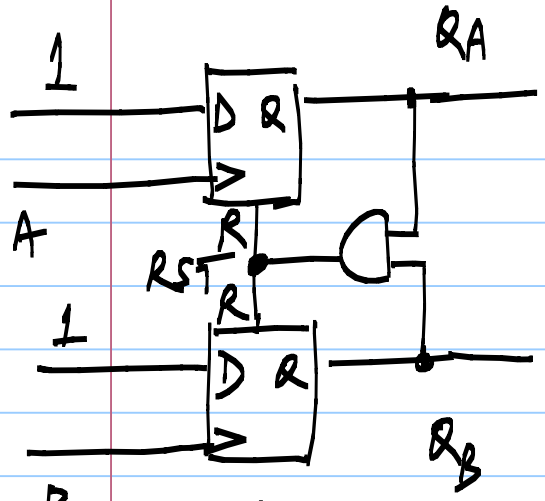


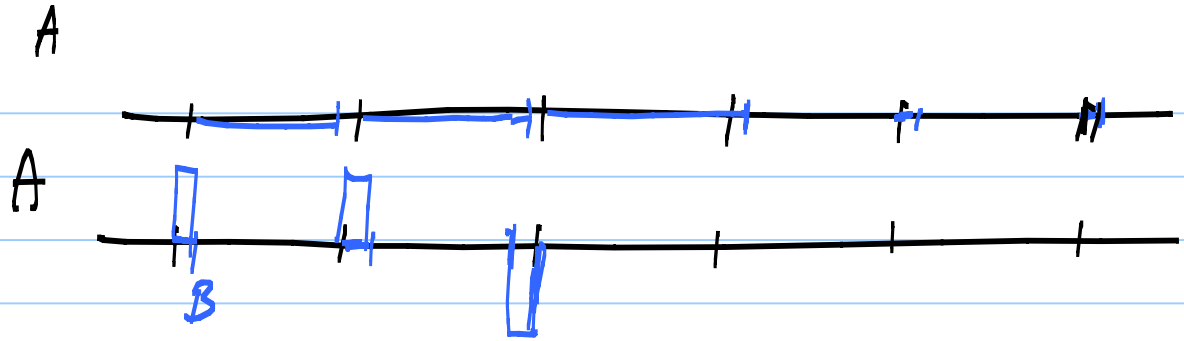
3-state phase detector

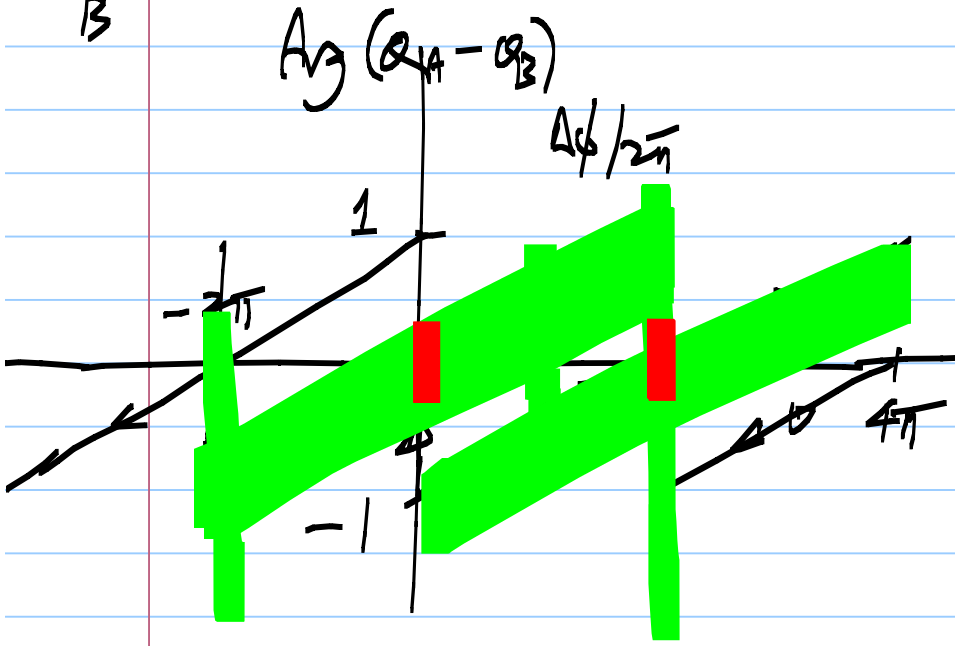


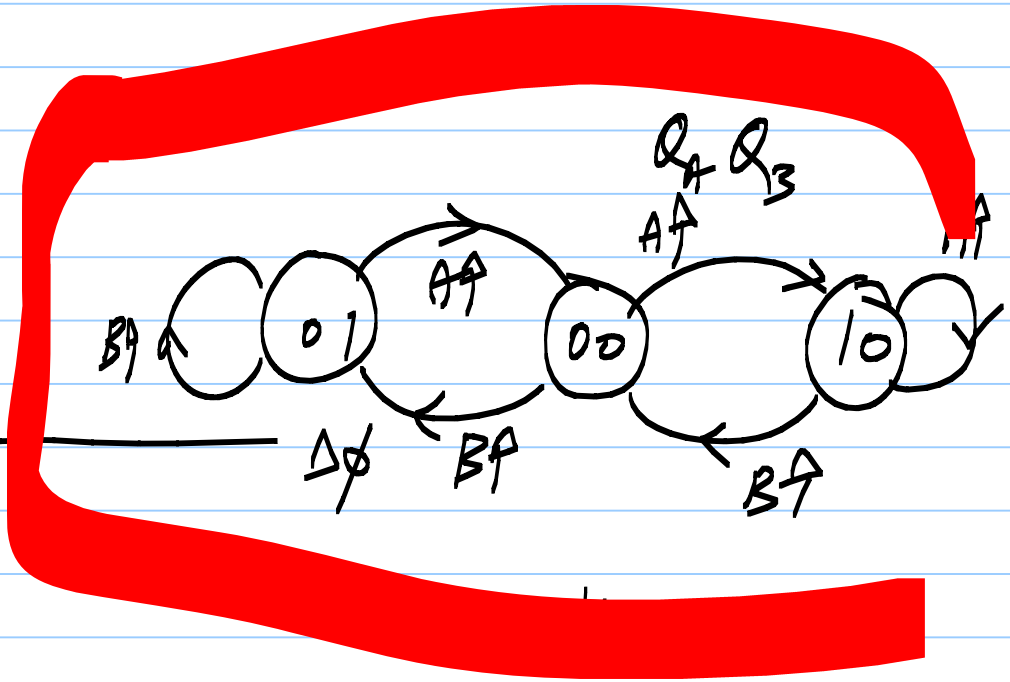
A leading B by $\Delta\phi$
= B leading A by $(2\pi - \Delta\phi)$

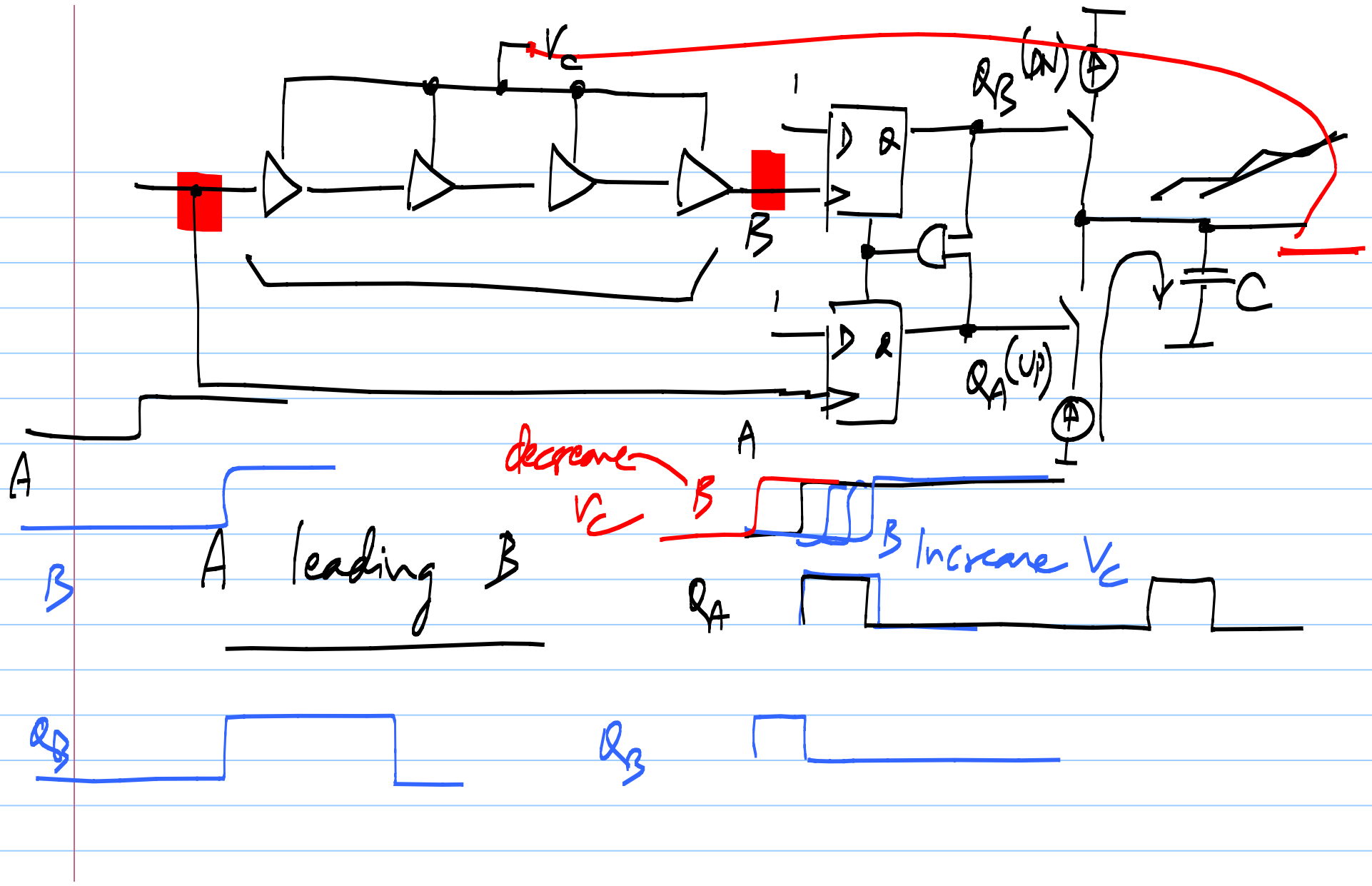



1
D Q
A
R
RST
R
1
D Q
B
QA
QB


A
A
B


Avg (QA − QB)
Δφ/2π
1
−2π
4π
−1


QA QB
01
00
10
Δφ
Δφ
Δφ
Δφ
Δφ


V_c
B
1
D
Q
Q_B (dn)
Q_A (up)
C
A
decrease V_c
B
A leading B
B Increase V_c
Q_A
Q_B
Q_B