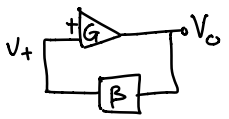
Today - Sine wave oscillators
- Review

Midterm: 4Q → 1 Short Ans.
3 $V_i \rightarrow V_a, V_o$

{ 15% for better midterm
5% for worse

Sine Wave Oscillators

FB will oscillate if $G\beta > 1$

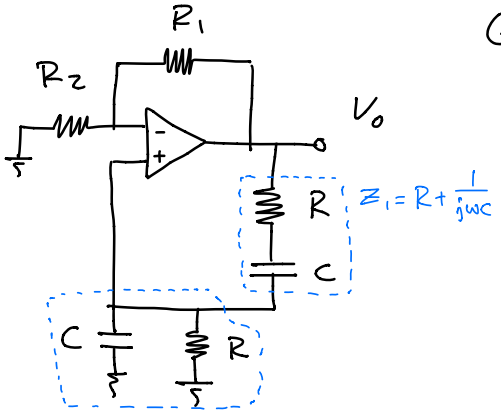


Oscillator is stable if $G\beta > 1$ is true at one freq.

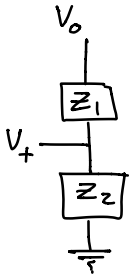
Wien-bridge

Max Wien 1891

Hewlett 1939



$$G = 1 + \frac{R_1}{R_2}$$



$$\beta = \frac{Z_2}{Z_1 + Z_2}$$

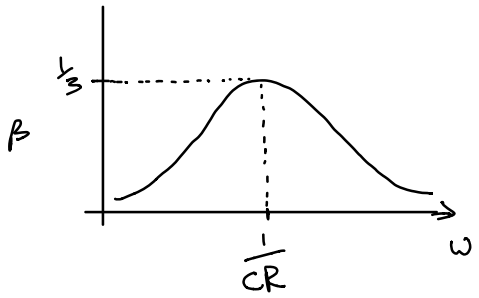
$$\beta = \frac{\left(\frac{R}{1+j\omega CR}\right)}{\left(\frac{R}{1+j\omega CR} + \frac{1+j\omega CR}{j\omega C}\right)} \cdot \frac{j\omega C(1+j\omega CR)}{j\omega C(1+j\omega CR)} = \frac{j\omega CR}{j\omega CR + 1 + 2j\omega CR + (j\omega CR)^2}$$

$$\beta = \frac{j\omega CR}{1 + 3j\omega CR - (\omega CR)^2}$$

if $\omega < \frac{1}{CR}$ phase lead

$\omega = \frac{1}{CR}$ $\beta = \frac{1}{3}$

$\omega > \frac{1}{CR}$ phase lag



Oscillate if $G\beta > 1$

$G\left(\frac{1}{3}\right) > 1 \Rightarrow G > 3$

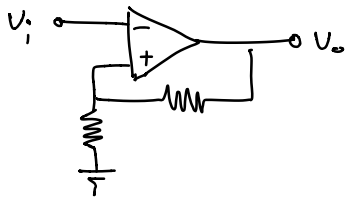
This is not a particularly good oscillator (more next class).

List of Topics (for review)

- → schmitt trigger
- → +ve vs. neg. FB
- → 555 - monostable
- → Square wave w/ opAmp
- → V_{os}, I_B

Schmitt Trigger

V_{CC} , V_{EE} $(+10, -10)$



Important: $V_+ \neq V_-$

States

$V_o = +10V \rightarrow V_+ = \left(\frac{V_+}{V_o}\right)(+10)$

$V_o = -10V \rightarrow V_+ = \left(\frac{V_+}{V_o}\right)(-10)$

Thresholds

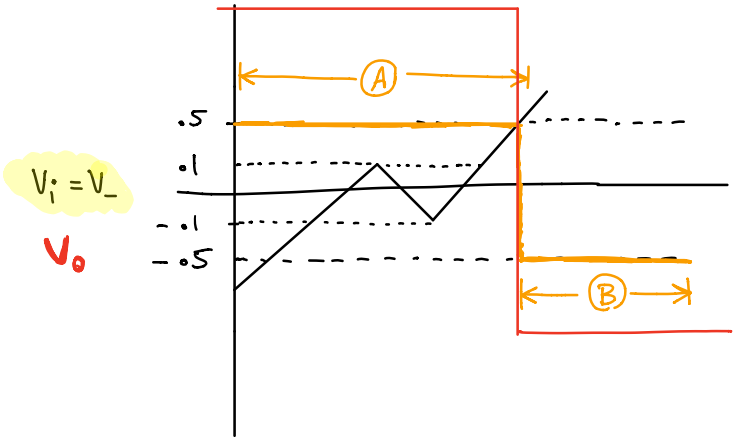
$V_- < V_+$

$V_- > V_+$

Conditions

if $V_- < V_+ \Rightarrow V_o = 10V$, $V_+ = 0.5V$

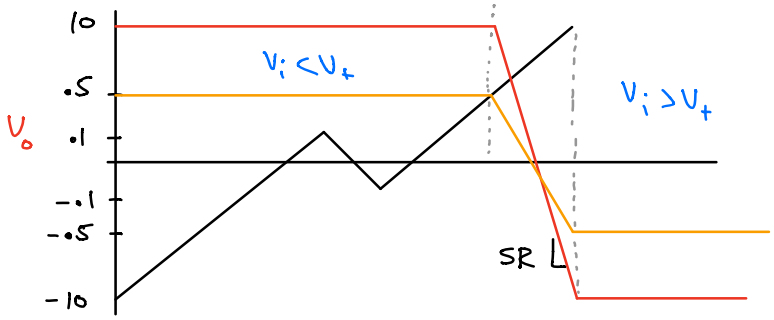
$V_- > V_+ \Rightarrow V_o = -10V$, $V_+ = -0.5V$



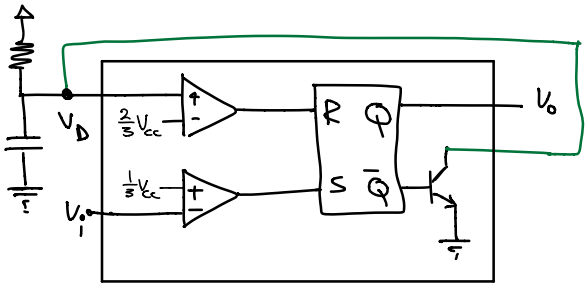
$T = \frac{0.6V}{\text{slope}}$

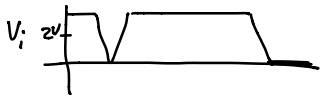
$\text{Slope} = \frac{0.6V}{T}$

What if we have a slew rate?



555



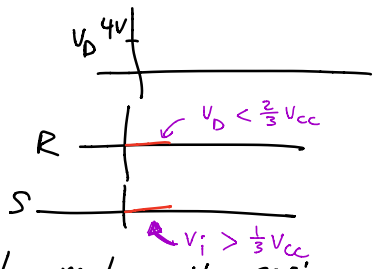


$V_{cc} = 6V$

$\frac{2}{3} V_{cc} = 4V$

$\frac{1}{3} V_{cc} = 2V$

S	R	Q	$\bar{Q}$
0	0	Remem.	
1	0	1	0
0	1	0	1



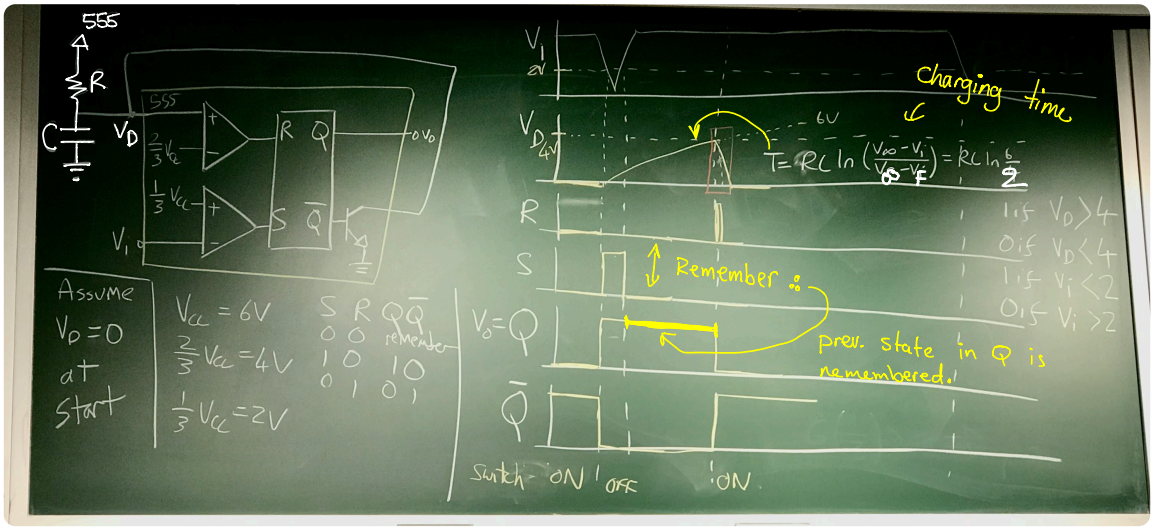
Always assume $V_D = 0$ @ start to make it easier

$V_D < \frac{2}{3}V_{cc}$ = R = Low ? R = High

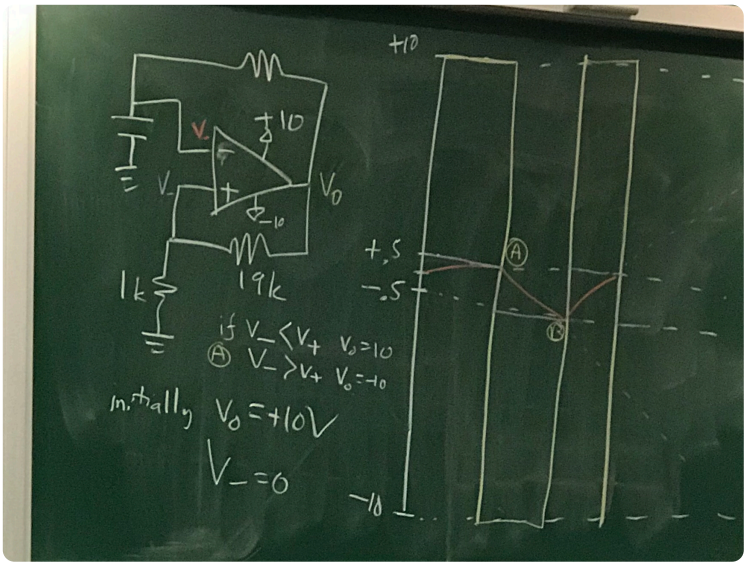
$V_i < \frac{1}{3}V_{cc}$ = S = High ? S = Low

∴ R → 1 if $V_D > 4$
0 if $V_D < 4$

S → 1 if $V_i < 2$
0 if $V_i > 2$



Note Having an input that stays low for long time won't be on the midterm. (b/c R&S will both go high at the same time which is not desirable.)


+10
V-
+10
V+
V0
-10
1k
19k
if V- < V+ V0 = 10
A V- > V+ V0 = -10
initially V0 = +10V
V- = 0
+10
+.5
-.5
-10
A
B