Lecture 10: Schmitt Trigger

0. Review
1. Intro
2. Relaxation Oscillator
3. Schmitt Trigger

- PreLab 4 due today
- HW4 due Fri (Oct 25)
- Exam #1 re-do
  Quiz
  } next Tue (Oct 29)
- Lab 3 report due Nov 04 (Mon)

Textbook Reading:

Ch 20-1 Comparators with zero reference

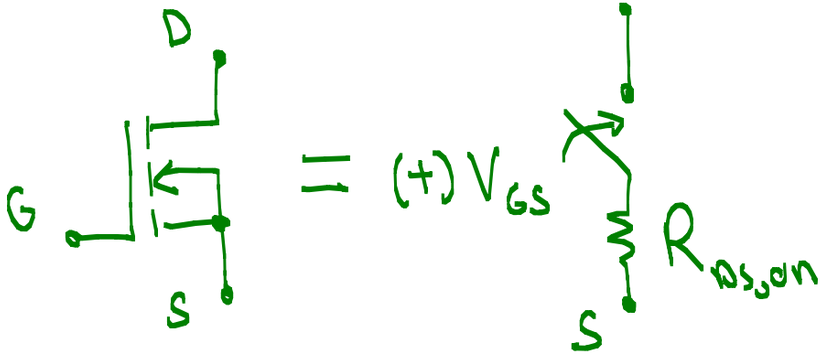
20-3 Comparators with hysteresis

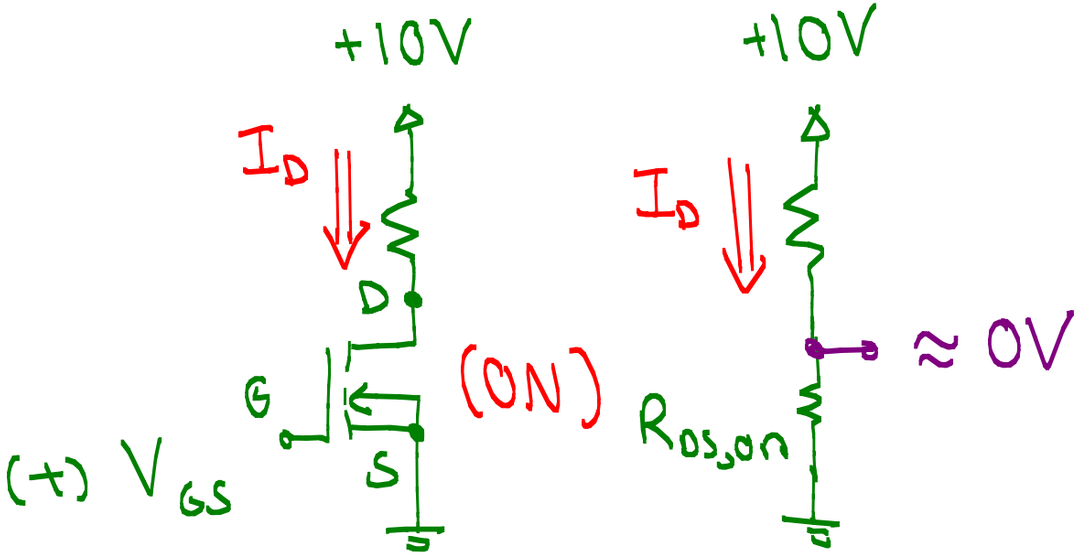
20-7 Waveform Generation

0. Review

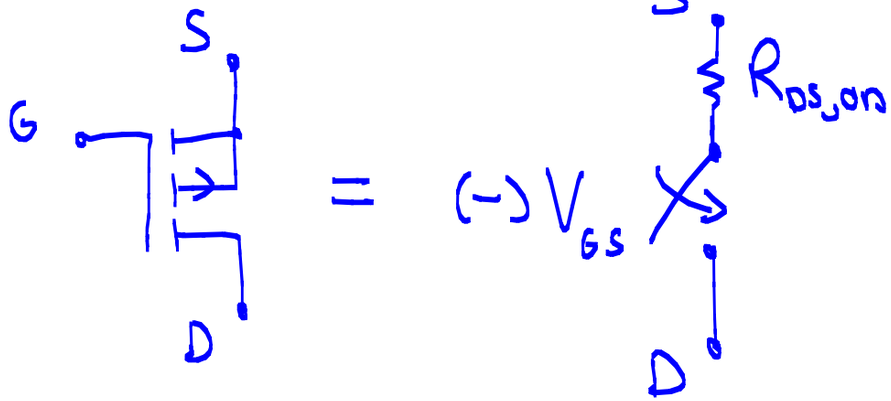
• MOSFET switches

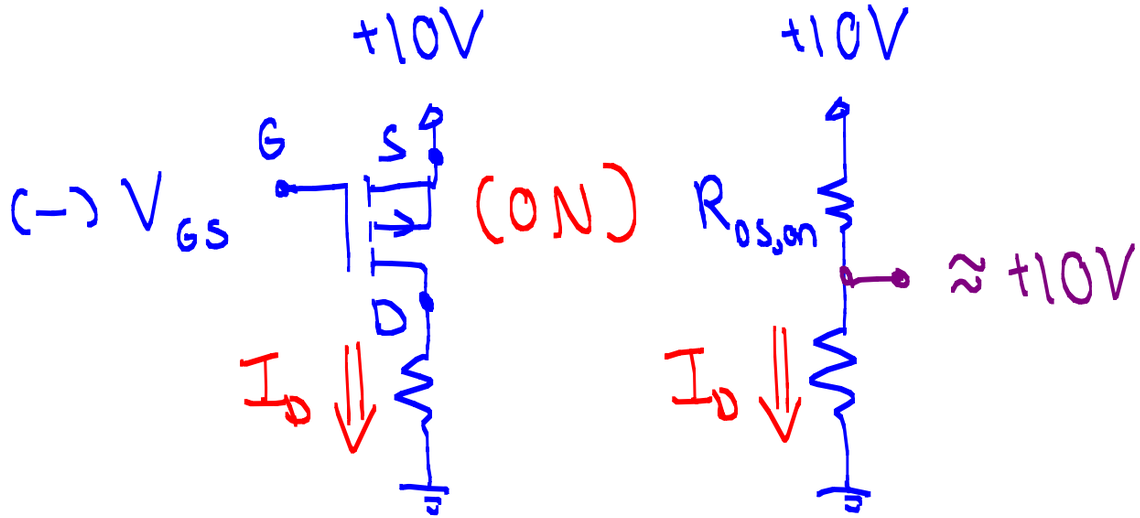
NMOS





PMOS



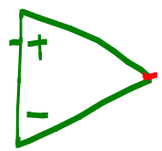


1. Intro

- Unlike amplifiers, waveform generators use positive feedback!

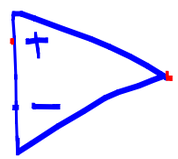
Negative Feedback

Ex:



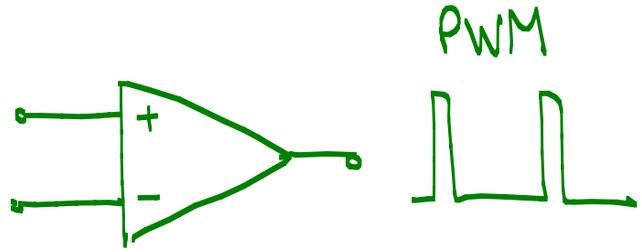
Positive Feedback

Ex:

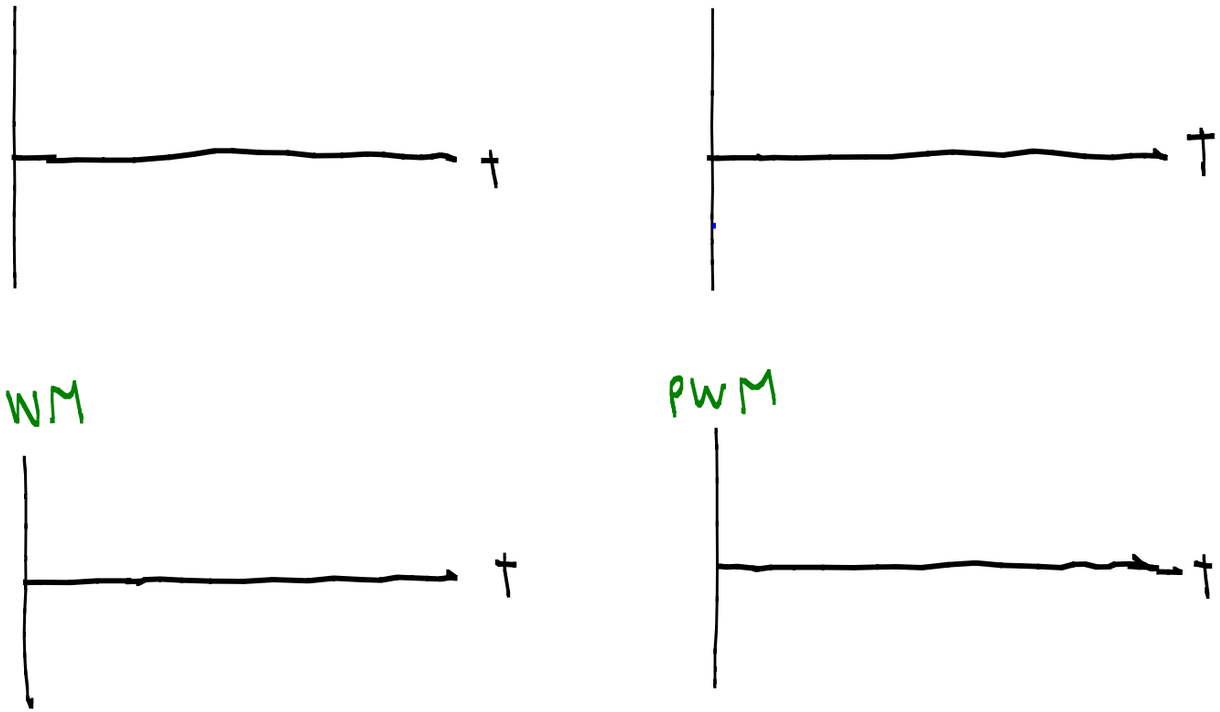


Example Pulse Width Modulation (PWM)

- Many applications!



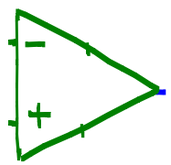
Q: How to implement PWM?

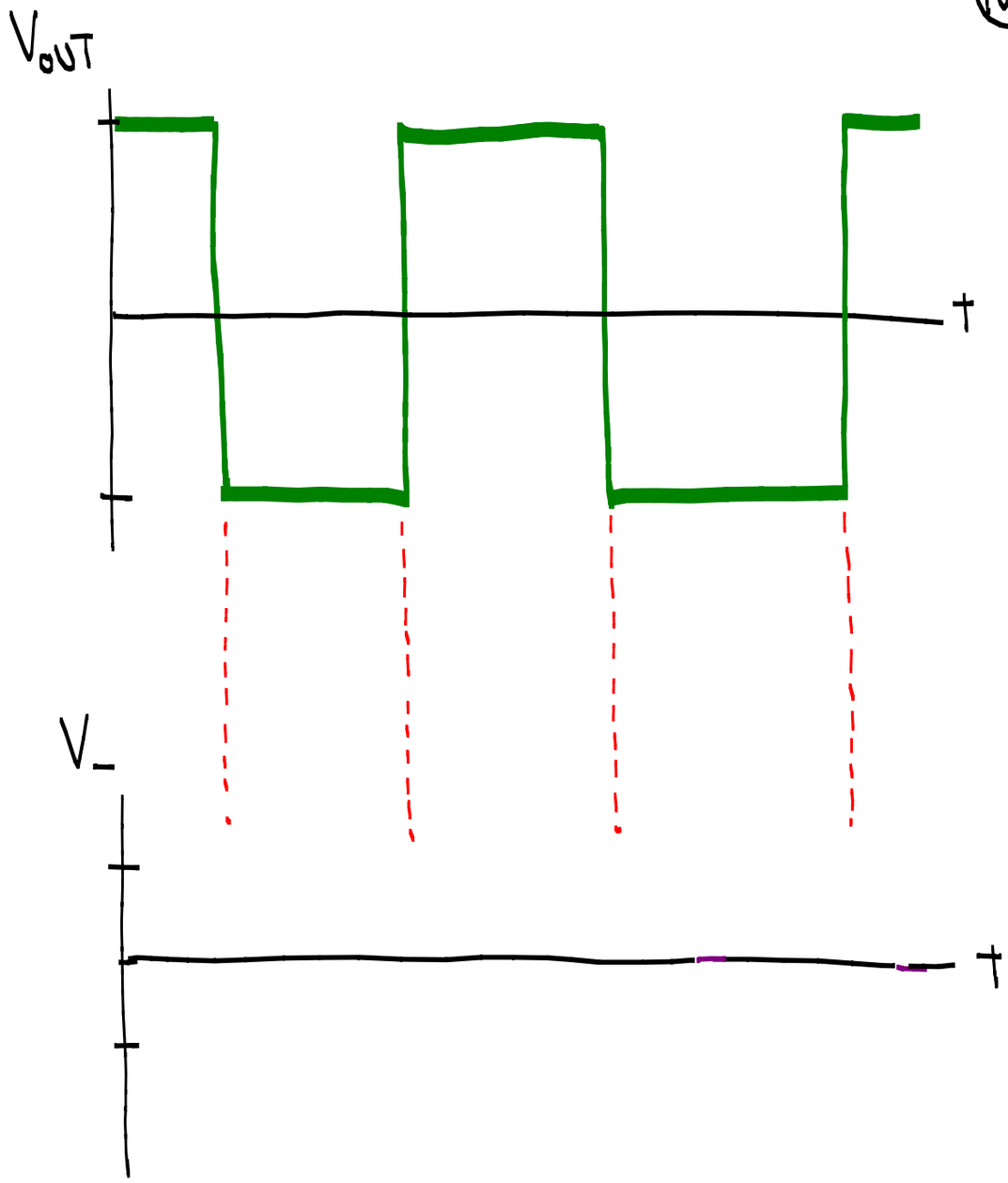


2. Relaxation Oscillator

- Simple example of (+) feedback.

  → Produces a square wave.

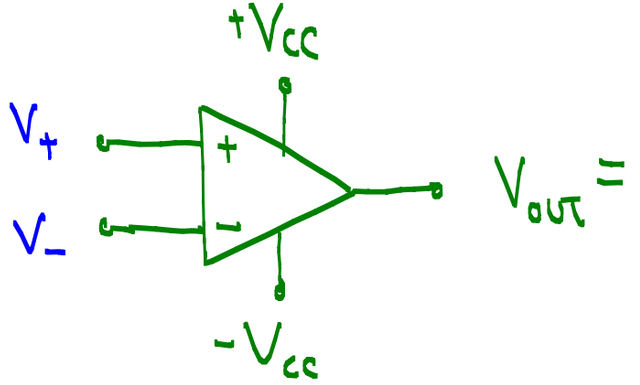




Q: How does this work?

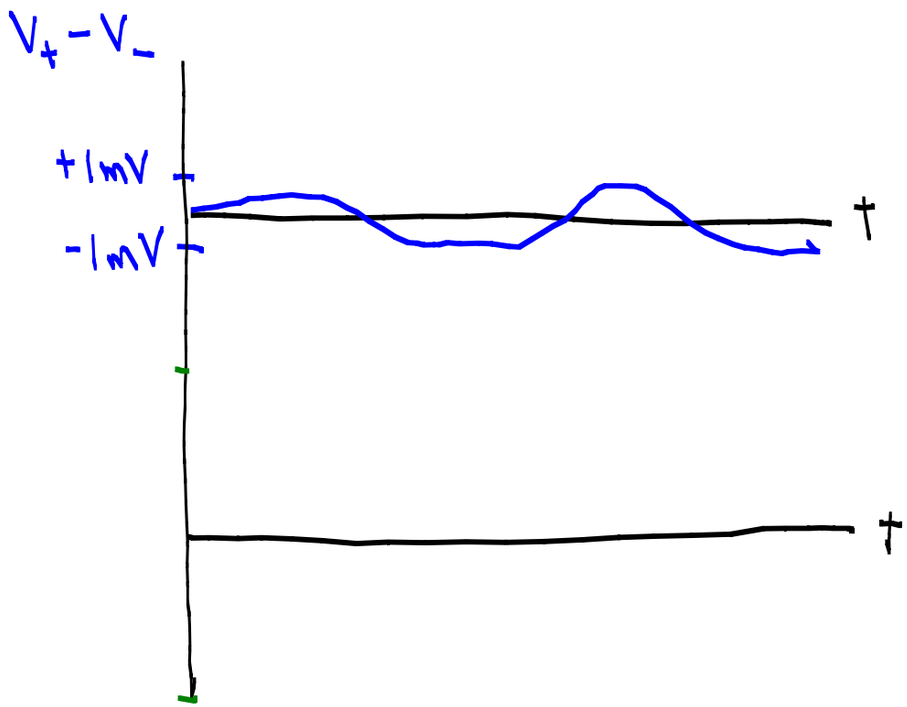
→ Op amp is an ultra-high gain differential amplifier.

Ex:



(A) If $V_+ > V_-$

(B) If $V_+ < V_-$

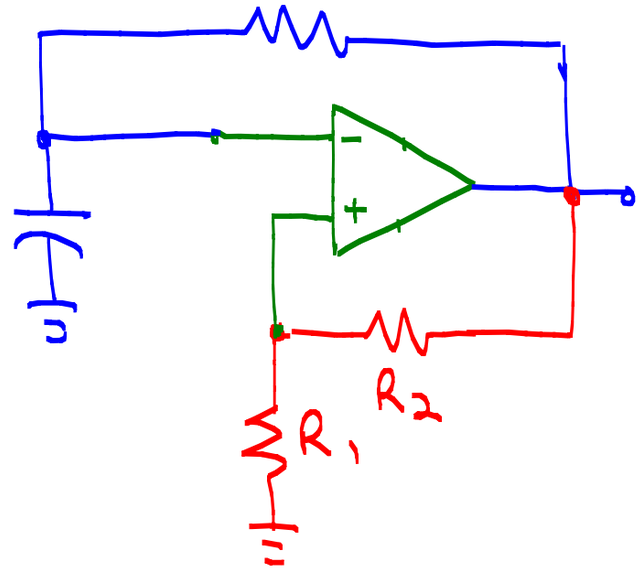


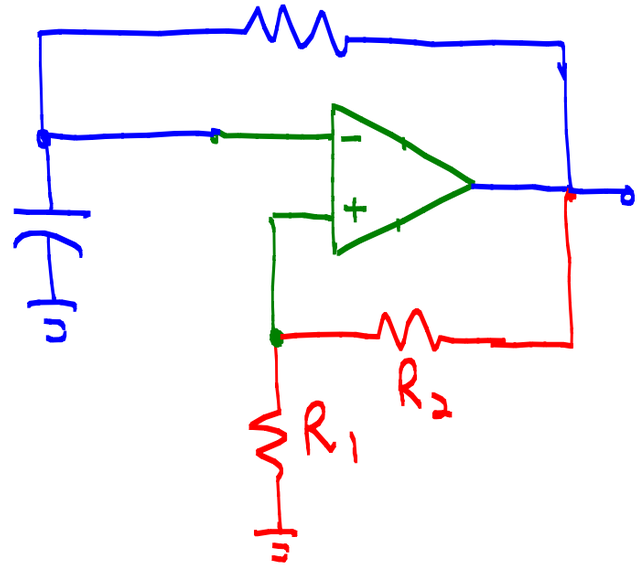
- Start with Region ①:

Initially, $V_{out} = +V_{sat}$ and $V_c = 0$

$V_- =$

$V_+ =$



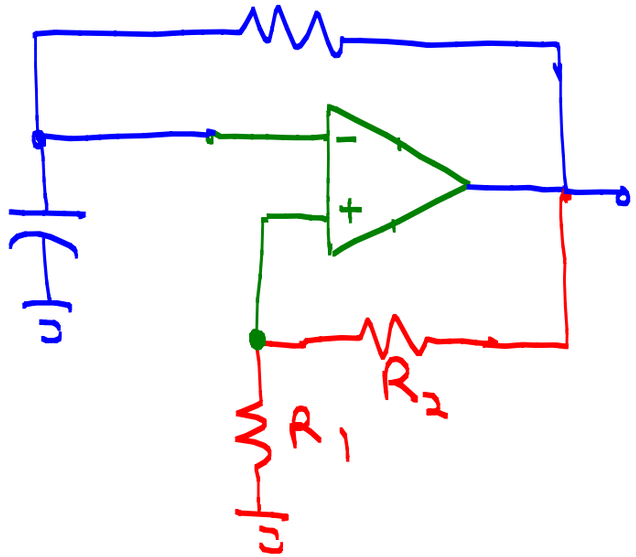


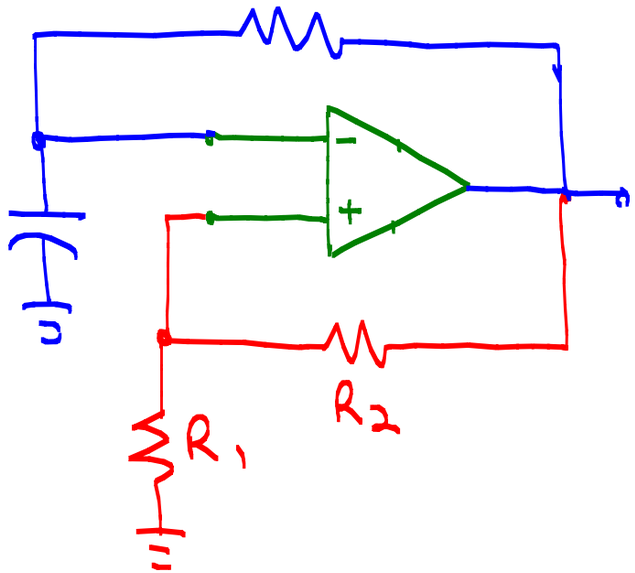
- Now consider region ②:

Now have $V_{out} = -V_{sat}$ and $V_c = +V_{sat}\frac{R_1}{R_1+R_2}$

$V_- =$

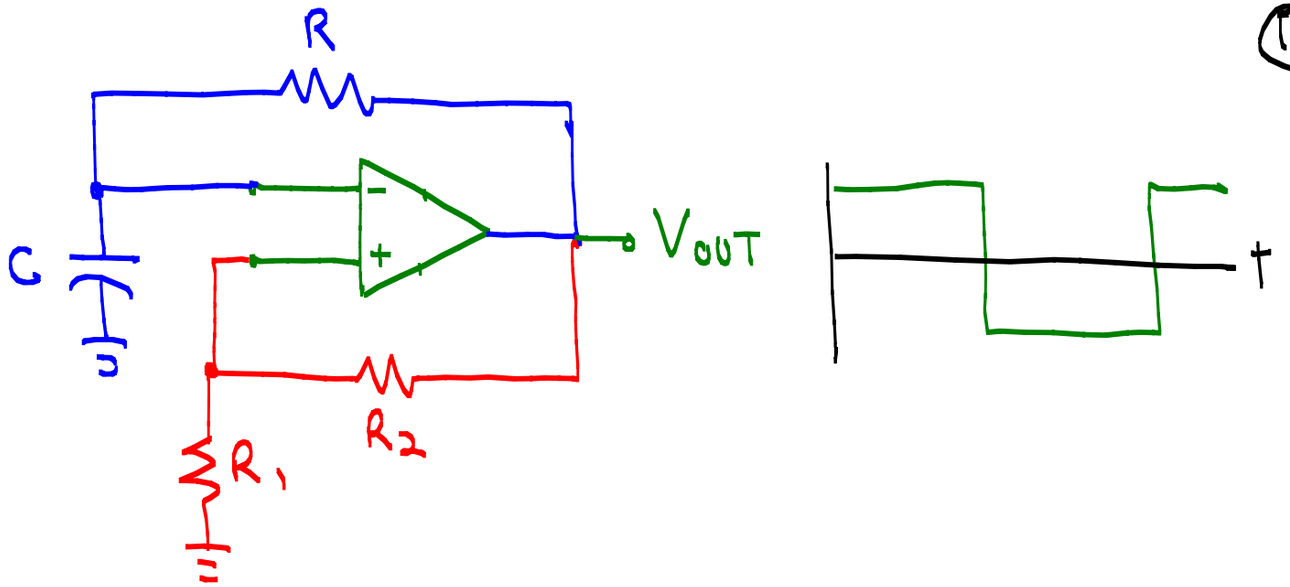
$V_+ =$





- Period?

$T =$

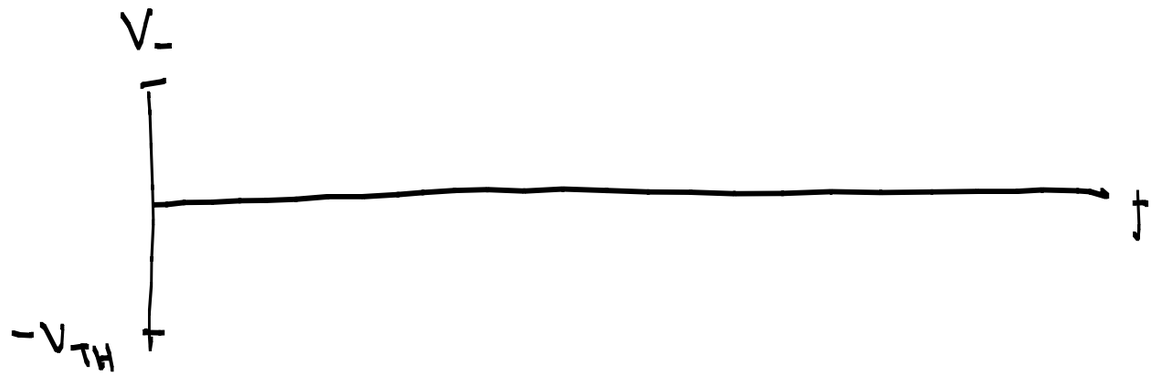


Ex: $R_1 = 18K$

$R_2 = 2K$

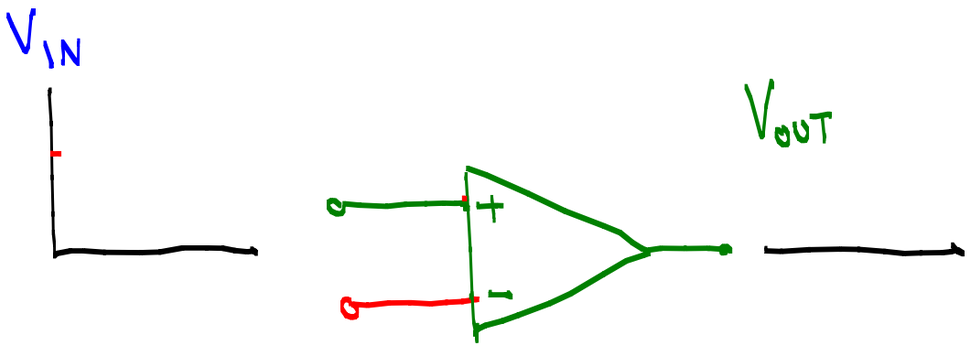
$C = 0.1\mu F$

$R = 1K$



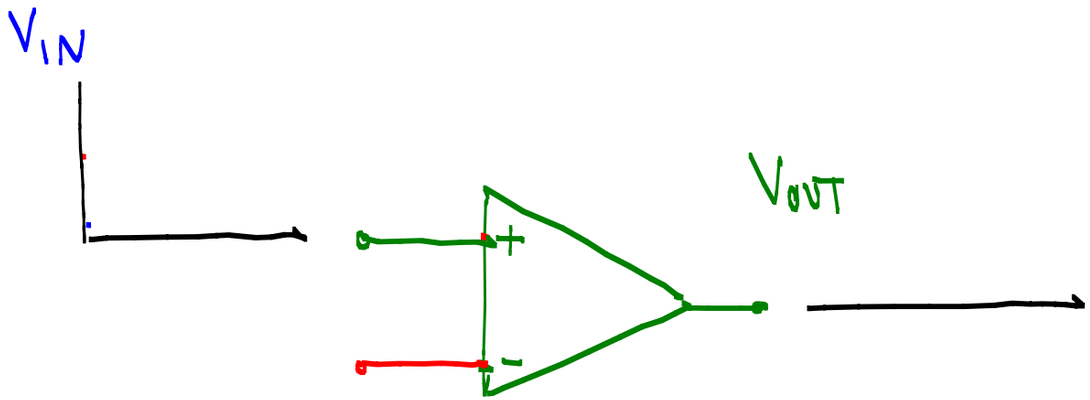
3. Schmitt Trigger

- An open loop op amp can be used as a _____.



e.g.

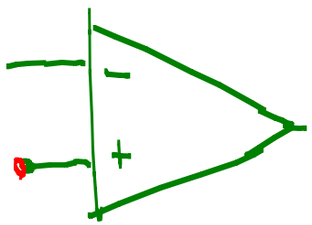
- Problem with this circuit...

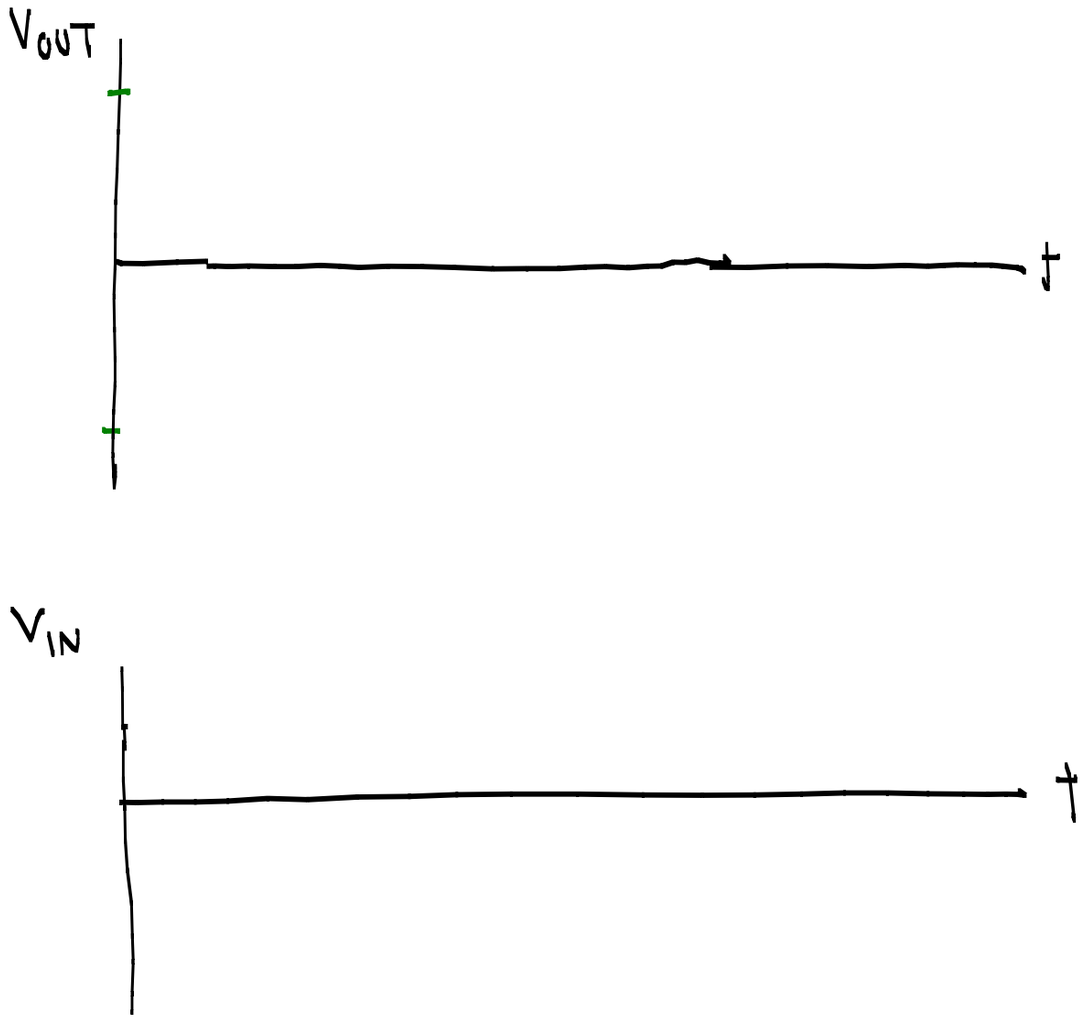


Q:

- Threshold detector with hysteresis

→ Value of V_{OUT} depends on





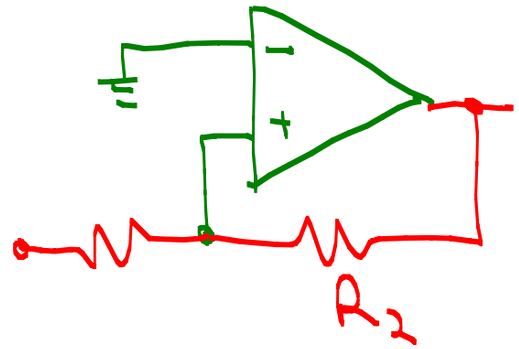
How does this work? Assume V_+ draws no current...

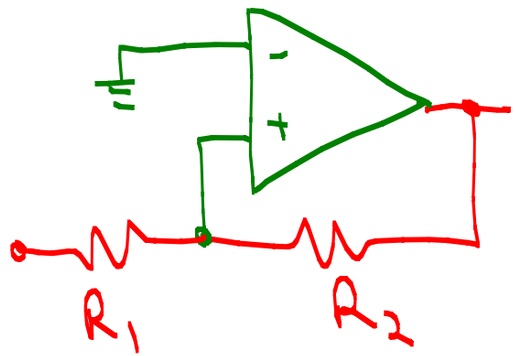
Region ①: $V_{OUT} = -V_{sat}$

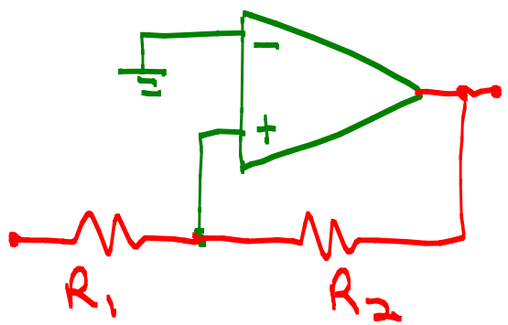
(V_{IN})

- While V_{IN}
  then V_+
- When V_{IN}
  then V_+

what is the UTP?

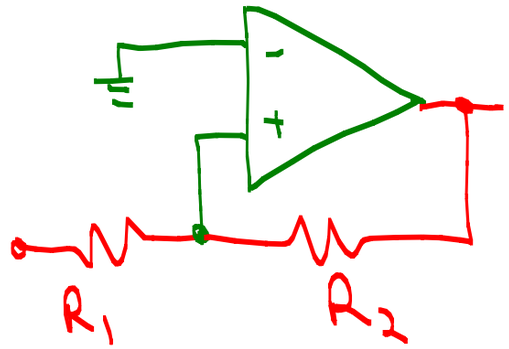




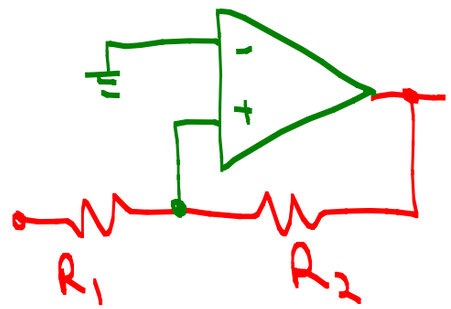


Region ②: $V_{out} = +V_{sat}$

- V_{out}



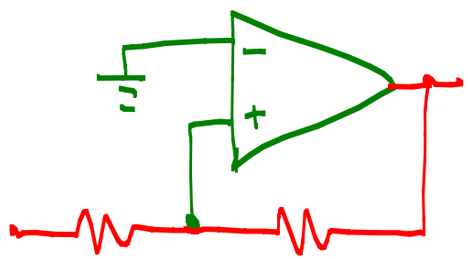
- when V_{IN} then V_+



LTP?

Region ③: $V_{out} = -V_{sat}$

- V_{out}



- V_{out}

- Noise immunity with Schmitt trigger