ECE3204 Lecture 14

Schmitt Trigger (17.4)
Key ideas

Review Lab 3

Clock Generation (17.5)
Square Wave Oscillator
LM555 Timer

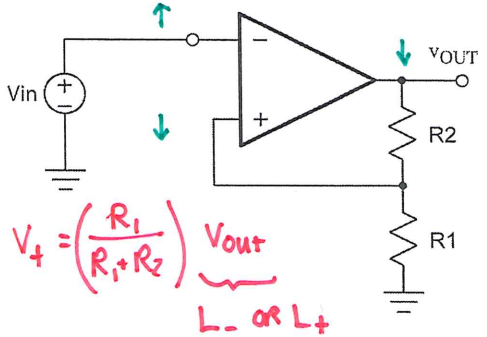
Schmitt Trigger Key Ideas

Positive feedback forces v_-, v_+ apart $\Rightarrow$ Output always at $\pm V_{SAT}$ rails (logic levels L_- or L_+)

Condition for input trip points V_{TL}, V_{TH} $\Rightarrow$ When $v_- = v_+$ (this is an unstable equilibrium!)

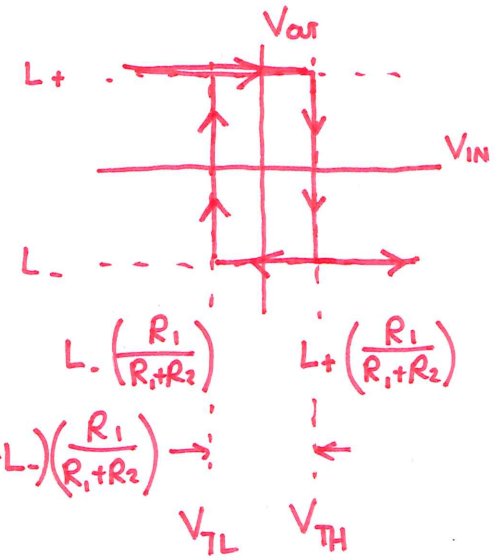
Hysteresis loop in $v_{IN} \rightarrow v_{OUT}$ plot $\Rightarrow$ Need to know past history when v_{IN} between V_{TL}, V_{TH}

Inverting

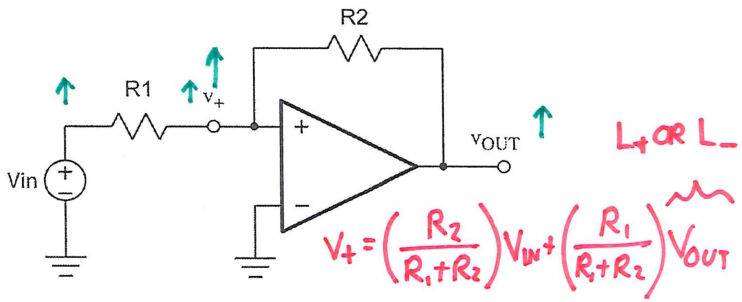


$V_+ = \left(\frac{R_1}{R_1+R_2}\right) V_{OUT}$

L_- OR L_+

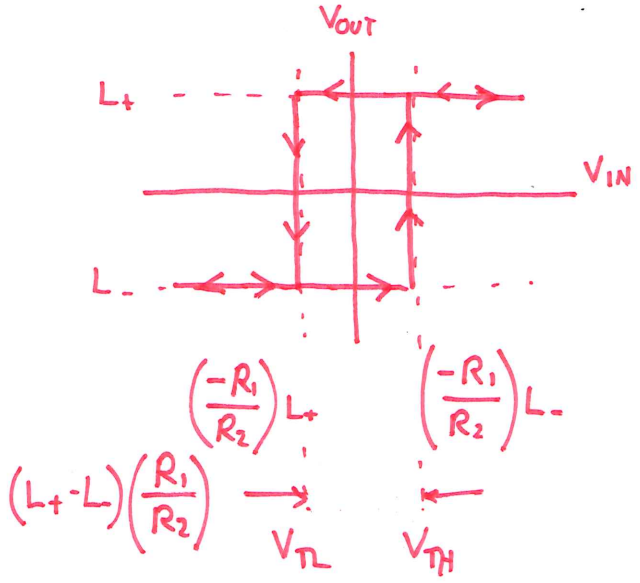


Non-Inverting



L_+ OR L_-

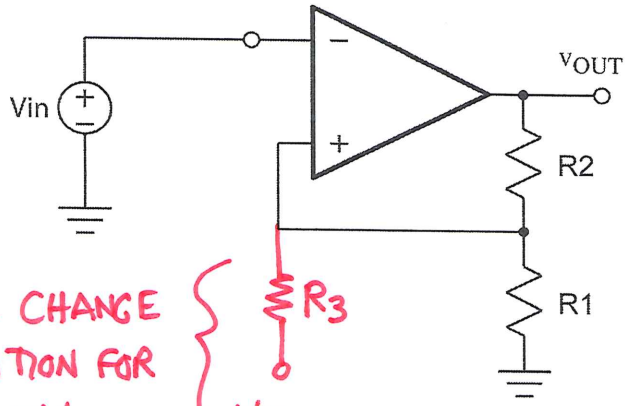
$V_+ = \left(\frac{R_2}{R_1+R_2}\right) V_{IN} + \left(\frac{R_1}{R_1+R_2}\right) V_{OUT}$



Schmitt Trigger: Asymmetric Trip Points

$L_- = 0$
$L_+ = $ SOME + VALUE

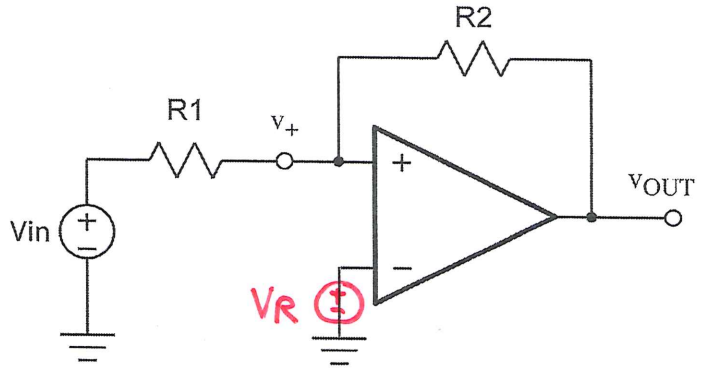
Inverting



WILL CHANGE CONDITION FOR $V_- = V_+$ AT V_{TL}, V_{TH}

ADDING V_R, R_3 GIVES EXTRA DEGREE OF FREEDOM IN DESIGN

Non-Inverting



TRIP POINT CONDITION: $V_+ = V_-$

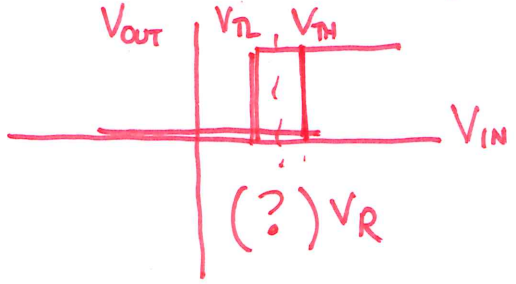
$$\left(\frac{R_2}{R_1+R_2}\right)V_T + \left(\frac{R_1}{R_1+R_2}\right)L_- = V_R$$

WAS ZERO

FIND V_T:

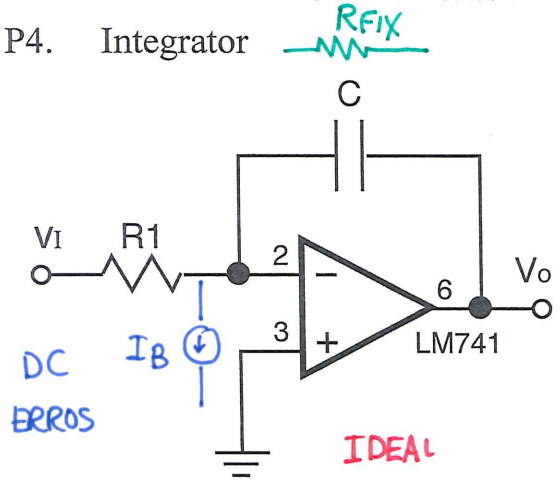
$$R_2 V_T + \frac{R_1}{R_2}L_- = V_R\left(\frac{R_1+R_2}{R_2}\right)$$

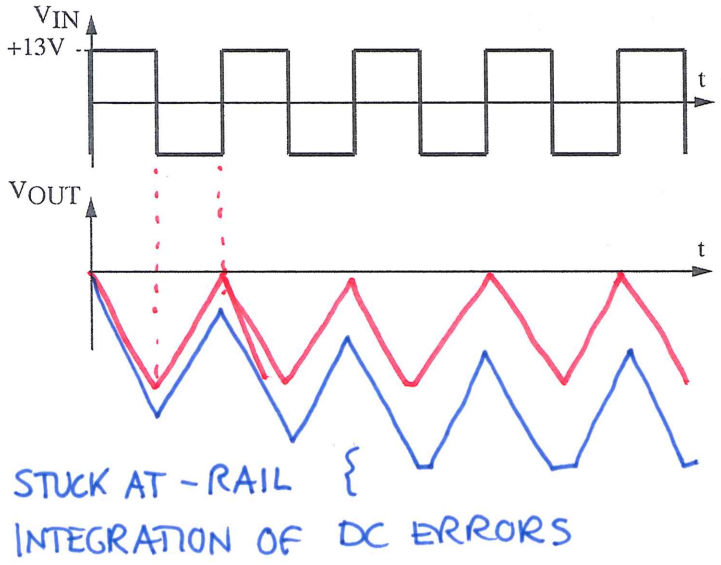
$$V_T = \left(\frac{R_1+R_3}{R_2}\right)V_R - \left(\frac{R_1}{R_2}\right)L_-$$



ECE3204 Lab 2

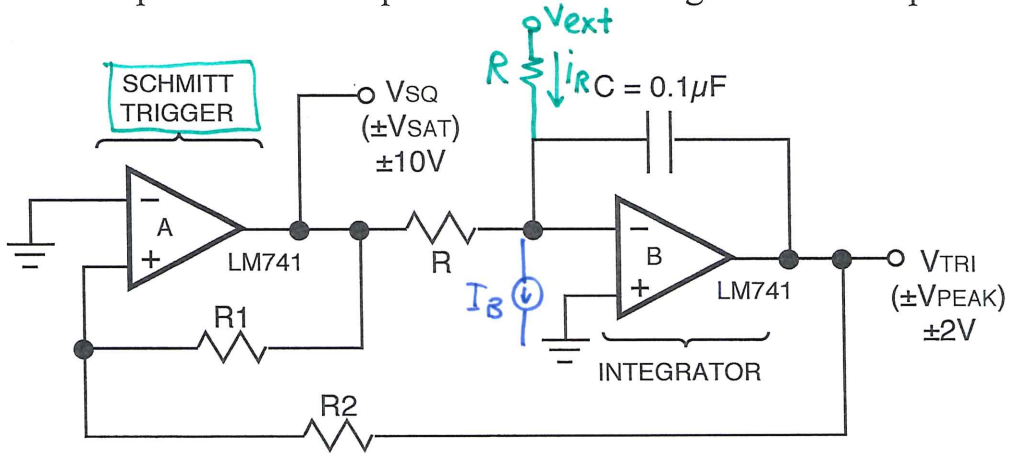
P4. Integrator



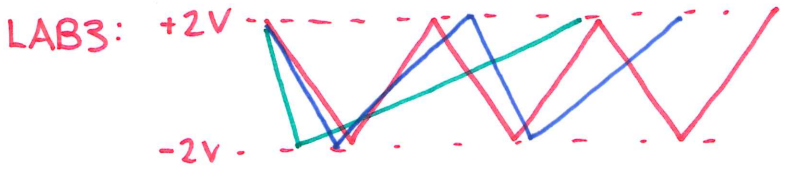


ECE3204 Lab 3

P1. Function generator: Figure 3.1 shows a function generator circuit that produces both square wave and triangular wave outputs.



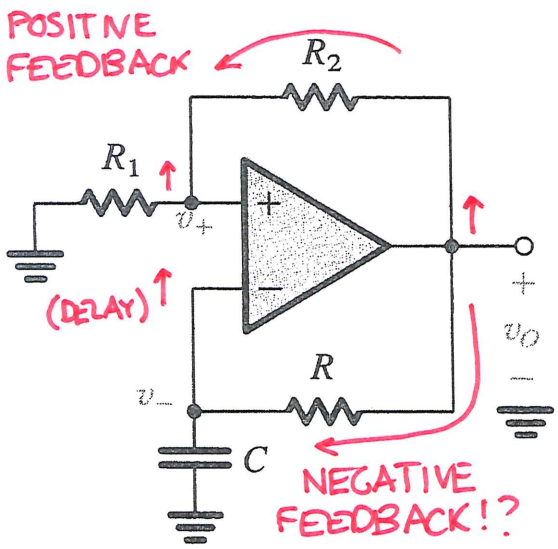
WHY DID WE NOT SEE DC ERROR PROBLEM IN LAB 3?



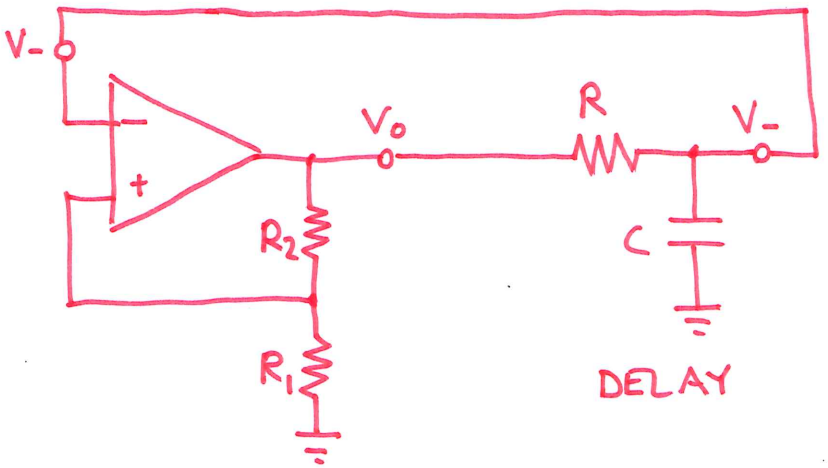
SCHMITT TRIGGER
WATCHING FOR -2V OR +2V

Square Wave Oscillator (17.5)

Figure 17.24



REDRAW



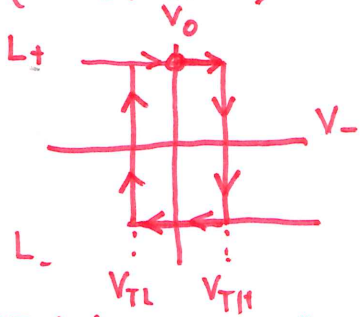
SCHMITT TRIGGER (NONLINEAR)

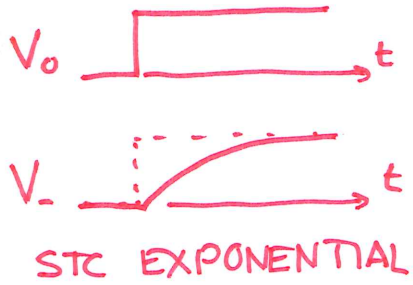
RC LOWPASS

BOTH +, - FEEDBACK:
WHICH ONE WINS?

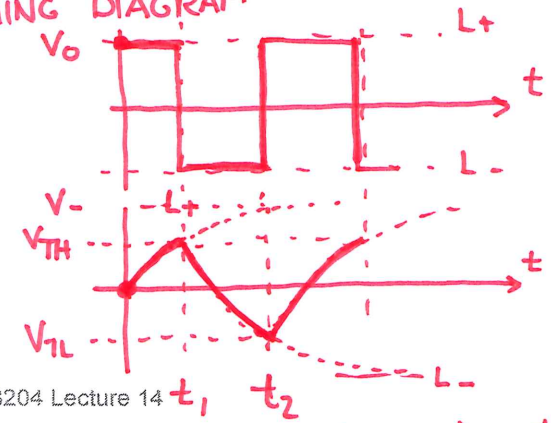
FAST SHORT TERM: SCHMITT TRIGGER WINS

LONGER TERM: $V_- \rightarrow V_+$

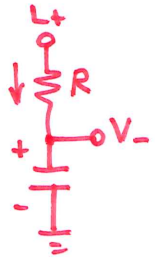




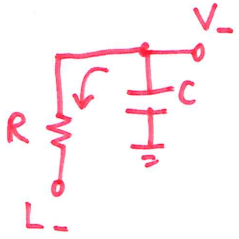
TIMING DIAGRAM



AT $t=0$



AT $t=t_1$



"BIG IDEA" FOR SQUARE WAVE OSCILLATOR

2 STABLE STATES

LINEAR TIME DELAY THAT CONTROLS SWITCHING

$$V(t) = V_F - (V_F - V_I)e^{-t/RC}$$