Comparators

$$V_{out} = A(V_+ - V_-)$$

$$V_{SS} = V_{pos}$$

V_{ref}

V_{in}

R_1

R_2

$-V_{SS} = V_{neg}$

Signal

$V_{+V_{SS}}$

reference

t
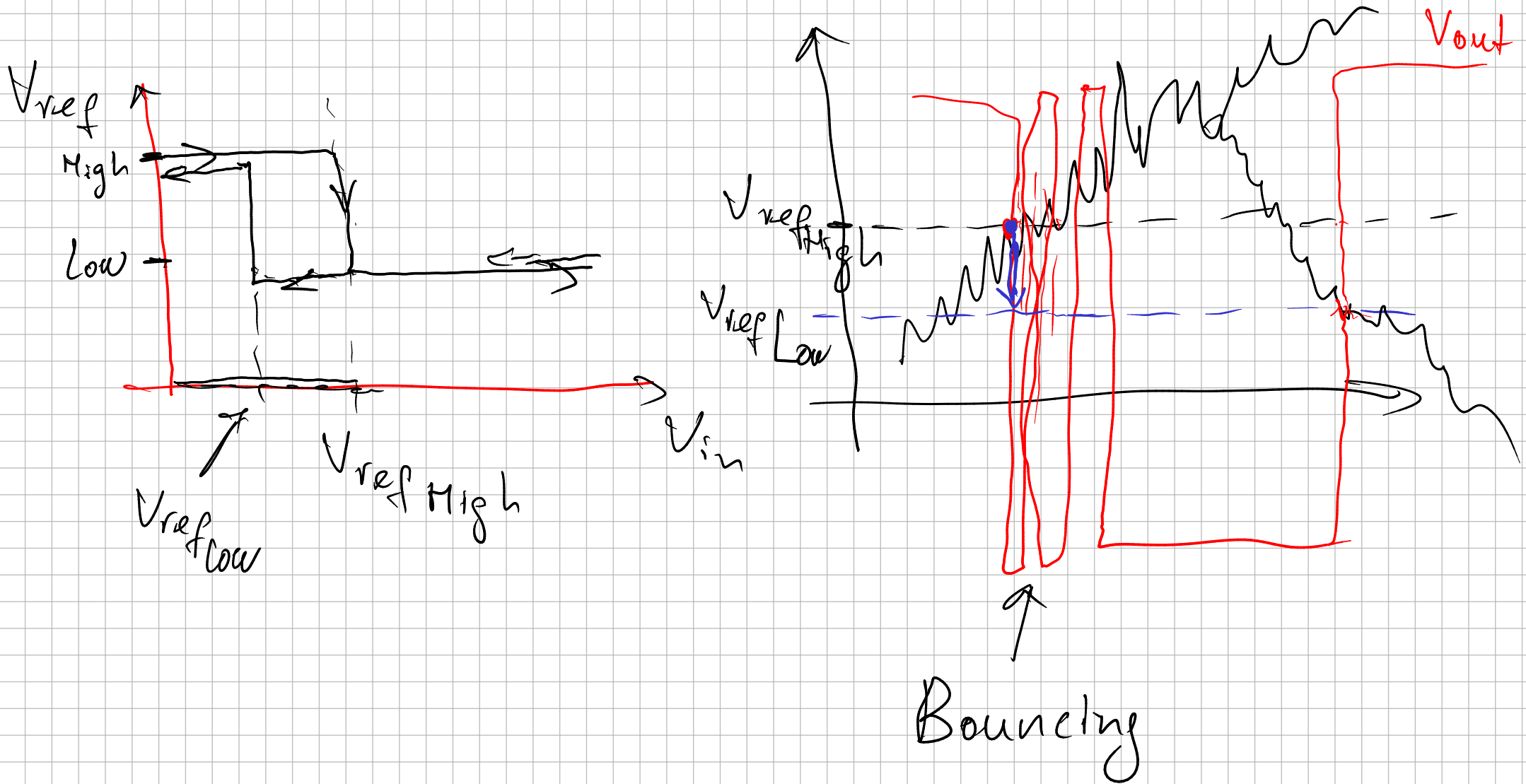
$-V_{SS}$

$$I = \frac{V_{pos} - V_{neg}}{R_1 + R_2}$$
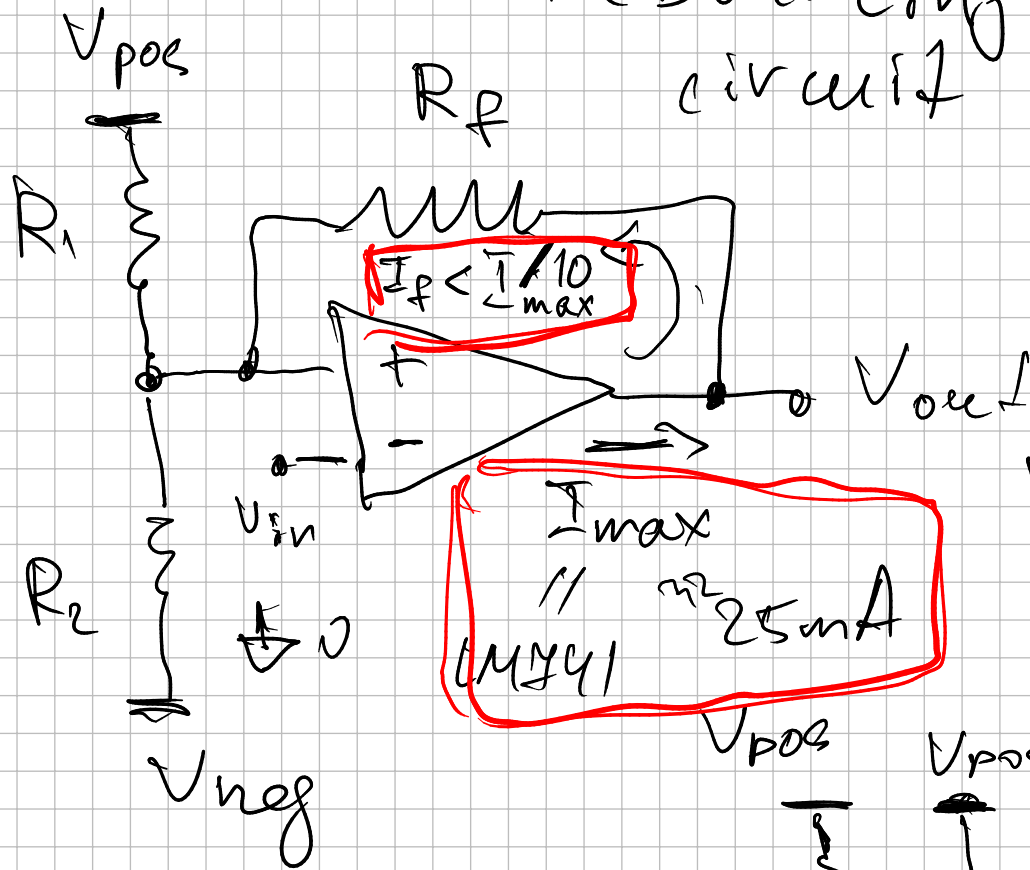
$$I \approx 1\,mA$$

$$V_{ref} = I_o R_2 + V_{neg} = V_{pos} - I R_1$$

Comparator with hysteresis: Schmitt trigger

V_{ref} High

Low

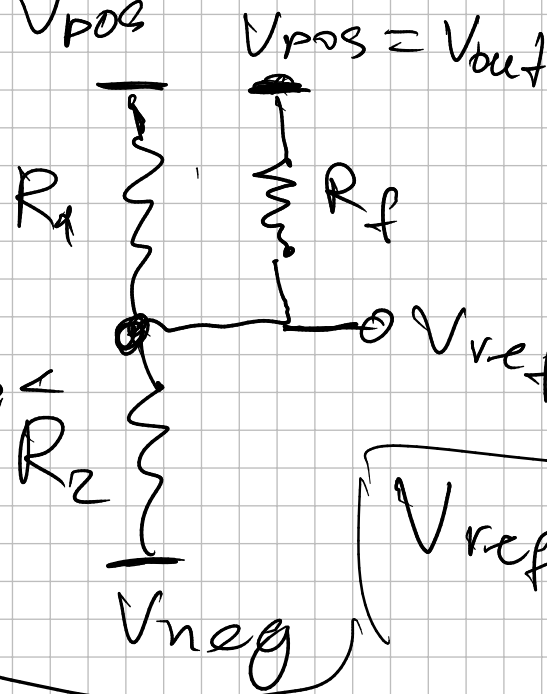$V_{ref\ Low}$

$V_{ref\ High}$

V_{in}

$V_{ref\ High}$

$V_{ref\ Low}$

V_{out}

Bouncing

Debouncing circuit $V_{in} < V_{ref}$

V_{pos}

R_1

R_f

$I_f < I_{max}/10$

$+$

$-$

V_{in}

$\rightarrow 0$

V_{out}

R_2

V_{neg}

$\boxed{\dfrac{I_{max}}{\|} \approx 25mA \\ (LM741)}$

$V_{ref\ high}$

$V_{ref\ mid}$

$V_{ref\ low}$

$V_{ref\ high}$

$V_{ref\ low}$

V_{in}

i

$V_{pos} = V_{out}$

V_{pos}

R_1

R_f

V_{ref}

R_2

V_{neg}

$V_{ref} = \dfrac{V_{pos} - V_{neg}}{R_2 + R_1 \| R_f} \cdot R_2 + V_{neg}$
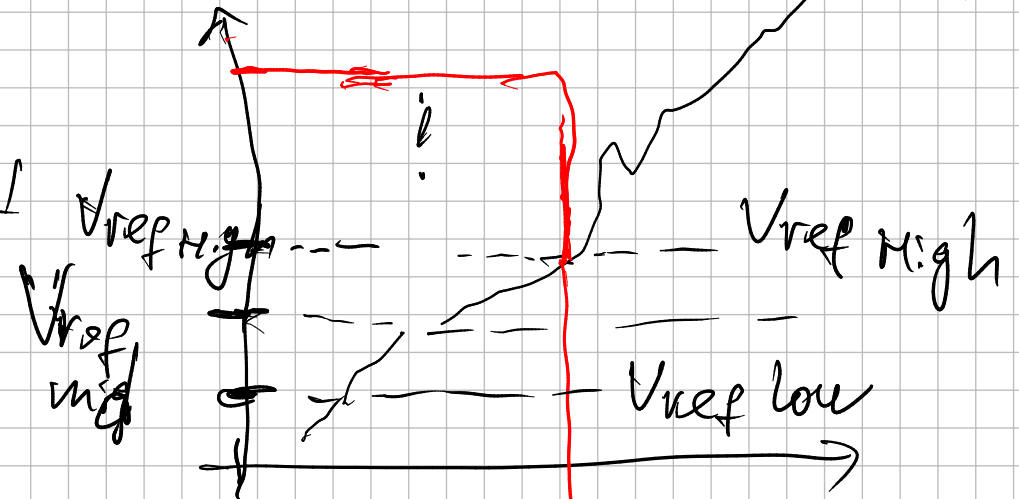
$V_{in} < V_{ref}$

"typical" :

$R_f > 10 (R_1 \text{ or } R_2)$

weak

$V_{ref\ high} - V_{ref\ low} \lesssim 1V$

$\lesssim |V_{pos}|$

$$V_{in} > V_{ref}$$

$$V_{out} = V_{neg}$$

V_{pos}

R_1

R_2

R_f
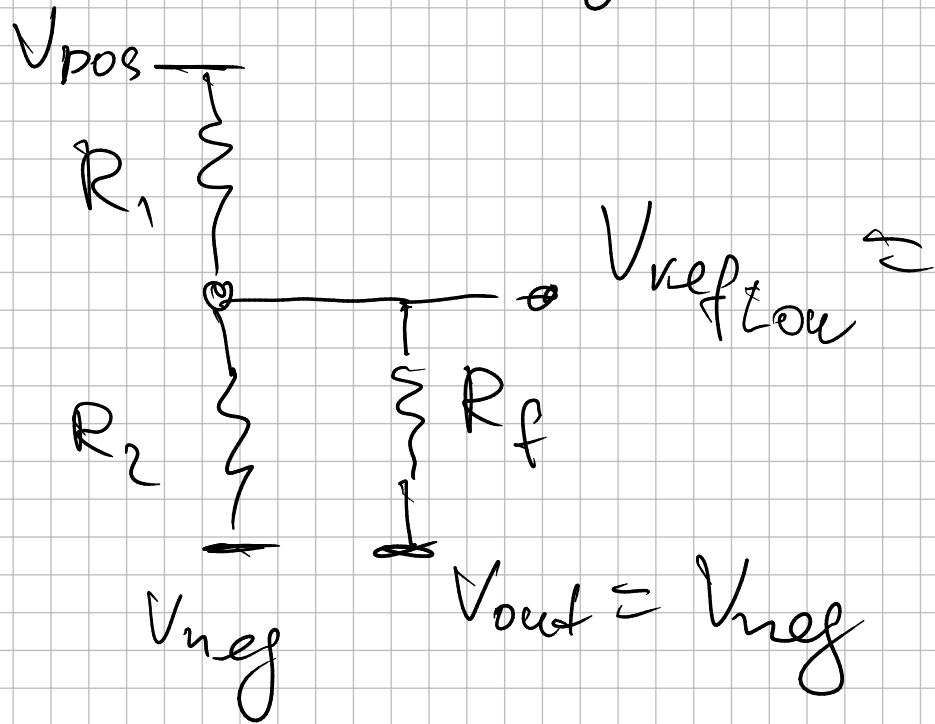
V_{neg}

$V_{out} = V_{neg}$

$$V_{reftou} = \frac{V_{pos} - V_{neg}}{R_1 + R_2 \| R_f} \cdot \left(R_2 \| R_f\right) + V_{neg}$$

Simple Comparator = 0 or High

non Op amp

V_{ref}

R_f

V_{pos}

$R_{pull up}$
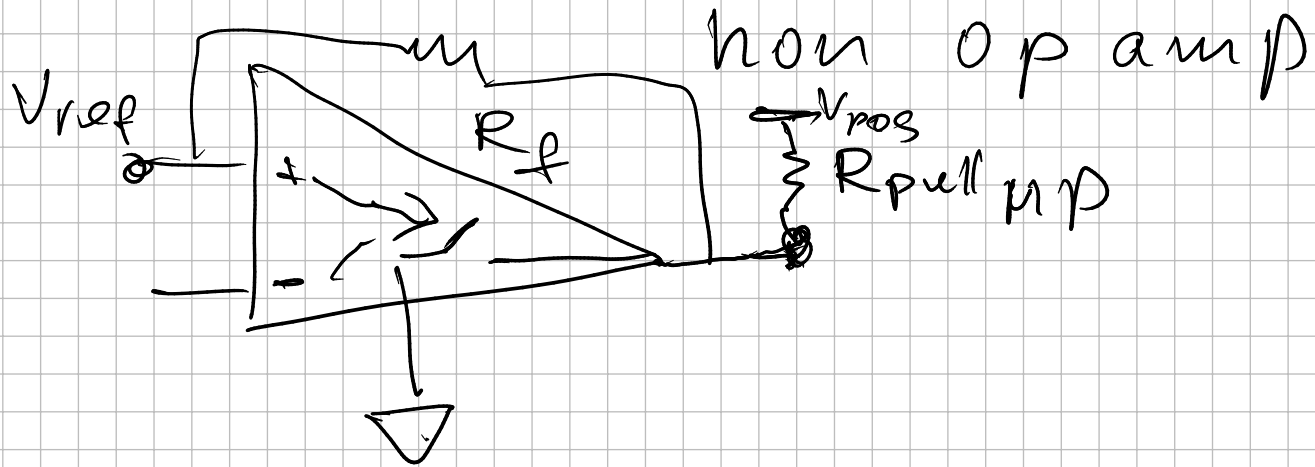
Relaxation oscillator

V_{pos}

R_F

R_1

V_{ref}

R_2

V_{neg}

V_c

R

C

$0V$

V_{out}

t, $V_{out} = V_{pos}$

V_{out}

$V_{ref high}$

$V_{ref low}$

V_c

V_c

t

T
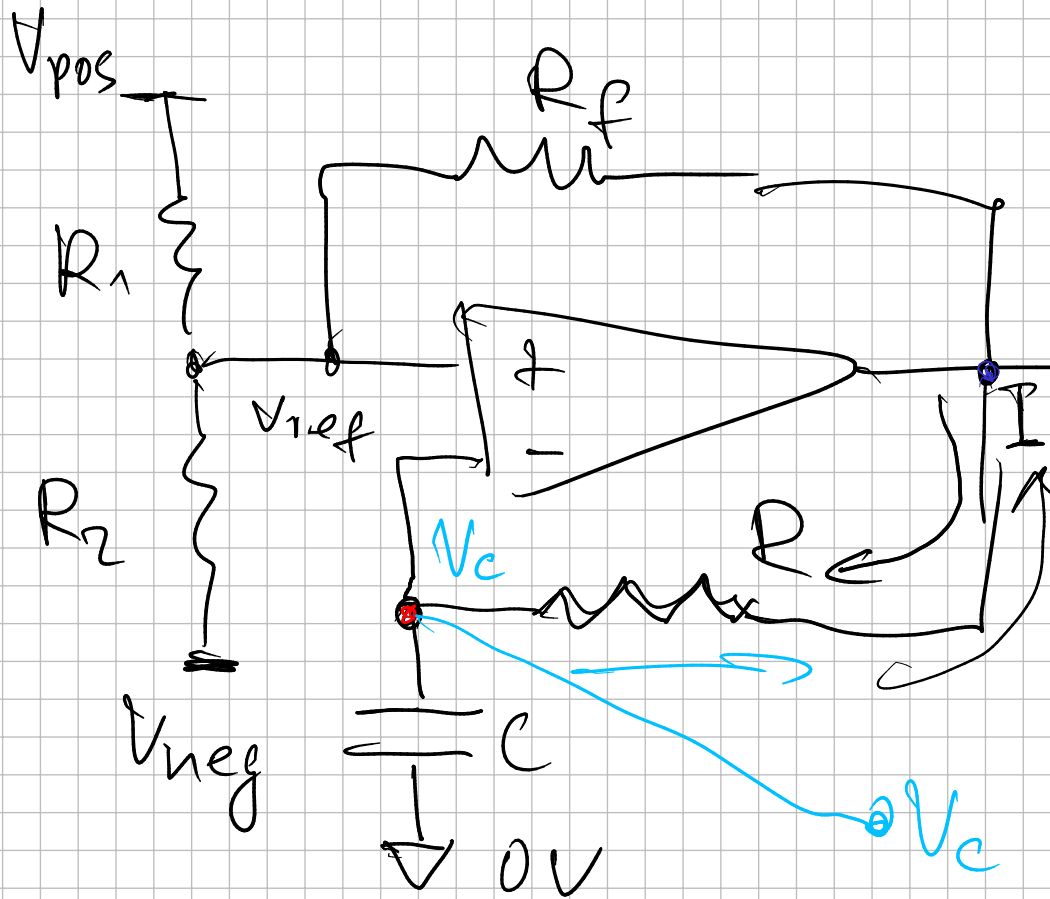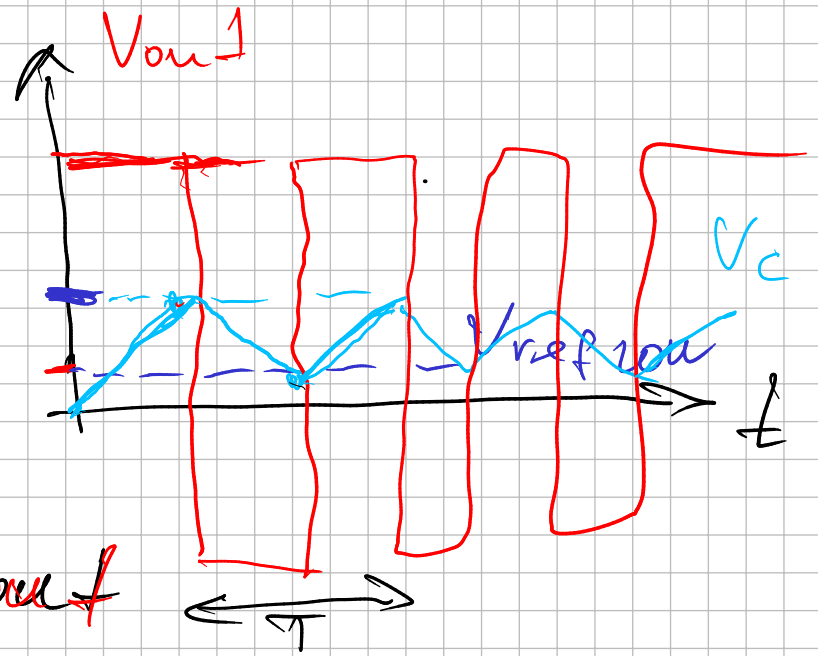
Period of oscillations

$$T = 2RC \cdot \ln\left(\frac{V_{ref\,High} - V_{neg}}{V_{ref\,low} - V_{neg}} \right)$$