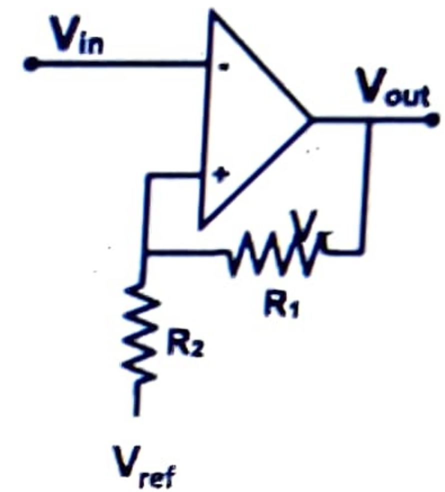
Waveform

Regenerative comparator (Schmitt trigger)

- Input is given to inverting terminal
- Feedback voltage is given to non-inverting terminal
- Input triggers output every time it exceeds certain **voltage levels**
- The voltage levels are
  - Upper threshold voltage (V_{UT})
  - Lower threshold voltage (V_{LT})



Regenerative comparator (Schmitt trigger)

assume that $v^+ > v^-$

- Let, $v_{out} = +V_{sat}$

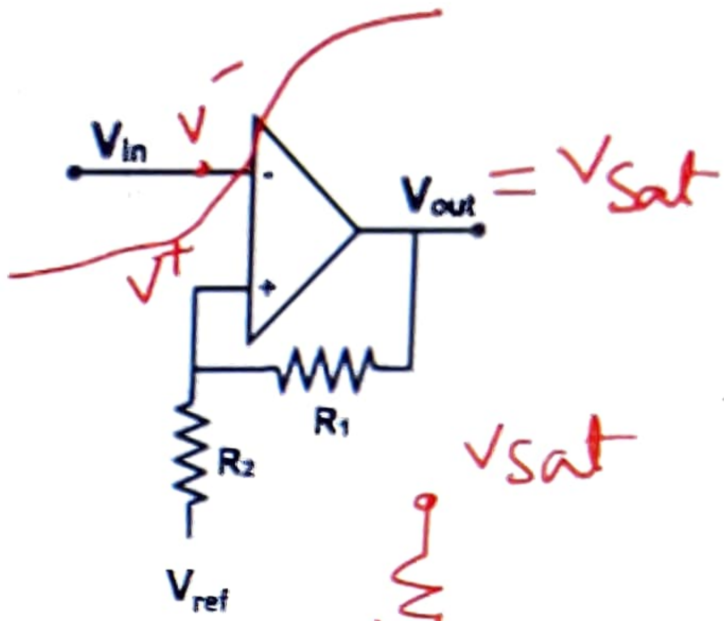
Then, voltage at non-inverting terminal is

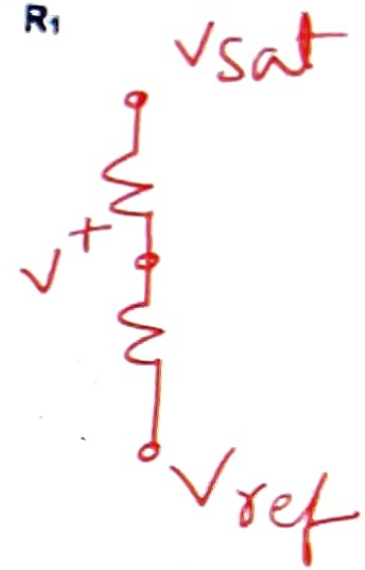
$$\frac{R_1}{R_1+R_2}V_{ref} + \frac{R_2}{R_1+R_2}V_{sat}$$

Let, $v_{out} = -V_{sat}$

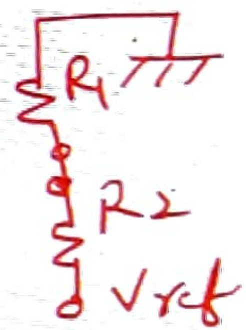
Then, voltage at non-inverting terminal is

$$\frac{R_1}{R_1+R_2}V_{ref} - \frac{R_2}{R_1+R_2}V_{sat}$$

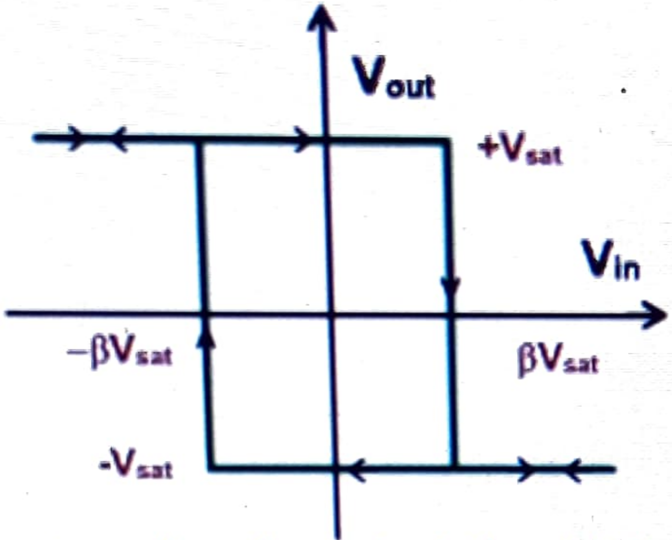




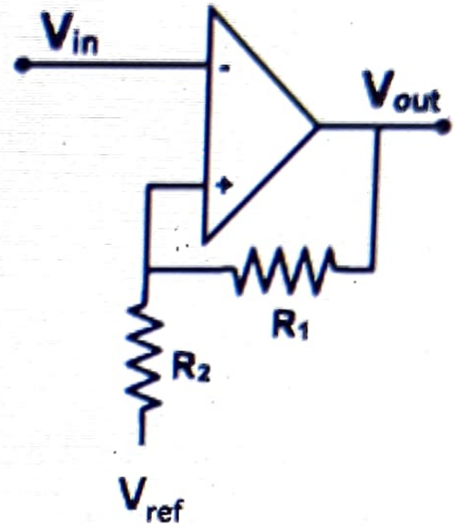
$\frac{R_1 V_{ref}}{R_1+R_2} \leftarrow v^+$



Regenerative comparator (Schmitt trigger)

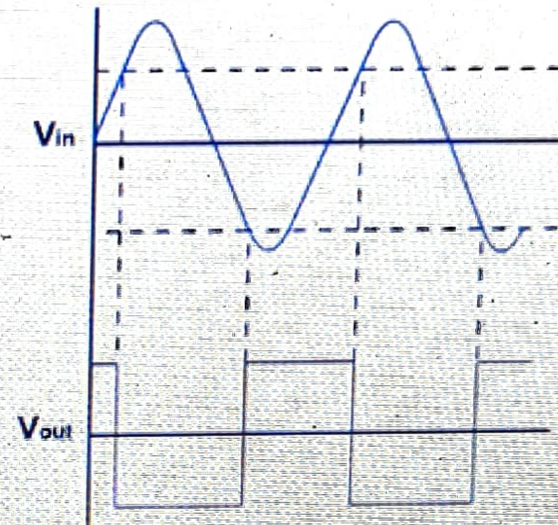


The transfer characteristic of Schmitt trigger circuit



$$V_{UT} = \frac{R_1}{R_1 + R_2} V_{ref} + \frac{R_2}{R_1 + R_2} V_{sat}$$

$$V_{LT} = \frac{R_1}{R_1 + R_2} V_{ref} - \frac{R_2}{R_1 + R_2} V_{sat}$$



If sinusoidal input is given, square wave results

In the circuit of Schmitt trigger of Fig. 5.8 (a), $R_2 = 100\ \Omega$, $R_1 = 50\ k\Omega$, $V_{ref} = 0V$, $v_i = 1V_{pp}$ (peak-to-peak) sine wave and saturation voltage $= \pm 14V$. Determine threshold voltages V_{UT} and V_{LT}.

Solution

From Eqs. (5.1) and (5.2)

$$V_{UT} = \frac{100}{50100} \times 14 = 28 \text{ mV}$$

$$V_{LT} = \frac{100}{50100} \times (-14) = -28 \text{ mV}$$

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etails ^

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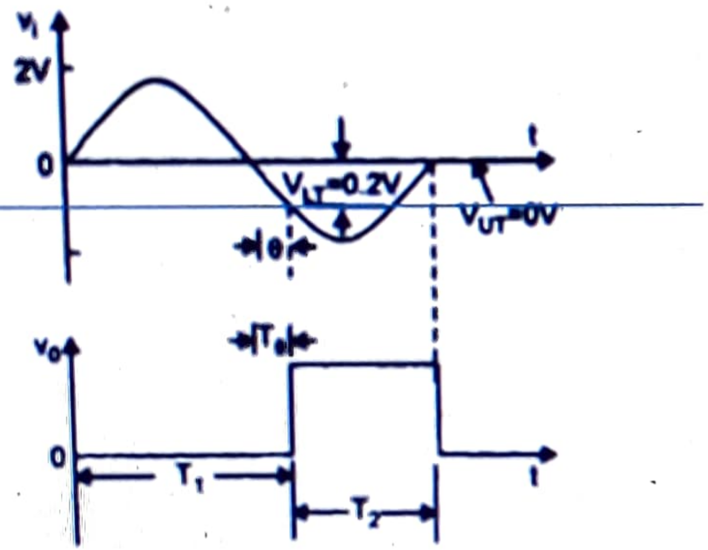
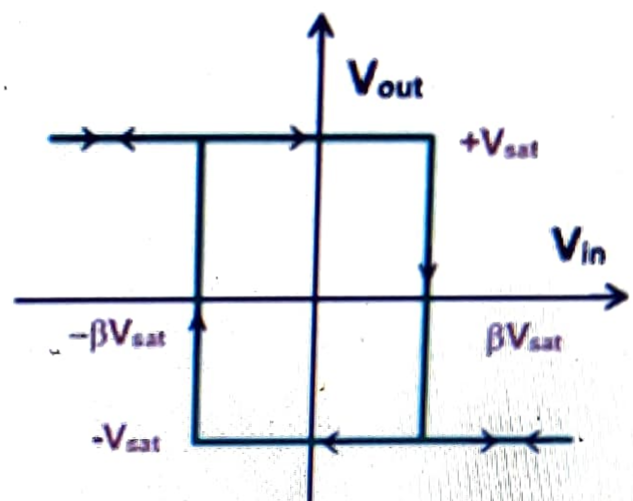
A Schmitt trigger with the upper threshold level $V_{UT} = 0V$ and hysteresis width $V_H = 0.2V$ converts a 1 kHz sine wave of amplitude $4V_{pp}$ into a square wave. Calculate the time duration of the negative and positive portion of the output waveform.





$$V_{UT} = 0$$

$$V_H = V_{UT} - V_{LT} = 0.2 \text{ V}$$

So, $$V_{LT} = -0.2 \text{ V}$$

the angle θ can be calculated as

$$-0.2 = V_m \sin(\pi + \theta) = -V_m \sin\theta = -2\sin\theta$$

$$\theta = \arcsin 0.1 = 0.1 \text{ radian}$$

The period, $T = 1/f = 1/1000 = 1$ ms

$$\omega T_\theta = 2\pi(1000)\, T_\theta = 0.1$$

$$T_\theta = (0.1/2\pi) \text{ ms} = 0.016 \text{ ms}$$

So, $$T_1 = T/2 + T_\theta = 0.516 \text{ ms}$$

and $$T_2 = T/2 - T_\theta = 0.484 \text{ ms}$$