Comparators

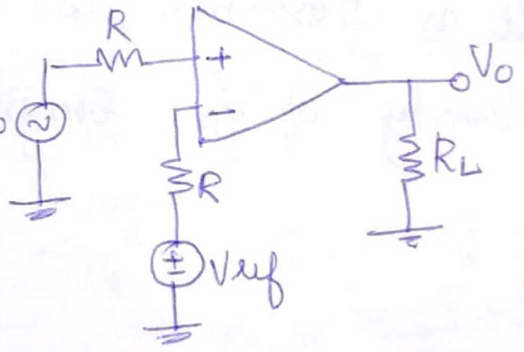
A comparator which compares a signal voltage applied at one i/p of an op-amp with a known ref. voltage at the other i/p. It is basically an open loop op-amp with o/p ±Vsat depending on which i/p is larger.

Basically two types of comparators are there

① Non-inverting comparator
② Inverting Comparator

Non-inverting comparator

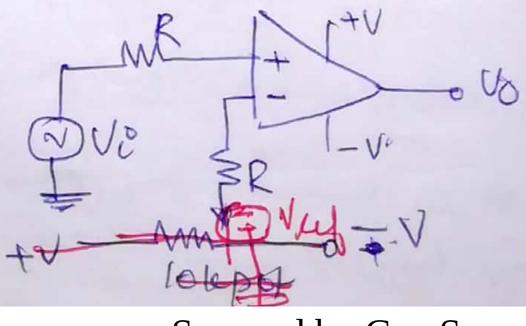
A fixed ref. voltage is applied to −ve i/p and a time varying signal V_i is applied to +ve i/p.



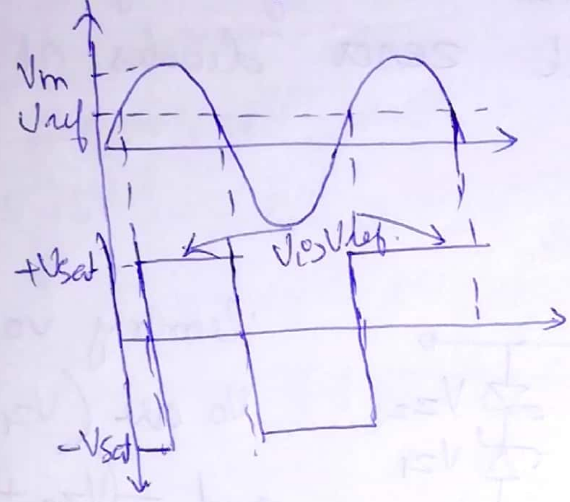
For $V_i < V_{ref}$ $\quad V_o = -V_{sat}$

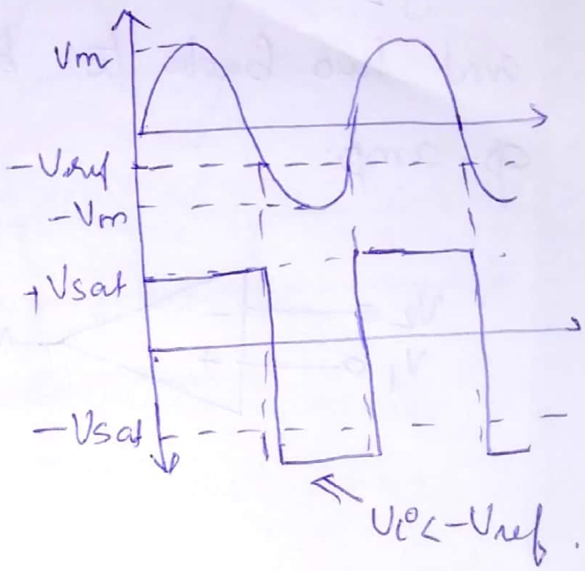
$V_i > V_{ref}$ $\quad V_o = +V_{sat}$.

In a practical ckt Vref can be obtained by using a 10kΩ pot

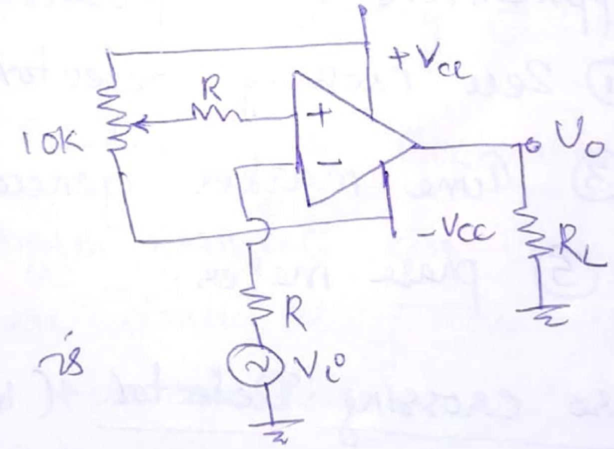


The o/p waveform for +ve Vref and -ve Vref are shown in fig



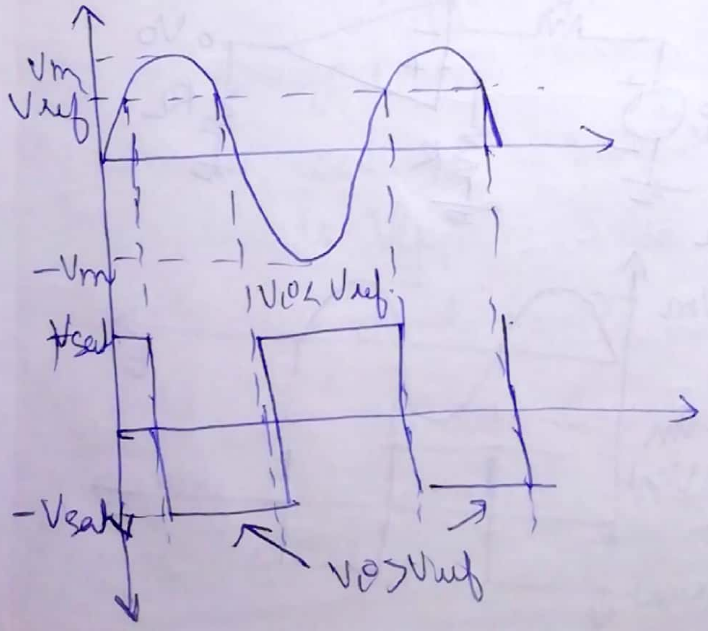


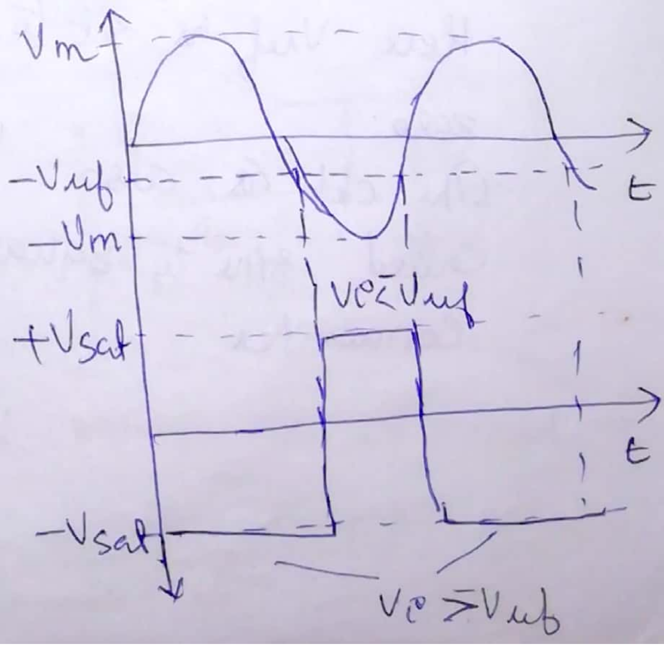
Inverting Comparator



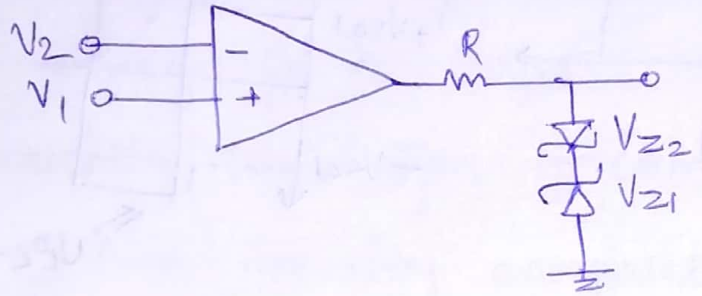
Vref is applied to the +ve terminal. and Vi is the -ve terminal.

The o/p waveform is shown in fig





o/p voltage levels independent of power supply voltages can also be obtained by using a resistor R and two back to back zener diodes at the o/p of op-amp.

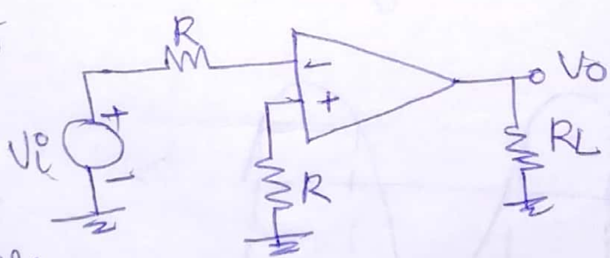


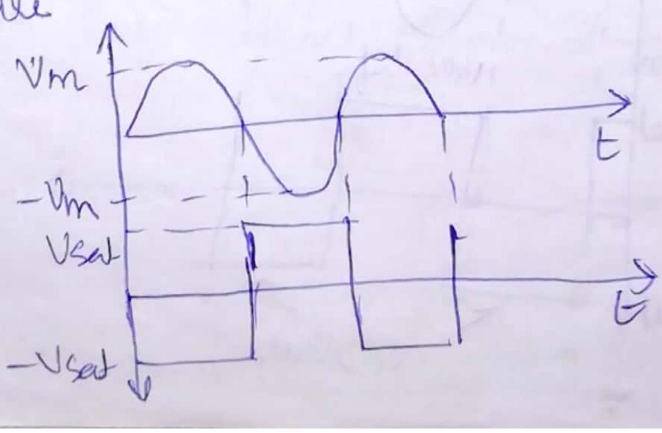
limiting voltages of V_0 are $(V_{Z_1}+V_D)$ and $-(V_{Z_2}+V_D)$ when $V_D \simeq 0.7V$.

Applications of comparators are
① Zero crossing detector ② Window detector
③ Time marker generator ④ Time marker genera
⑤ phase meter.

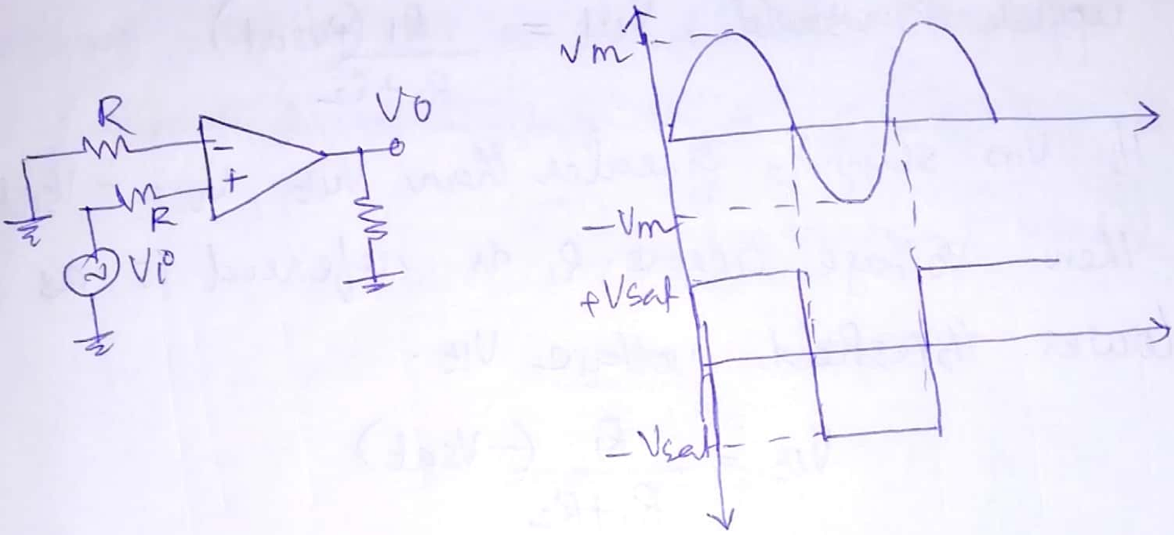
Zero crossing Detector (Inverting)

Here V_{ref} is set to zero.
The ckt is also called sine to square converter





Non inverting zero crossing detector



Comparator characteristics

The important characteristics of comparator are

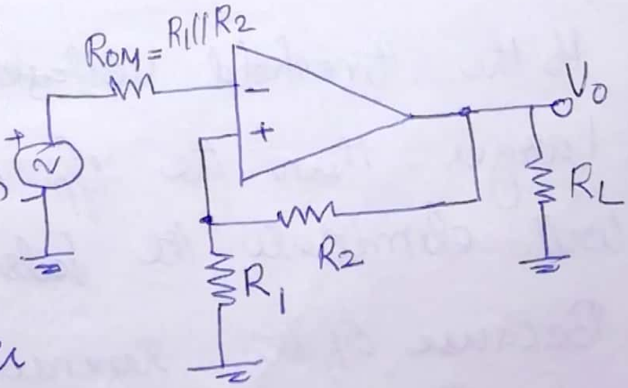
1. Speed of operation ② Accuracy ③ Compatibility of o/p

limitation levels

Schmitt Trigger (Regenerative Comparator)

Schmitt trigger converts an irregular shaped waveform to a square wave or pulse. It is an inv. comparator with +ve feedback.

The i/p Vin triggers the o/p Vo every time it exceeds certain voltage levels Upper threshold V_{UT} and lower threshold V_{LT}. These threshold voltages are obtained by using the voltage divider $R_1 - R_2$ where voltage across R_1 fed back to the +ve i/p.



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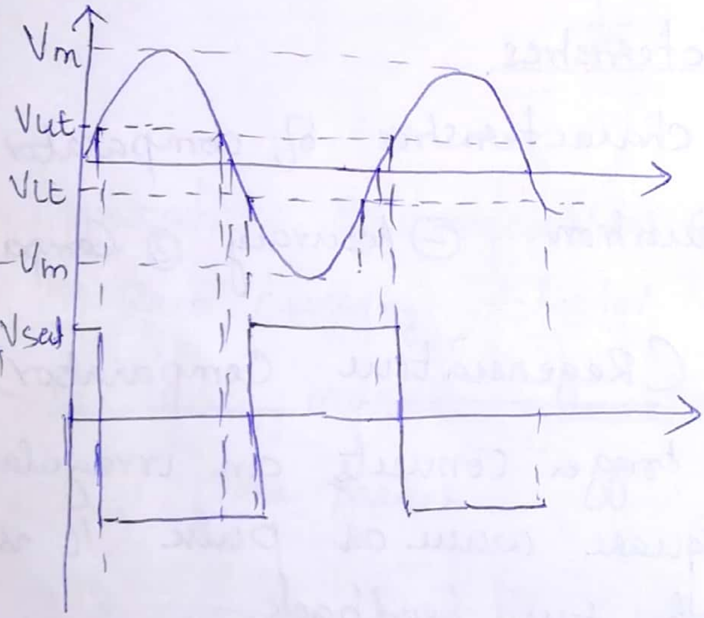
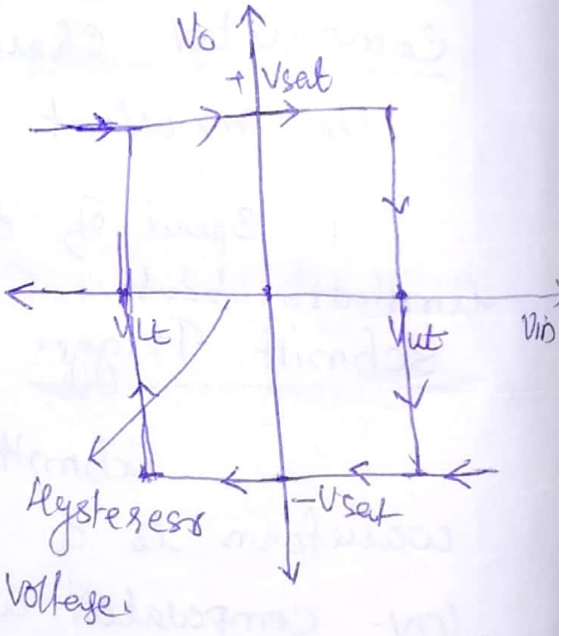
when $V_o = +V_{sat}$ Voltage across R_1 is called upper threshold, $V_{ut} = \frac{R_1 (+V_{sat})}{R_1 + R_2}$.

If V_{in} slightly greater than V_{ut}, $V_o = -V_{sat}$. then voltage across R_1 is refereed to as the lower threshold voltage V_{lt}.

$$V_{lt} = \frac{R_1}{R_1 + R_2} (-V_{sat})$$





If the threshold voltages Vut and VLt are made larger than the i/p noise voltages, the +ve feedb will eliminate the false o/p transitions.

Because of the regenerative action of +ve feedback Vo switch faster between +Vsat and -Vsat.

when i/p triangular wave o/p of schmitt trigger is square wa
" " Saw tooth " " pulse waveform

The comparator with +ve feedback said to exhibit hysteresis; a deadband condition

The hysteresis voltage $V_{hy} = V_{ut} - V_{lt}$

$$= \frac{R_1}{R_1+R_2}\left[+V_{sat} - (-V_{sat})\right]$$

$$= \frac{R_1 (2V_{sat})}{R_1+R_2}$$

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