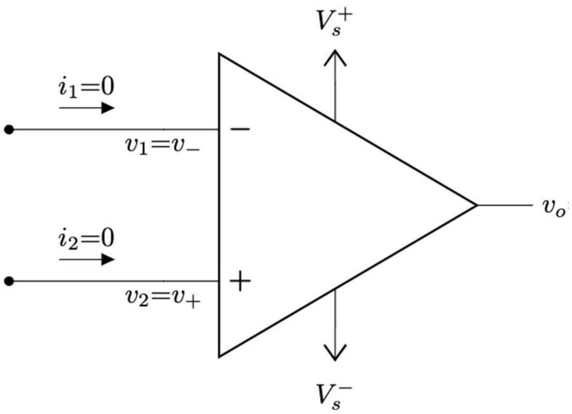
VTC (Voltage Transfer Characteristics):

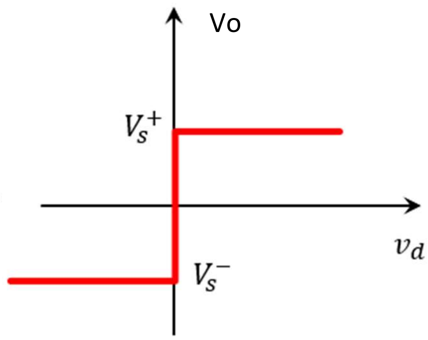
Y axis→ output voltage, X axis→ Input voltage

Ideal Op-Amp VTC:

Y axis→ output voltage= **Vo**, X axis→ Input voltage= Vd

Differential voltage, Vd= $(V_+) - (V_-)$ = V2-V1



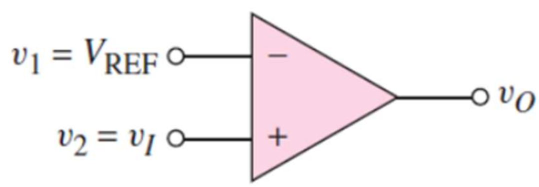


VTC of ideal op amp

$$v_o = \begin{cases} V_s^+ \; if \; v_d > 0 \Rightarrow v_2 > v_1 \\ V_s^- \; if \; v_d < 0 \Rightarrow v_2 < v_1 \end{cases}$$

Non-inverting comparator VTC:

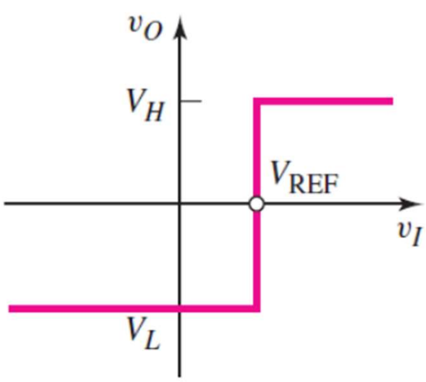
A non-*inverting comparator* is an op-amp based *comparator* for which a reference voltage (V_{REF}) is applied to the inverting terminal and the input voltage (V_I) is applied to the **non-inverting terminal**



Y axis→ output voltage= **Vo**, X axis→ Input voltage= V_I

V_H= V_{S+}= V_{CC}

V_L= V_{S-}= -V_{CC}



$$\boldsymbol{v_o = \begin{cases} V_s^+ \; if \; v_d > 0 \Rightarrow V_I - V_{REF} > 0 \Rightarrow V_I > V_{REF} \\ V_s^- \; if \; v_d < 0 \Rightarrow < V_I - V_{REF} < 0 \Rightarrow V_I < V_{REF} \end{cases}}$$

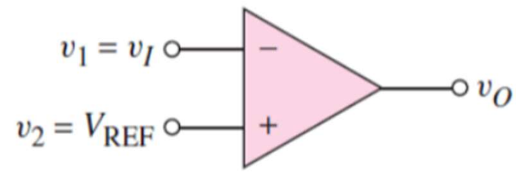
If V_I is a sine/triangular/square wave or DC signal, the VTC graph would be same. **The graph would change if V_{REF} changes.**

Now, try to draw the VTC of non-inverting op-amp when-

a) V_{REF}= 3V, b) V_{REF}= -2V

Inverting comparator VTC:

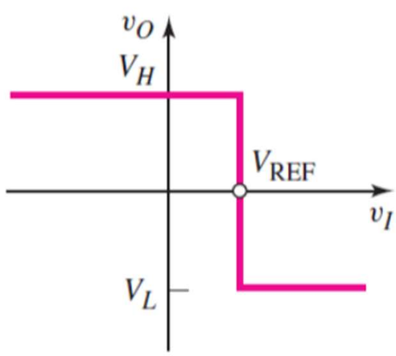
An *inverting comparator* is an op-amp based *comparator* for which a reference voltage (V_{REF}) is applied to the non-inverting terminal and the input voltage (V_I) is applied to the **inverting terminal**



Y axis→ output voltage= **Vo**, X axis→ Input voltage= V_I

$V_H = V_{S+} = V_{CC}$

$V_L = V_{S-} = -V_{CC}$



$$v_o = \begin{cases} V_s^+ \text{ if } v_d > 0 \Rightarrow V_{REF} - V_I > 0 \Rightarrow V_I < V_{REF} \\ V_s^- \text{ if } v_d < 0 \Rightarrow < V_{REF} - V_I < 0 \Rightarrow V_I > V_{REF} \end{cases}$$

(Opposite graph of non-inverting comparator VTC)

If V_I is a sine/triangular/square wave or DC signal, the VTC graph would be same. **The graph would change if V_{REF} changes.**

Now, try to draw the VTC of inverting op-amp when

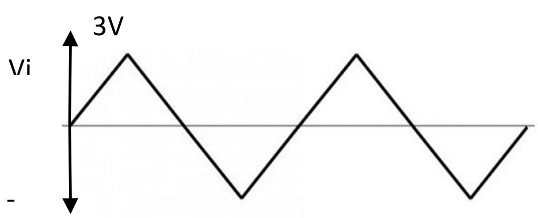
a) V_{REF}= 4V, b) V_{REF}= -3V

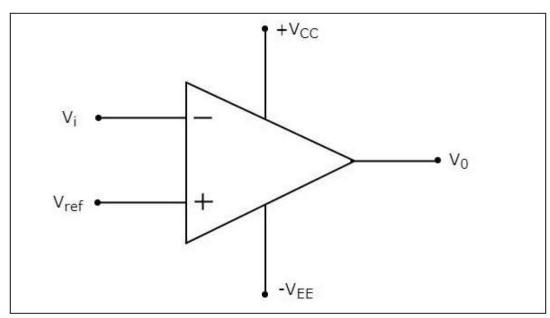
Waveform Graph:

Y axis→ Voltage/Current, X axis→ time

Q1: V_{CC}= 15V= V_{EE}, Vref= 1V, Vi is a 6V p-p triangular signal as shown below

Draw output Vo for the following op-amp circuit.



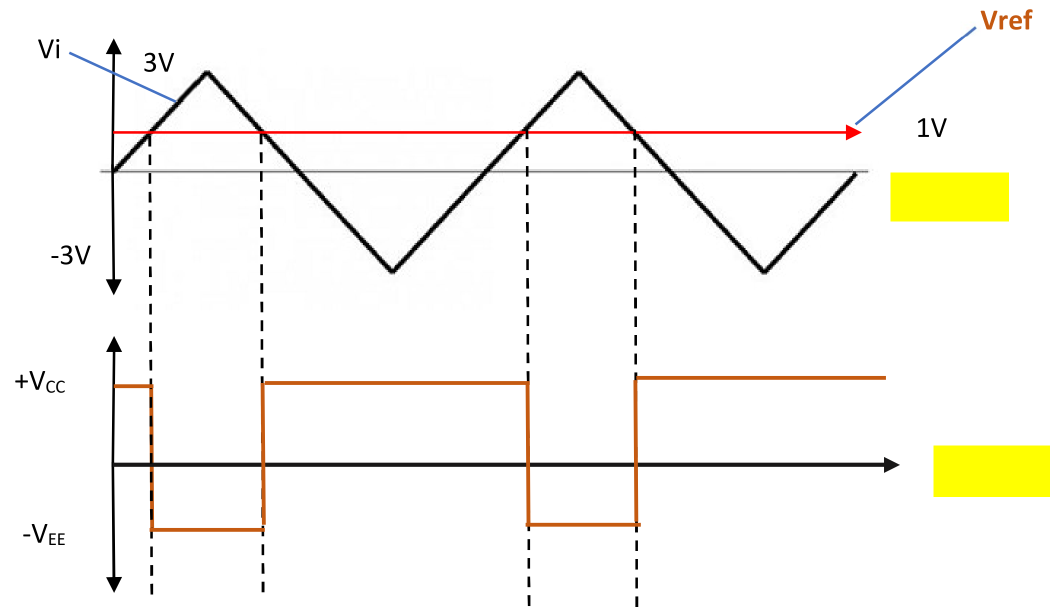


Sol:

Vi (input voltage) in the -ve terminal & Vref (reference voltage) in the +ve terminal → inverting comparator. So,

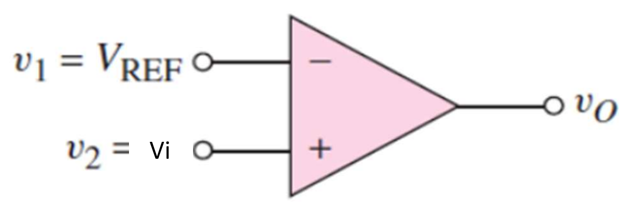
$$V_o = \begin{cases} +V_{CC} \text{ if } v_d > 0 \Rightarrow V_{ref} - V_i > 0 \Rightarrow V_i < V_{ref} \\ -V_{EE} \text{if } v_d < 0 \Rightarrow < V_{ref} - V_i < 0 \Rightarrow V_i > V_{ref} \end{cases}$$

[Here, drawing output Vo means drawing waveform graph of Vo vs time not VTC graph.]



Q1: $V_{s+} = 15V = V_{S-}$, $V_{REF} = 1V$, Vi is a 6V p-p sinusoidal signal.
Draw output Vo for the following op-amp circuit

Sol:
Vi (input voltage) in the +ve terminal & V_{REF} (reference voltage) in the -ve terminal → non-inverting comparator. So,



$$v_o = \begin{cases} V_s^+ \ \mathbf{if}\ v_d > 0 \Rightarrow V_i - V_{REF} > 0 \Rightarrow V_i > V_{REF} \\ V_s^- \ \mathbf{if}\ v_d < 0 \Rightarrow < V_i - V_{REF} < 0 \Rightarrow V_i < V_{REF} \end{cases}$$