15ECE381 Circuits and Communication Laboratory /

15ECE383 Linear Integrated Circuits Laboratory

B. Tech (ECE and EIE) – V Semester

Experiment 5

Schmitt Trigger

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SECTION : ECE-C

GROUP : C2

AIM:

To design a circuit to implement the given VTC curve using an Op-Amp. This is basically to design a Schmitt Trigger based on the given threshold values.

Instructions:

1. All resistors used in your design should be from the E24 series
2. You may make use power supplies of ±10 V.
3. Please ensure proper polarity for the connections to the power supply pins (4 and 7) of the opamp. Wrong polarity may cause the opamp to explode.

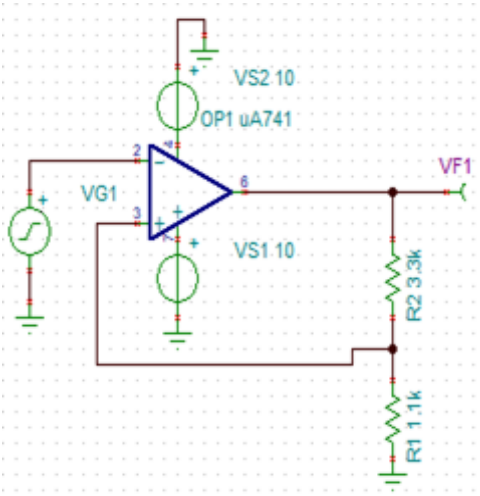
Questions:

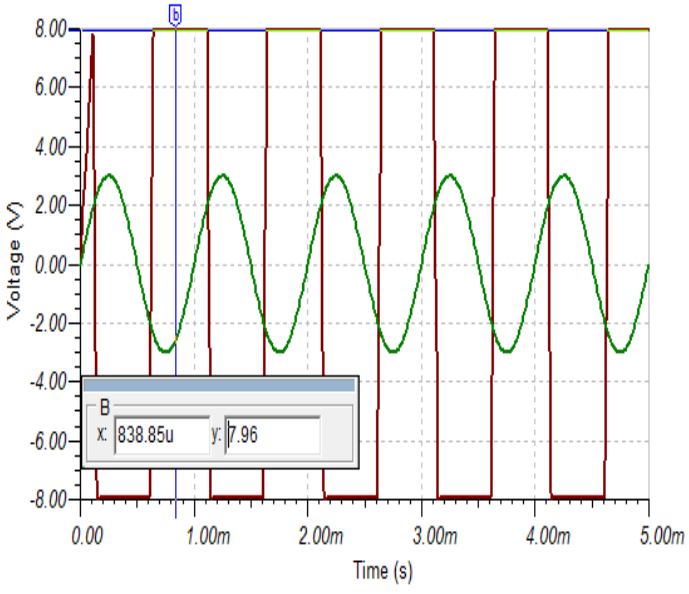
1. Design and implement a circuit to obtain the following transfer characteristics with

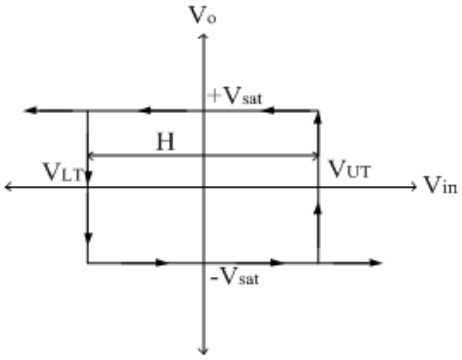
   V_{UT}, V_{LT} = {2.5, -1.5}

ANS:

We have taken Saturation Voltage as 8volts (8volts is taken from simulation)





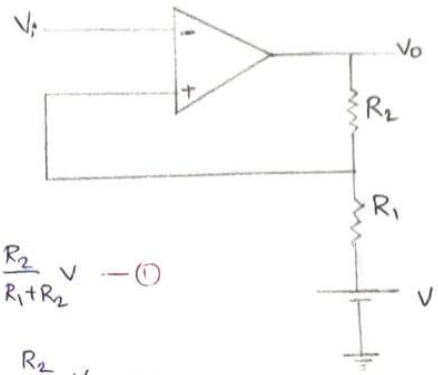


Design :

Given

$V_{UT} = 2.5V$

$V_{LT} = -1.5V$



WKT,

$$V_{UT} = \frac{R_1}{R_1+R_2} V_{sat} + \frac{R_2}{R_1+R_2} V \quad -(1)$$

$$V_{LT} = \frac{-R_1}{R_1+R_2} V_{sat} + \frac{R_2}{R_1+R_2} V \quad -(2)$$

(1) - (2)

$$V_{UT} - V_{LT} = \frac{2R_1}{R_1+R_2} V_{sat}$$

$V_{sat} = 8V$ (taken from simulation)

$$2.5 - (-1.5) = \frac{2R_1}{R_1+R_2}(8)$$

$$4 = \frac{16R_1}{R_1+R_2} \Rightarrow R_1+R_2 = 4R_1 \Rightarrow \boxed{R_2 = 3R_1}$$

as from the E24 series,

$\boxed{R_1 = 1.1K \text{ ohms}}$

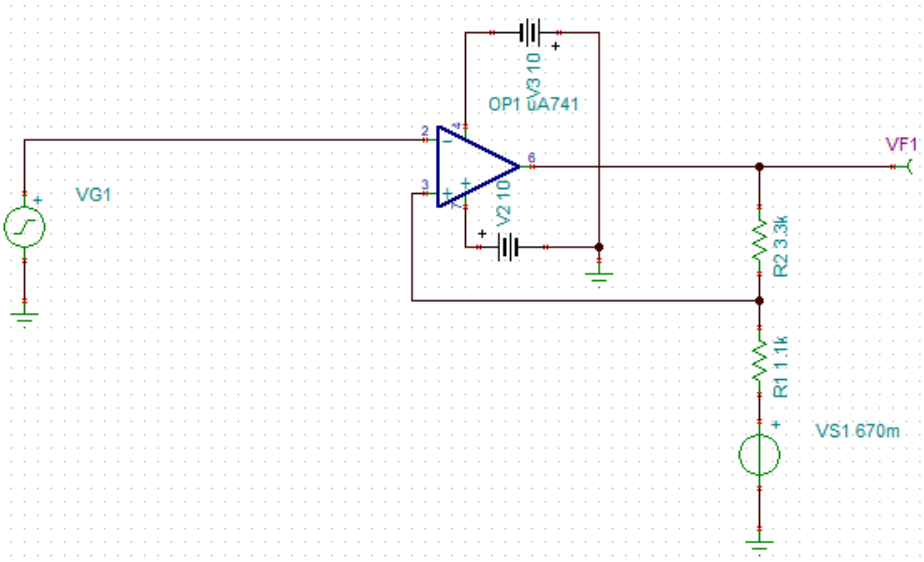
$\boxed{R_2 = 3.3K \text{ ohms}}$ —(3)

Now, (3) in (1)

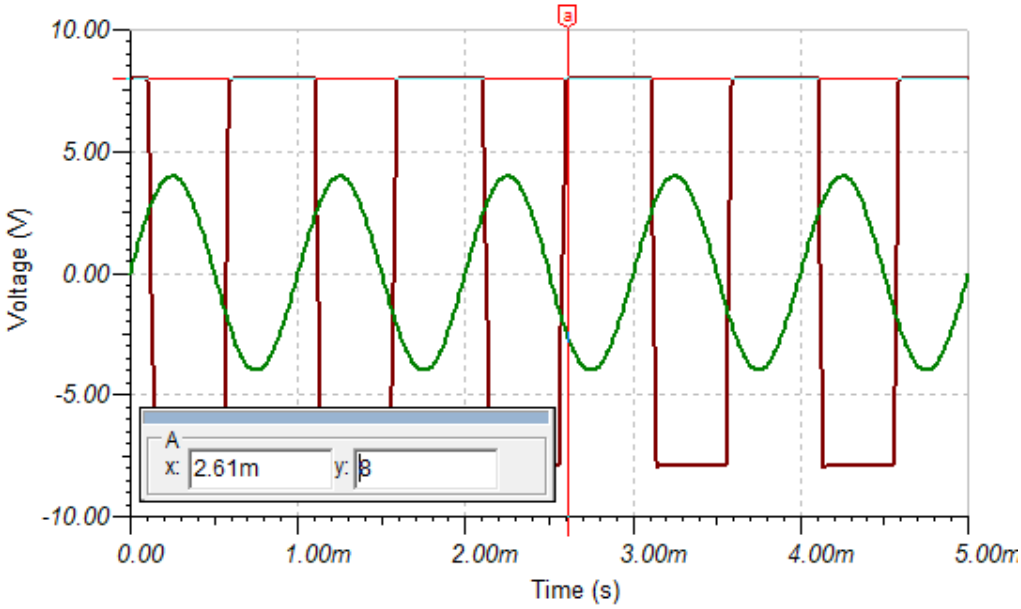
$$2.5 = \frac{1.1K}{R_1+3R_1}(8) + \frac{R_2}{R_1+3R_1}V = \frac{1.1K(8)}{4R_1} + \frac{R_2}{4R_1}V$$

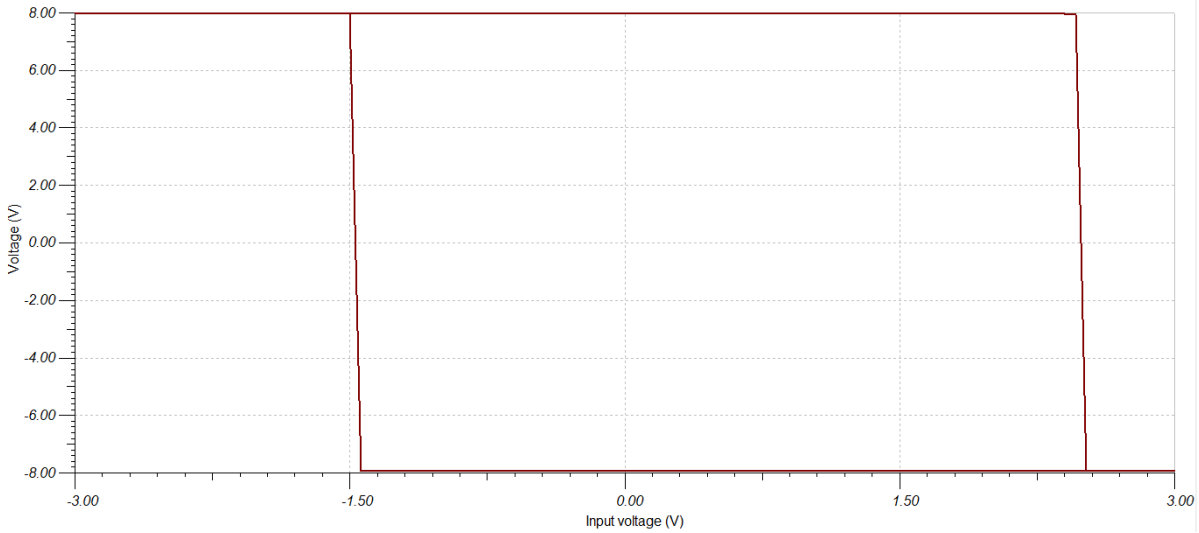
$$2.5 = \frac{8}{4} + \left(\frac{3}{4}\right)V \Rightarrow 2 = 3V \Rightarrow \boxed{V = 2/3 = 0.67V}$$

Circuit:



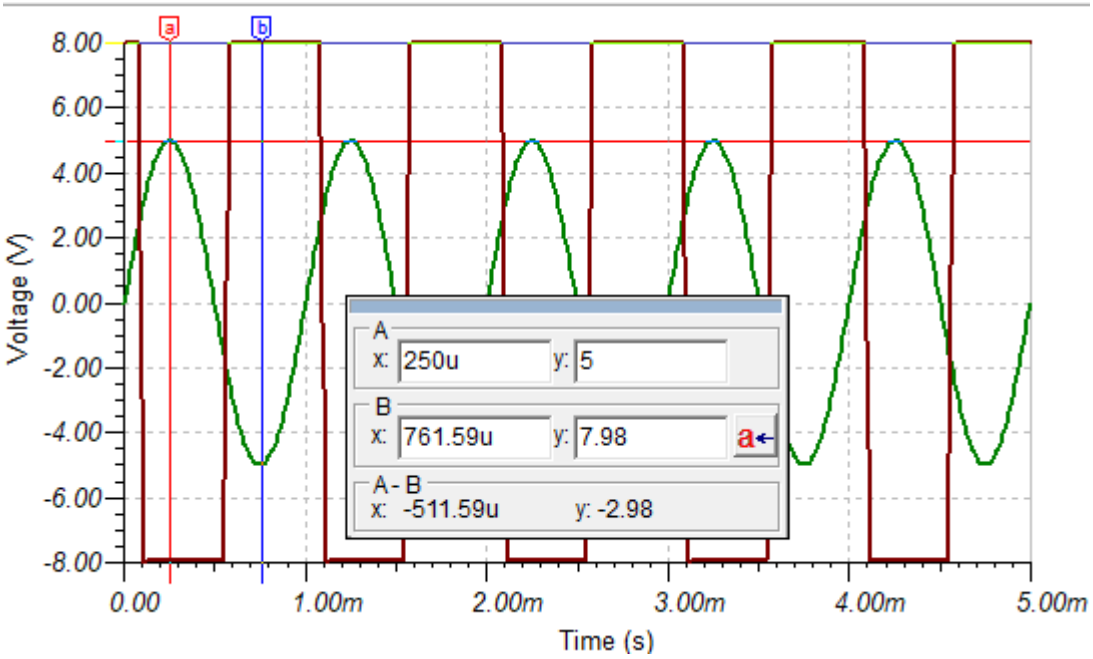
Working:



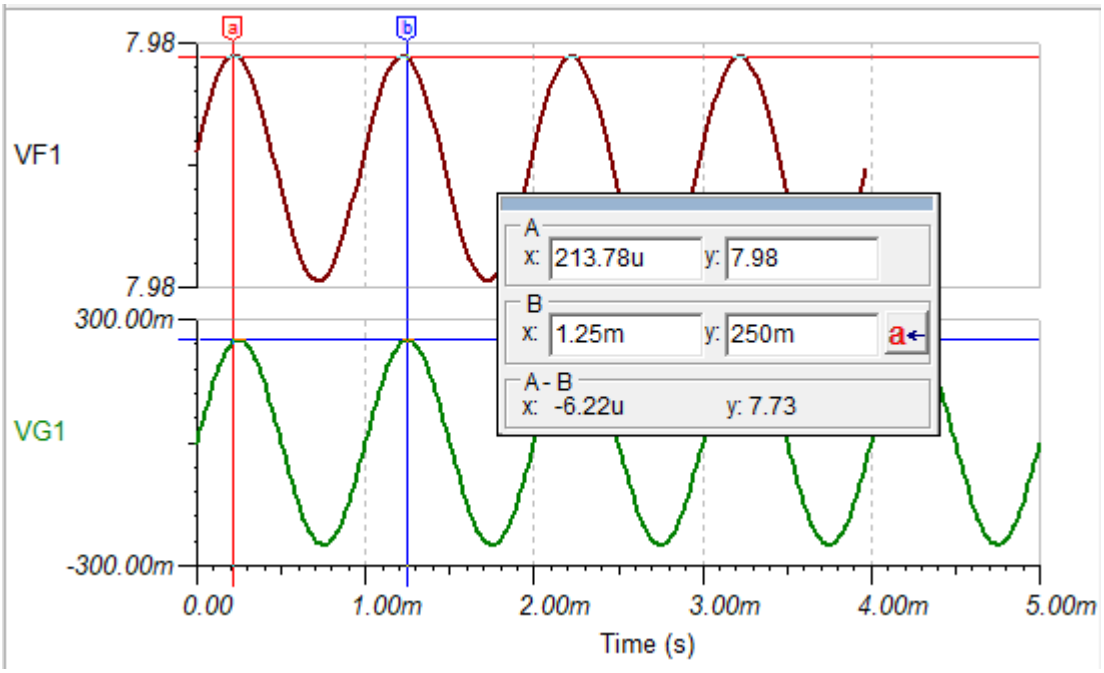


2. Plot the input and output waveforms for input amplitudes of approximately 5 V, 250 mV, V_{UT} , and V_{LT} with freq.of 1 KHz.

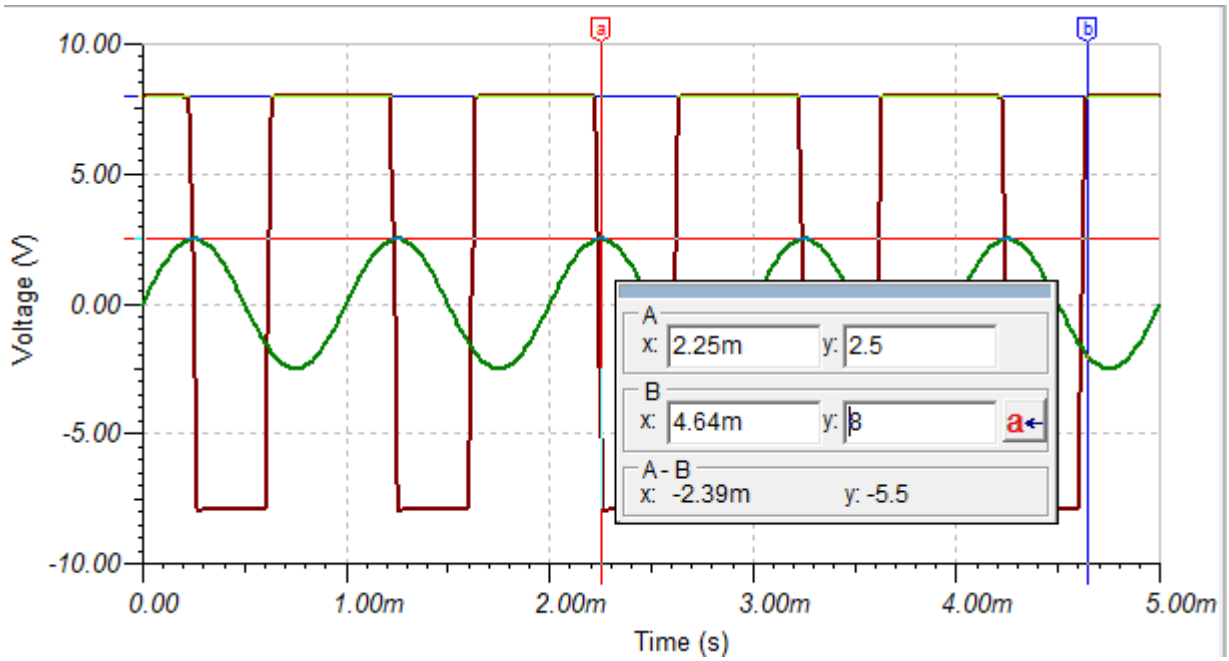
Vi=5Volts



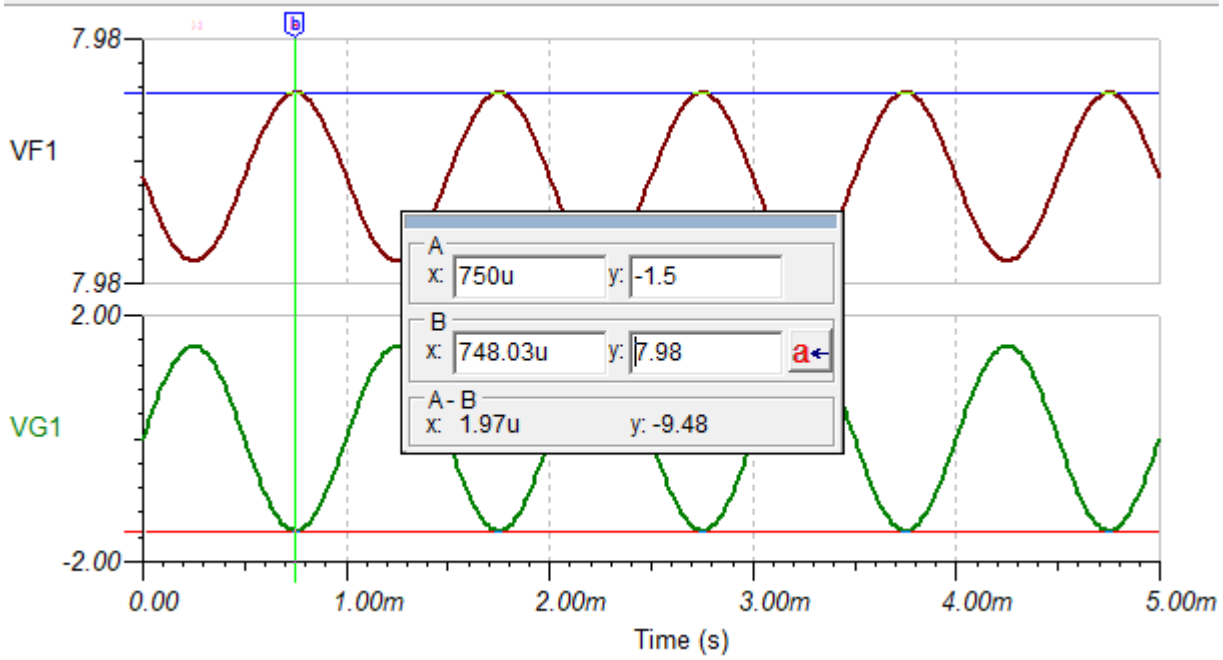
Vi=250mVolts



Vi= V_{UT} =2.5 Volts



Vi= V_{LT} =-1.5 Volts



3.Determine the hysteresis width of the designed circuit. What is the purpose of providing hysteresis width?

Ans:

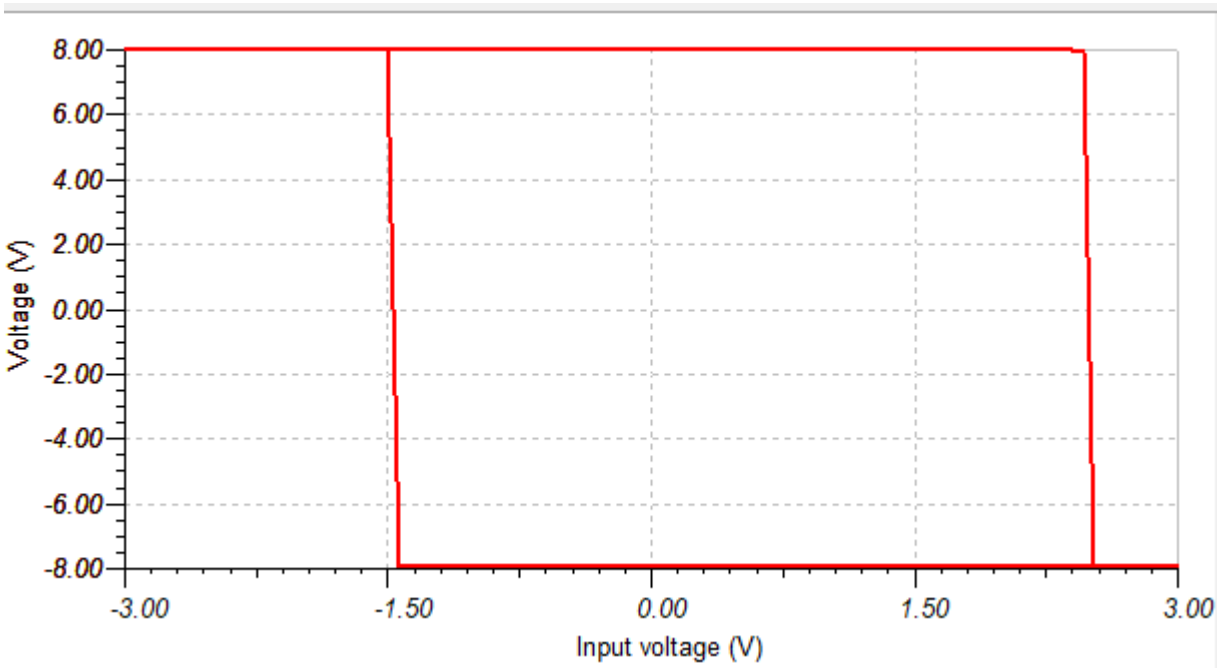
From the graph we noted that

V_{UT} =2.5

V_{LT}=-1.5

We know that,

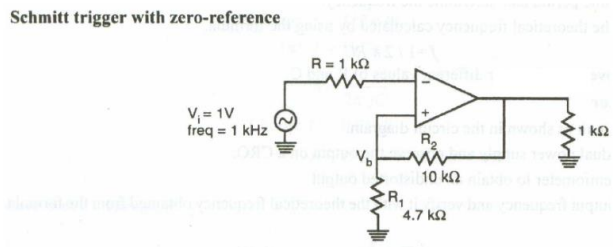
Hysteresis width= V_{UT}- V_{LT}= 2.5 –(-1.5)=2.5+1.5=4

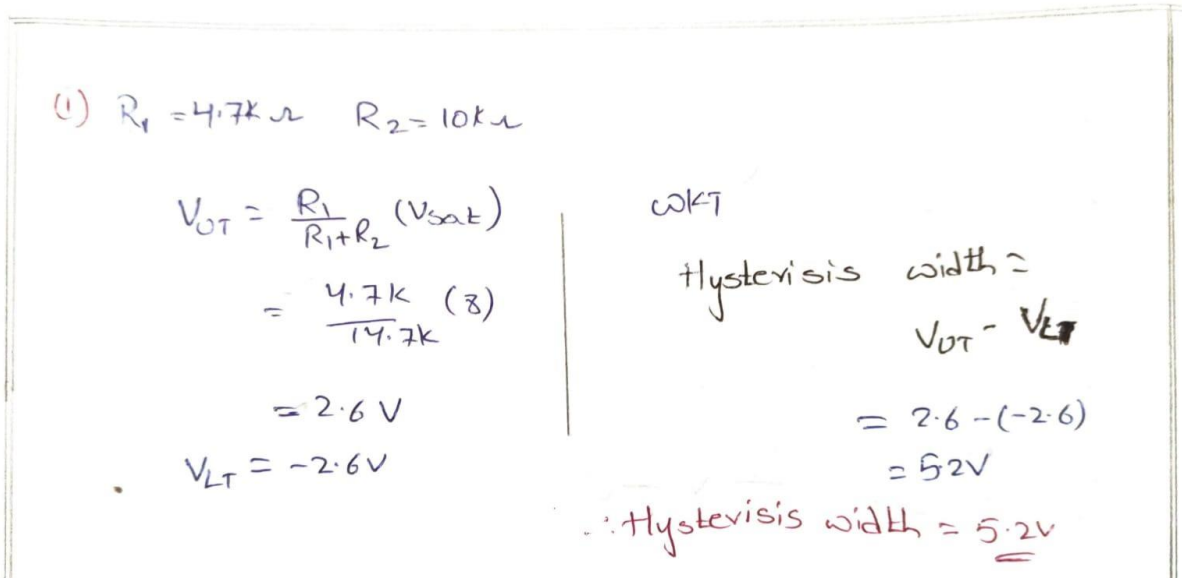


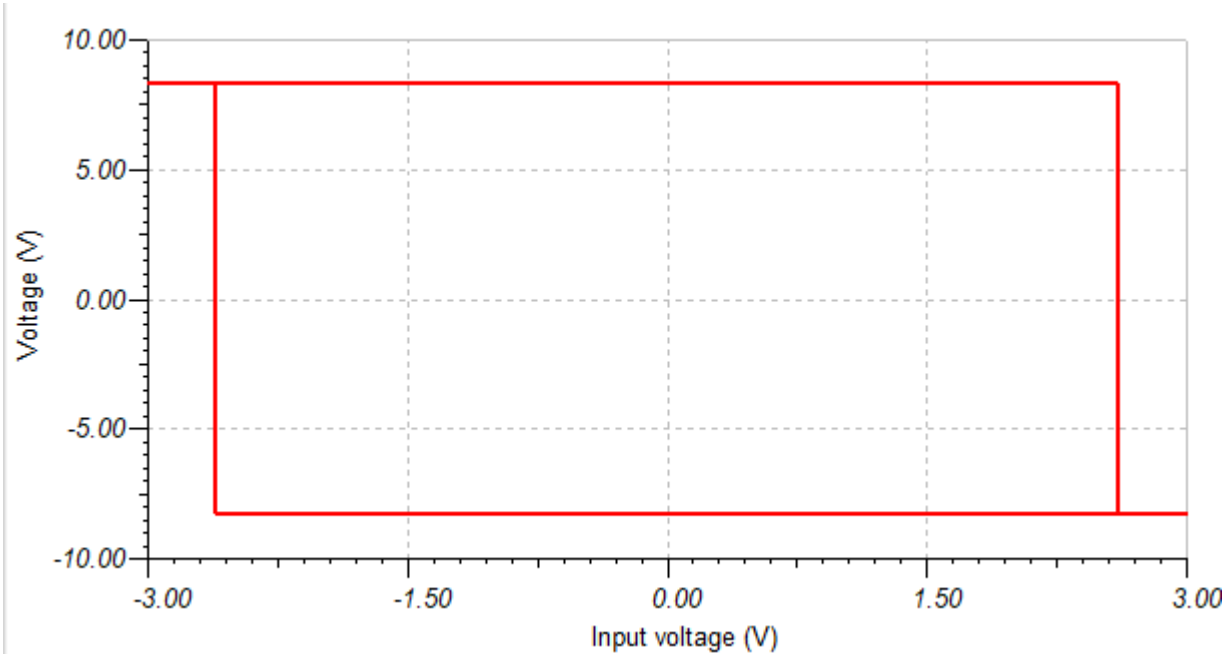
Hysteresis width=4Volts

Inference Questions:

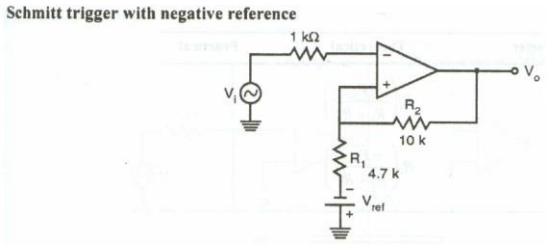
1. For the given circuits, calculate the upper and lower threshold voltages and the hysteresis width.

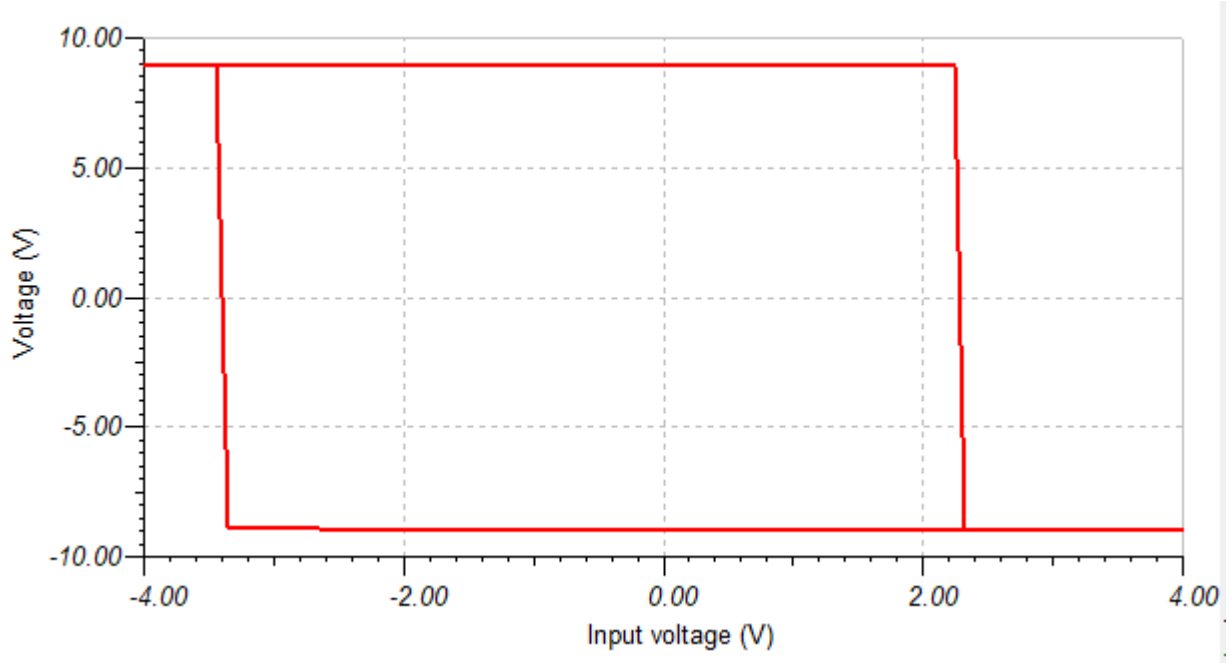






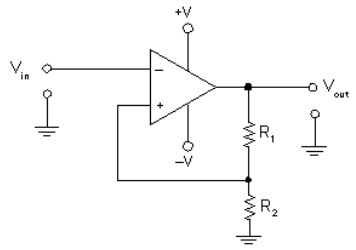
We got upper and lower threshold voltages are same because of **SYMMETRIC CIRCUIT**





Here upper and lower threshold voltages are 2.3V and -3.4V. So **hysteresis width is 5.7Volts**

2. Design the circuit below to obtain a hysteresis width of 3 V with an UTP of = 2 V?



$$V_{UT} = \left(\frac{R_1}{R_1+R_2}\right) V_o + \left(\frac{R_2}{R_1+R_2}\right) V_{ref}$$

$$V_{LT} = -\left(\frac{R_1}{R_1+R_2}\right) V_o + \left(\frac{R_2}{R_1+R_2}\right) V_{ref}$$

$$V_{UT} - V_{LT} = 3 \qquad V_o = \pm V_{sat}$$

$$3 = \left(\frac{2R_1}{R_1+R_2}\right) 8 \Rightarrow \frac{R_1+R_2}{R_1} = \frac{16}{3}$$

$$\Rightarrow R_1+R_2 = 5.34R_1$$

$$R_2 = 4.34R_1$$

$$R_1 = 1.2k\Omega, \quad R_2 = 5.2k\Omega$$

$$\Rightarrow 2 = \left(\frac{R_1}{5.34R_1}\right) 8 + \left(\frac{4.34R_1}{5.34R_1}\right) V_{ref}$$

$$\Rightarrow 2 = \frac{8}{5.34} + \frac{4.34}{5.34} V_{ref}$$

$$\Rightarrow \boxed{V_{ref} = 0.62V}$$