Experiment 8: SCHMITT TRIGGER CIRCUITS

Aim/Objective: To Design a Schmitt trigger circuit using IC 741 and verify the output wave forms.

Pre-requisite: NI Multisim and MyDAQ

Description:

To design a Schmitt trigger for a given value of $+V_{sat}$, $-V_{sat}$, UTP and LTP.

$+V_{sat} = V_{cc} - 3V$ (approx)

$-V_{sat} = V_{ee} + 3V$ (approx)

Select V_{cc} and V_{ee} as per the design requirements. UTP and LTP depends on β i.e. $R_2 / (R_1 + R_2)$. Select the resistors as per the UTP and LTP requirements.

$$V_{UTP} = \frac{R_2}{R_1 + R_2} V_{Sat}$$

$$V_{LTP} = \frac{R_2}{R_1 + R_2} (-V_{Sat})$$

Design a Schmitt Trigger for $+V_{sat} = 12V$ and $-V_{sat} = -12V$ and UTP and LTP as 4V and -4V. For this requirement, $V_{cc} = +15V$ and $V_{EE} = -15V$ and the $\beta = 1/3$ (R_2 can be selected as 1K which gives R_1 as 2K)

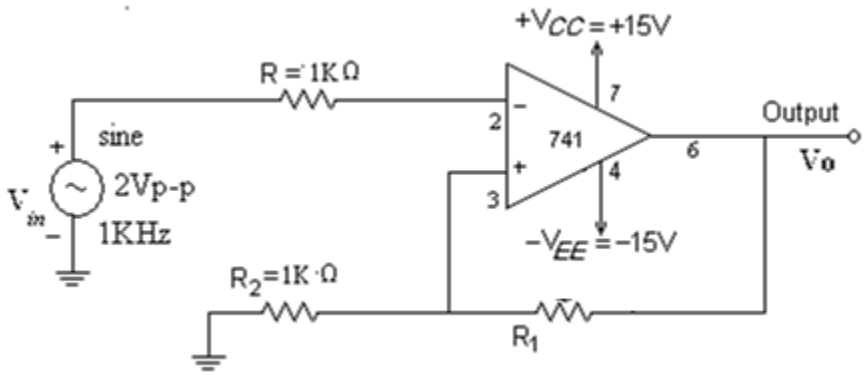
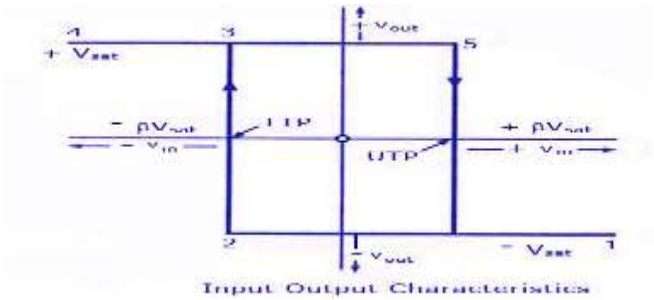


Figure 1: Schmitt trigger using IC 741



Pre-Lab Session

1) What is a Schmitt Trigger and how does it differ from a simple comparator?

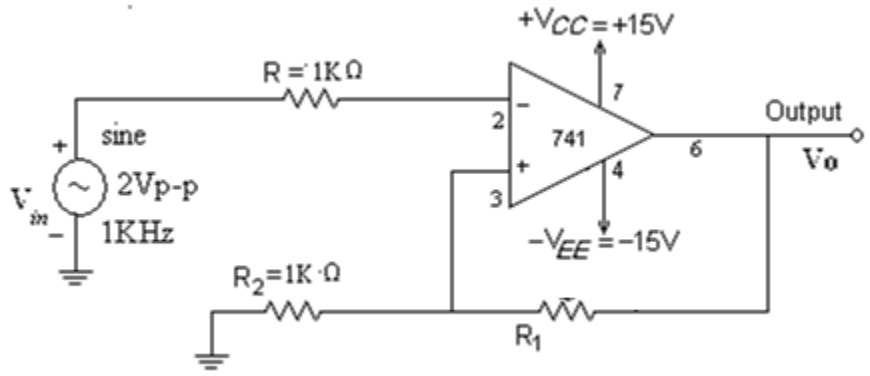
2) What is the duty cycle of the output square wave of the Schmitt Trigger?

3) Which type of feedback is used in Schmitt trigger?

4) Explain the role of the resistor network (R1 and R2) in the circuit shown. How does it affect the threshold levels?

In-Lab Session

It is a regenerative comparator or it is a comparator with hysteresis. This circuit uses positive feedback and the op-amp is operated in saturation. The output can take two values +Vsat and –Vsat. When output = +Vsat, the voltage appearing at the non-inverting terminal is V_{UTP} . When output = -Vsat, the voltage appearing at the non-inverting terminal is V_{LTP} . When Vin is greater than UTP, the output will switch from +Vsat to –Vsat. Similarly When Vin is less than LTP; the output will switch from -Vsat to +Vsat which is shown in the graph. The difference between UTP-LTP is called hysteresis. Hysteresis avoids false triggering of the circuit by noise. Hysteresis curve is the plot of Vo versus Vin . Schmitt trigger circuit is used to convert any irregular wave into square wave.

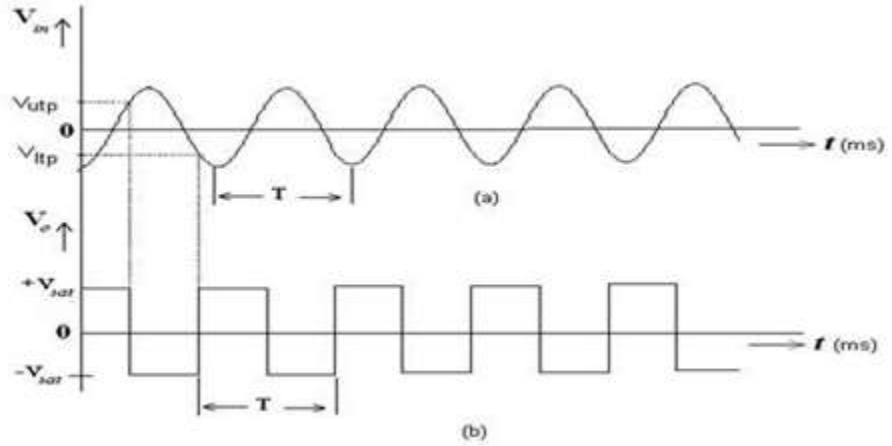


Procedure:

Using IC 741:

1. Connect the circuit as shown in fig 1(a) as Schmitt trigger using IC 741.
2. Give a 5 V_{p-p} sine wave of 1 kHz as input.
3. Observe the wave form on CRO and measure UTP and LTP, V_{sat} and - V_{sat}.
4. Use X-Y mode in CRO and observe hysteresis curve.
5. Repeat the above experiment for R_1 = 5.1Kohms and 15 K ohms and observe the effect.

Expected Waveforms



Analysis and Inference:

Parameter	Input	Output
Voltage(V_{p-p}), V		
Time period - Positive Half cycle(ms)		
Time period - Negative Half cycle(ms)		
	Theoretical	**Observed**
UTP		
LTP		

VIVA-VOCE Questions

1) **A Schmitt Trigger circuit is primarily used to:**

   A. Amplify analog signals

   B. Generate sine waves

   C. Convert noisy signals into clean digital transitions

   D. Multiply frequencies

2) **The characteristic feature of a Schmitt Trigger is:**

A. Negative feedback

B. High gain

C. Hysteresis

D. Low impedance

3) **In a Schmitt Trigger, hysteresis refers to:**

A. Delay in output response

B. Difference between two threshold levels

C. Output oscillation frequency

D. Input signal strength

4) **A Schmitt Trigger can be implemented using:**

A. Low-pass filter

B. Op-Amp with positive feedback

C. Class B amplifier

D. Zener diode

5) **If the input signal is a slowly varying sine wave, the output of a Schmitt Trigger will be:**

A. A sine wave

B. A triangular wave

C. A square wave

D. A constant voltage

Post-Lab Session

To analyze and understand the operation of a Schmitt Trigger circuit and explore its behavior with various input signals.

Apply a triangular wave and note the response

Result:

Studied the Schmitt trigger using opamps

Evaluator Remark (if Any):	**Marks Secured: _____out of 50**
	Signature of the Evaluator with Date