EXPERIMENT NO.9

**TITLE: OP-AMP AS SCHMITT TRIGGER.**

**OBJECTIVES:**

1. To assemble the circuit of SCHMITT TRIGGER using op-amp IC 741 in inverting configuration.
2. To observe and plot the output voltage waveform of SCHMITT TRIGGER.

**LAB REQUIREMENTS:**

Breadboard, Op-amp IC 741, Resistor (R1 & R2), DC regulated Dual power supply (0-30V ), Function Generator, CRO/DSO and connecting wires/Probes.

**CIRCUIT DIAGRAM:**

**THEORY:**

SCHMITT TRIGGER is a circuit which converts irregular shaped waveform into square or pulse. This circuit is also called as squaring circuit. Above circuit shows an inverting comparator with positive feedback. The input $v_{in}$ triggers (change of state) output $v_o$ every time it exceeds certain voltage levels called as upper threshold voltage $v_{ut}$ and lower threshold voltage $v_{lt}$.

These voltage levels are obtained by voltage divider R1-R2 where voltage across R1 is fed back to the (+) input. The voltage across R1 is the variable reference voltage that depends upon the value and polarity of output voltage $v_o$. When $v_o = +V_{sat}$, voltage across R1 is called as upper threshold voltage $v_{ut}$. The input voltage $v_{in}$ must be slightly

more positive than $v_{ut}$ in order to cause the output $v_o$ to switch from $+V_{sat}$ to $-V_{sat}$. As long as $v_{in} < V_{ut}$, $v_o = +V_{sat}$. Using voltage divider rule,

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

On the other hand, When $v_o = -V_{sat}$, voltage across R1 is called as lower threshold voltage $v_{lt}$. The input voltage $v_{in}$ must be slightly more negative than $v_{lt}$ in order to cause the output $v_o$ to switch from $-V_{sat}$ to $+V_{sat}$. As long as $v_{in} > V_{lt}$, $v_o = -V_{sat}$. Using voltage divider rule,

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

Output of Schmitt trigger is square wave when input is sine wave. This circuit is said to exhibit the phenomenon known as hysteresis. Hysteresis is the property of the system where output value incorporates some lag, delay or history dependence.

**EXPERIMENTAL PROCEDURE:**

1. Refer the Pin Diagram of op-amp IC741 & assemble the SCHMITT TRIGGER circuit in inverting configuration of op-amp as per circuit diagram on the breadboard.
2. Set the DC power supply to provide $+V_{CC}$ & $-V_{EE}$ by making necessary adjustment & Apply $V_{CC}$ & $V_{EE}$ = ±15V at respective pins of op-amp IC 741.
3. Set the function generator to provide 2V (p-p) sine wave at 500HZ & Apply this AC input at pin 2 (INV) of op-amp IC741.
4. Observe the output of this circuit on CRO/DSO.
5. Measure the output voltage swing, $V_{ut}$ & $V_{lt}$ .Note the readings in the observation table.
6. Plot the output voltage waveforms for $v_{in}$, $V_{ut}$ & $V_{lt}$ .

**OBSERVATION TABLE:**

| Sr. No. | Input Signal Voltage (Vin) p-p | Input Signal Frequency (Hz) | R1 KΩ | R2 KΩ | $V_{ut}$ (Volts) | $V_{lt}$ (Volts) | Output Voltage Swing (p-p) |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |

**CALCULATIONS:**

(Calculations for $V_{ut}$ & $V_{lt}$)

**RESULT:**

1. Circuit of SCHMITT TRIGGER using op-amp IC 741 has been assembled in _____configuration of op-amp with input _____wave signal set at _____amplitude & _____frequency.
2. It has been observed from the output waveform that output is _____wave for _____wave input.
3. The input $v_{in}$ triggers output $v_o$ every time it exceeds certain voltage levels called as _____and _____.

**EVALUATION (BY TEACHER):**

**Excellent/Good/Average/Poor**