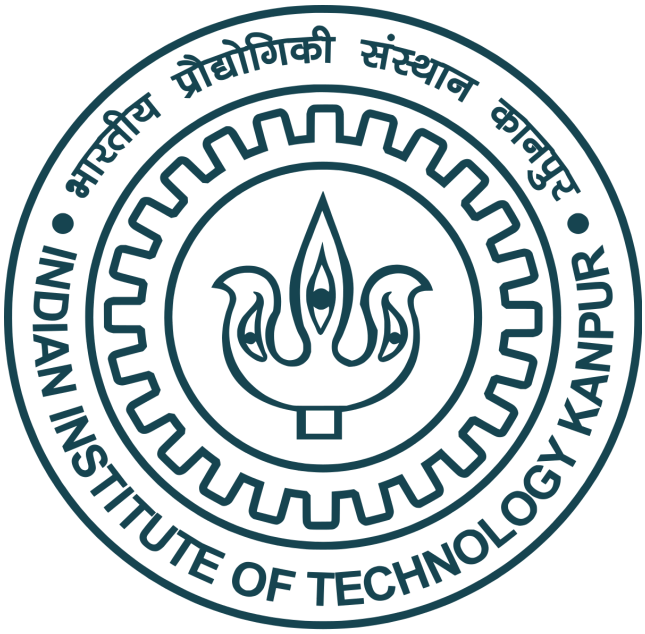



Lab Report for EE381A

2022-23(II)

MOHAN KRISHNA

200590

Section D

Department of Electrical Engineering

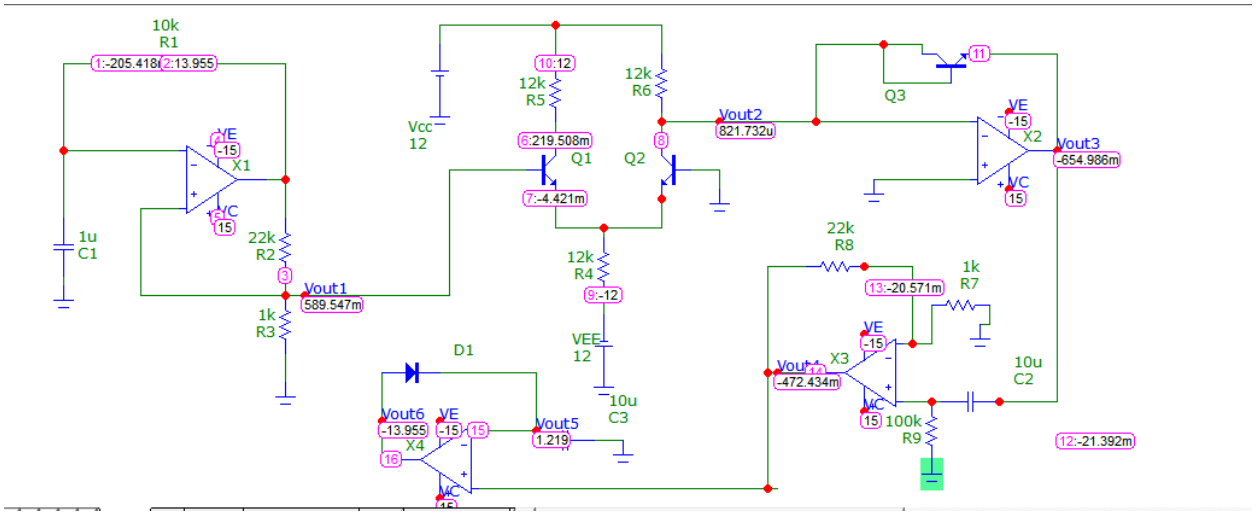
1st April, 2022

Experiment 2:

Design and Implementation of a Temperature Sensor

Pre Lab:

Microcap Circuit:



Observed Waveforms: Next page.

Frequency of Schmitt Oscillator: 500 Hz.

Transient Analysis Limits

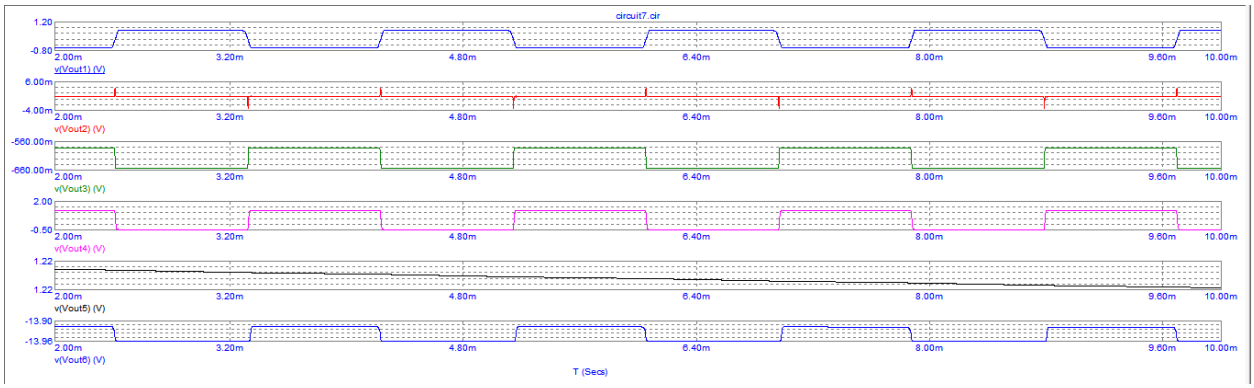
Run | Add | Delete | Expand... | Stepping... | PSS... | Properties... | Help...

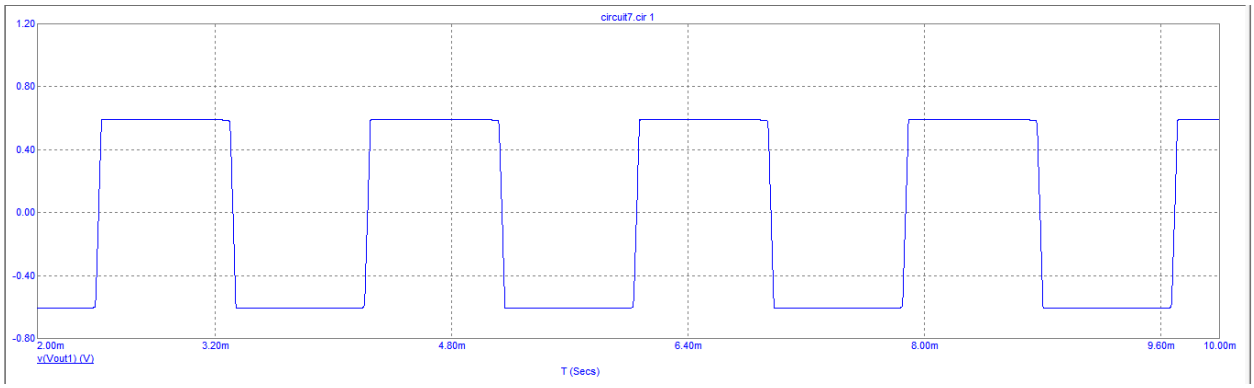
Maximum Run Time	10m	Run Options	Normal
Output Start Time (tstart)	2m	State Variables	Zero
Maximum Time Step	1u	☑ Operating Point	☐ Accumulate Plots
Number of Points	51	☐ Operating Point Only	☐ Fixed Time Step
Temperature Linear	27	☑ Auto Scale Ranges	☐ Periodic Steady State
Retrace Runs	1		

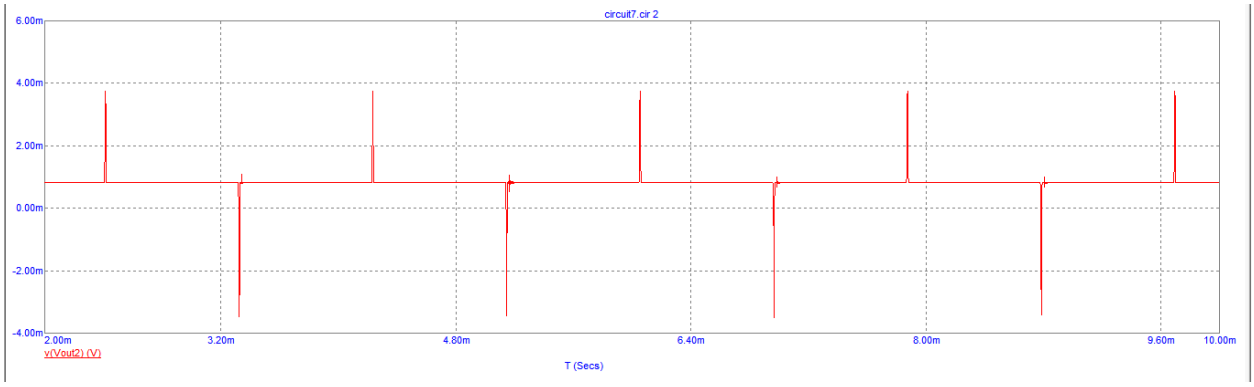
☐ Ignore Expression Errors

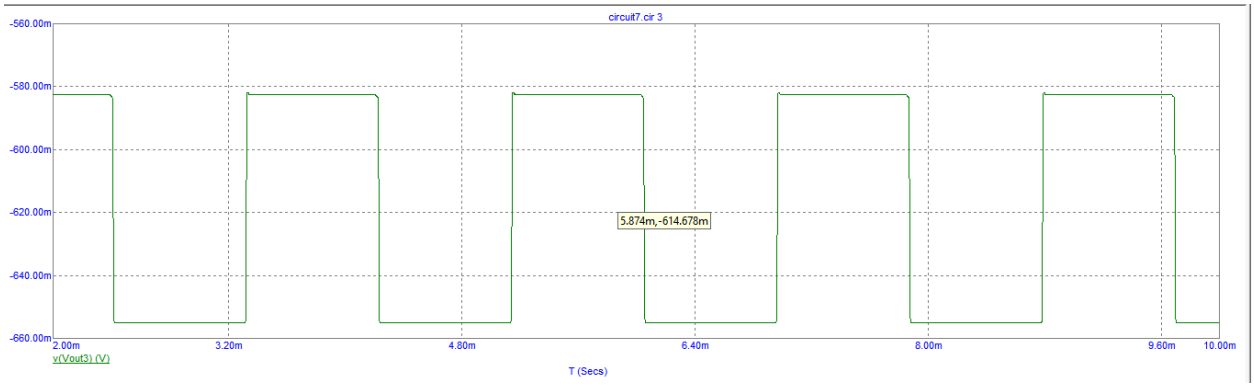
Page	P	X Expression	Y Expression	X Range	Y Range
	1	T	v(Vout1)	Auto	Auto
	2	T	v(Vout2)	Auto	Auto
	3	T	v(Vout3)	Auto	Auto
	4	T	v(Vout4)	Auto	Auto
	5	T	v(Vout5)	Auto	Auto
	6	T	v(Vout6)	Auto	Auto
				Auto	Auto

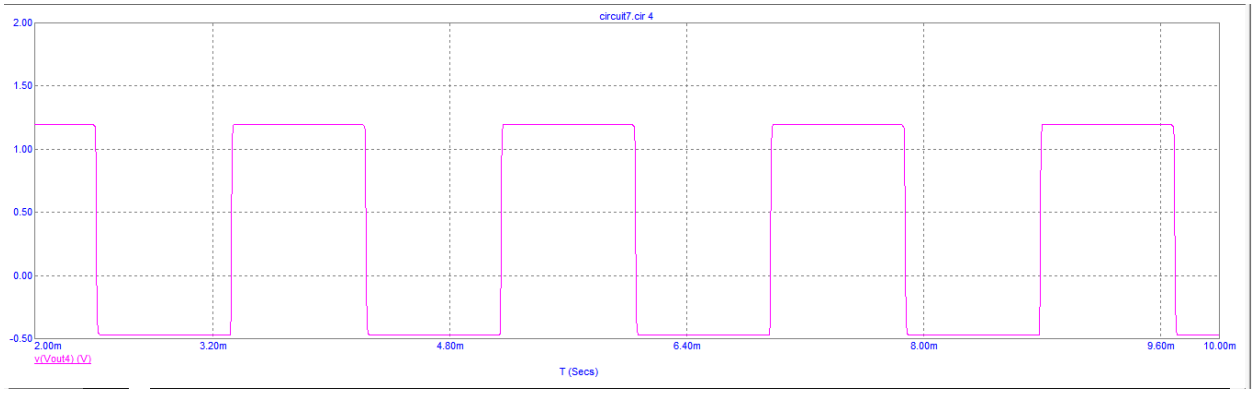
Specifies ending time of the simulation.

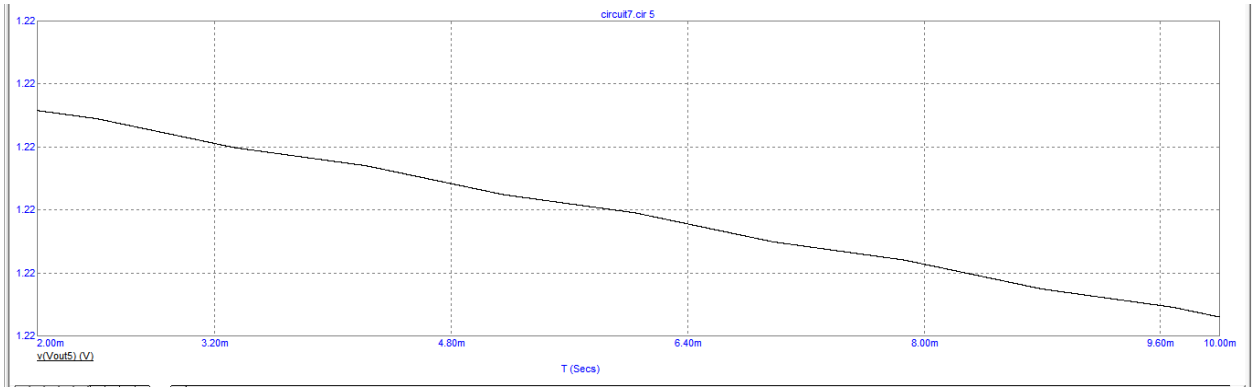


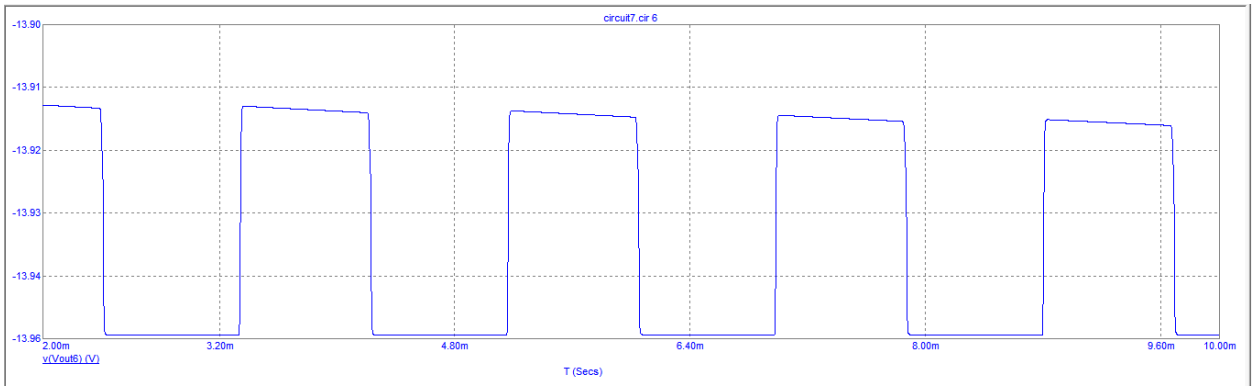



circuit7.cir 2
6.00m
4.00m
2.00m
0.00m
-2.00m
-4.00m
2.00m
3.20m
4.80m
6.40m
8.00m
9.60m
10.00m
v(Vout2) (V)
T (Secs)


circuit7.cir 3
-560.00m
-580.00m
-600.00m
-620.00m
-640.00m
-660.00m
5.874m,-614.678m
2.00m
3.20m
4.80m
6.40m
8.00m
9.60m
10.00m
v(Vout3) (V)
T (Secs)


circuit7.cir 4
2.00
1.50
1.00
0.50
0.00
-0.50
2.00m
3.20m
4.80m
6.40m
8.00m
9.60m
10.00m
v(Vout4) (V)
T (Secs)

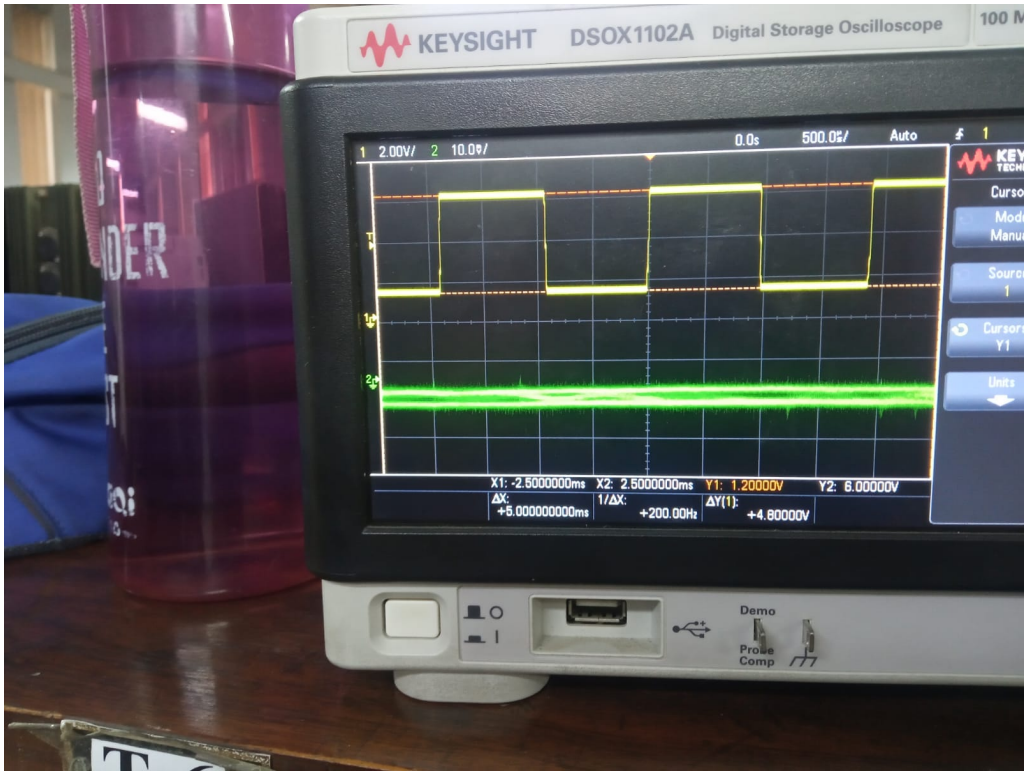

circuit7.cir 5
1.22
1.22
1.22
1.22
1.22
2.00m
3.20m
4.80m
6.40m
8.00m
9.60m
10.00m
v(Vout5) (V)
T (Secs)



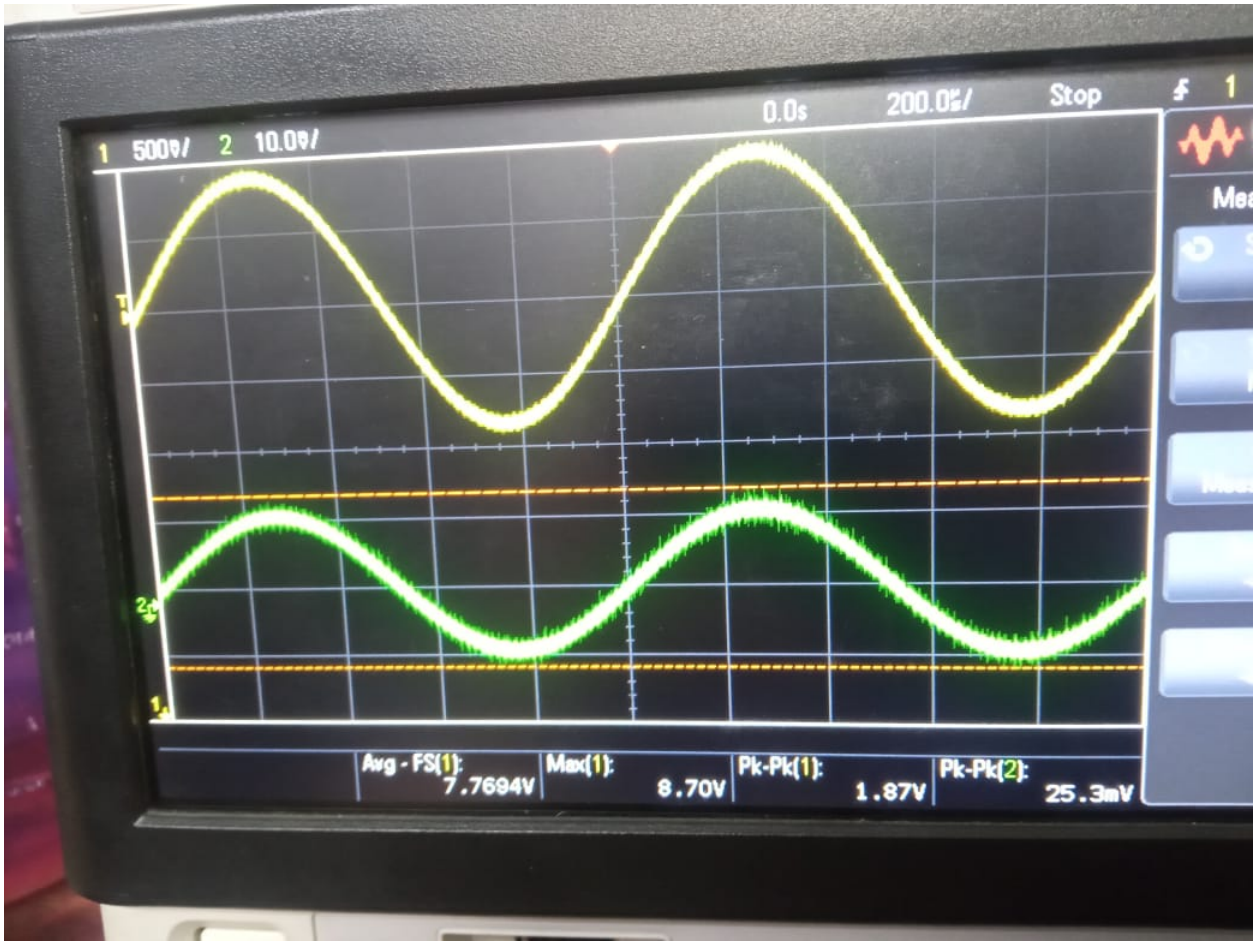
In Lab and Post Lab:

Observed Waveforms:

Waveform to calculate n from I1/I2:

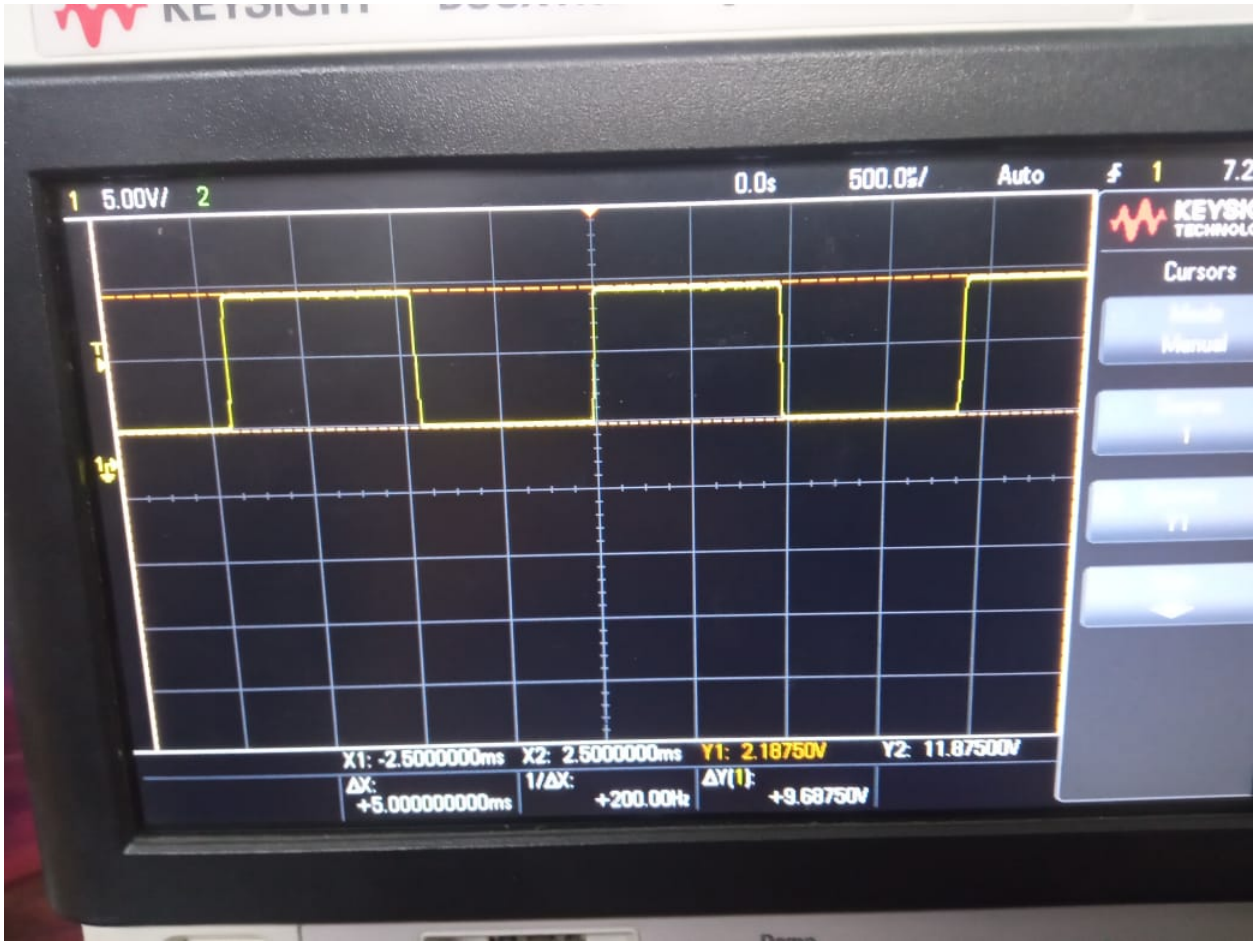


Capacitor Output (Vout5):

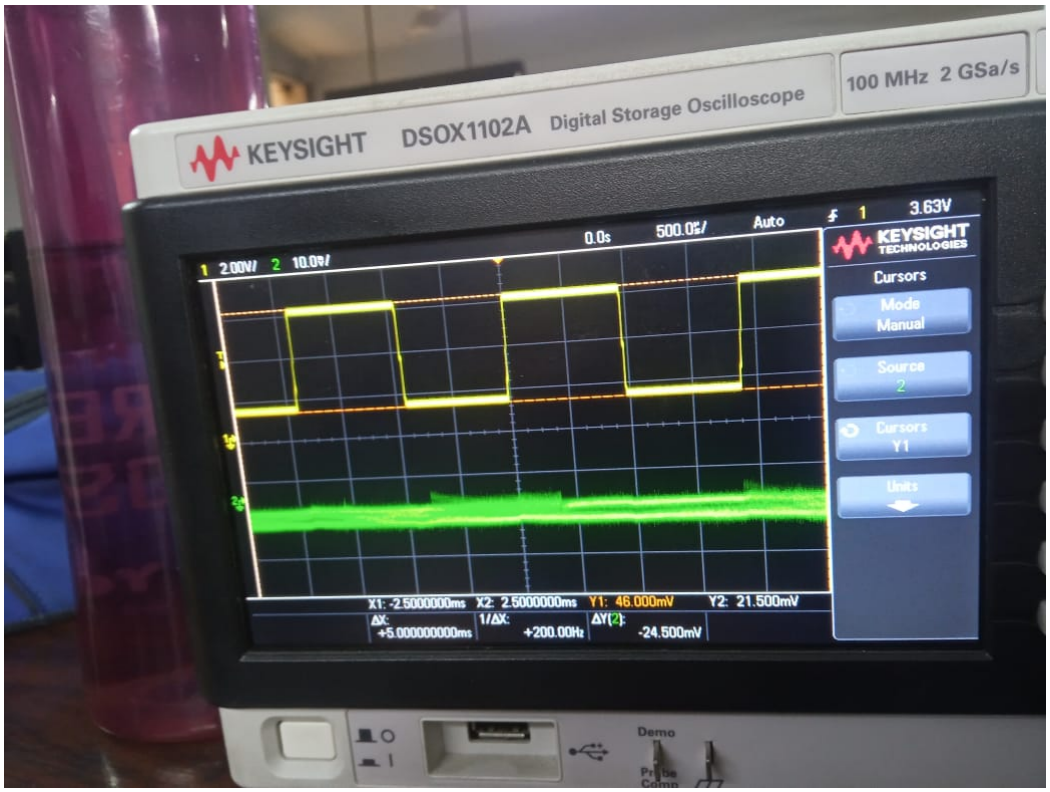


The reason this seems sinusoidal is because typically a square wave has higher frequency components (when expanded using fourier series). Because of the nature of the circuit (resistance/capacitance etc), and upper cutoff frequency of diodes/op-amps etc, the higher frequency components (which keep the shape square) get eliminated. The remaining waveform is closer to a distorted sine wave.

Differential Amplifier (Vout2):



Schmitt Trigger (Vout1):



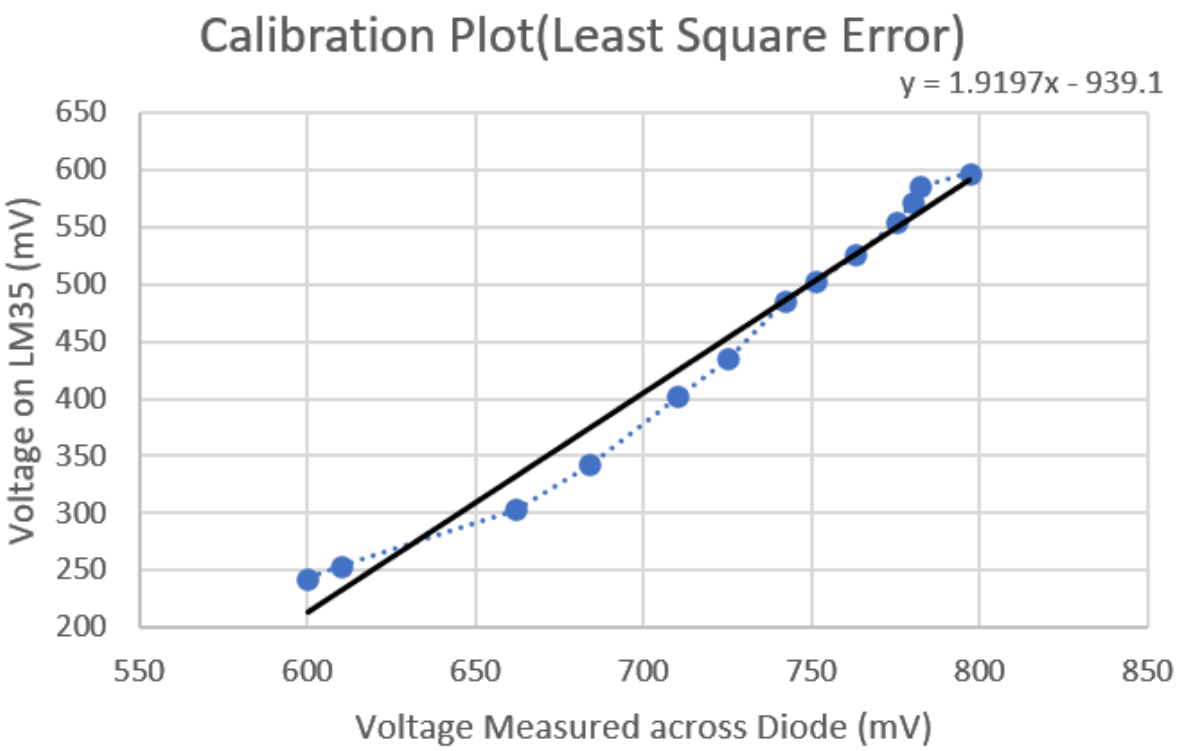
Frequency of square wave generated by Schmitt Oscillator: 557 Hz.

Temperature Calculation:

I1= 6*c
I1-I2=1.2*c
N=I1/(I1-I2)=5
A=1+(R2/R1)=1+22=23
ΔV_B=940/23 mV=40.87 mV
T={ (ΔV_B x 300) / ($\log_e$n x 0.02558) } - 273
=294.44-273=21.44°C. This value is close to the room temp.

Calibration with LM35:

Diode Voltage (mV)	LM35 Voltage(mV)
600	242.6
610	253.8
662	303
684	342.233
710	401.75
725	435
742	484.77
751	502.66
763	525.77
775	553.8
780	572.4
782	585.3
797	597.2



Slope: 1.92

LM35 Gradient: 10 mV/°C

Calibration: 10/1.92=5.21 mV/°C.

Possible Sources of Error in our experiments:

- Joule's heating affects diode temperature.
- Very high sensitivity of resistor values.
- Thermal variations of Vfe value of transistors.
- Burning up of bread-board due to very high current.
- Parallax error while measuring cursors.
- Imperfect Voltage Source(DC offset).
- Wires not connected properly/error in bread-board
- Capacitor value fluctuation/line capacitance.
- Oscilloscope zero error
- Non-linearity of resistors/non-ideal transistors.
- Error in resistor/capacitor values.
- Non-ideal voltage source.
- Resistance in connecting wires.
- Thermal variation of resistance/Vt.
- Noise Fluctuations.
- Harmonic Distortions
- Charging and discharging of capacitor.
