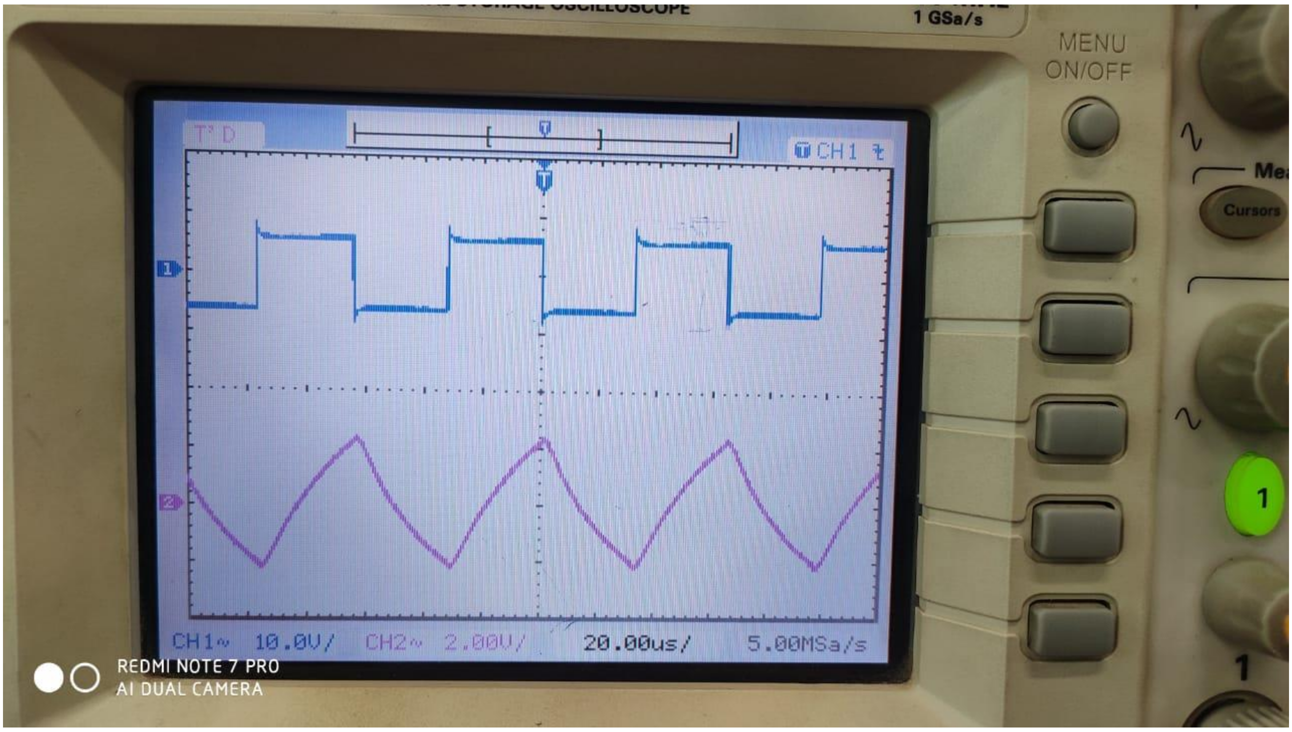
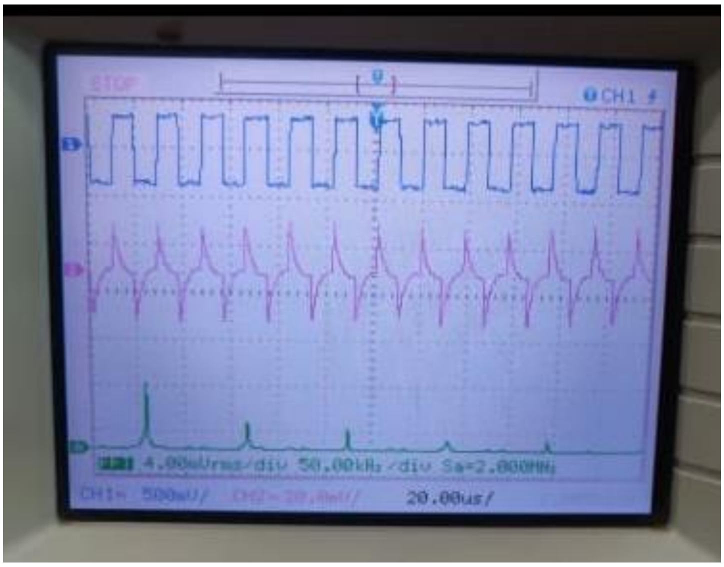
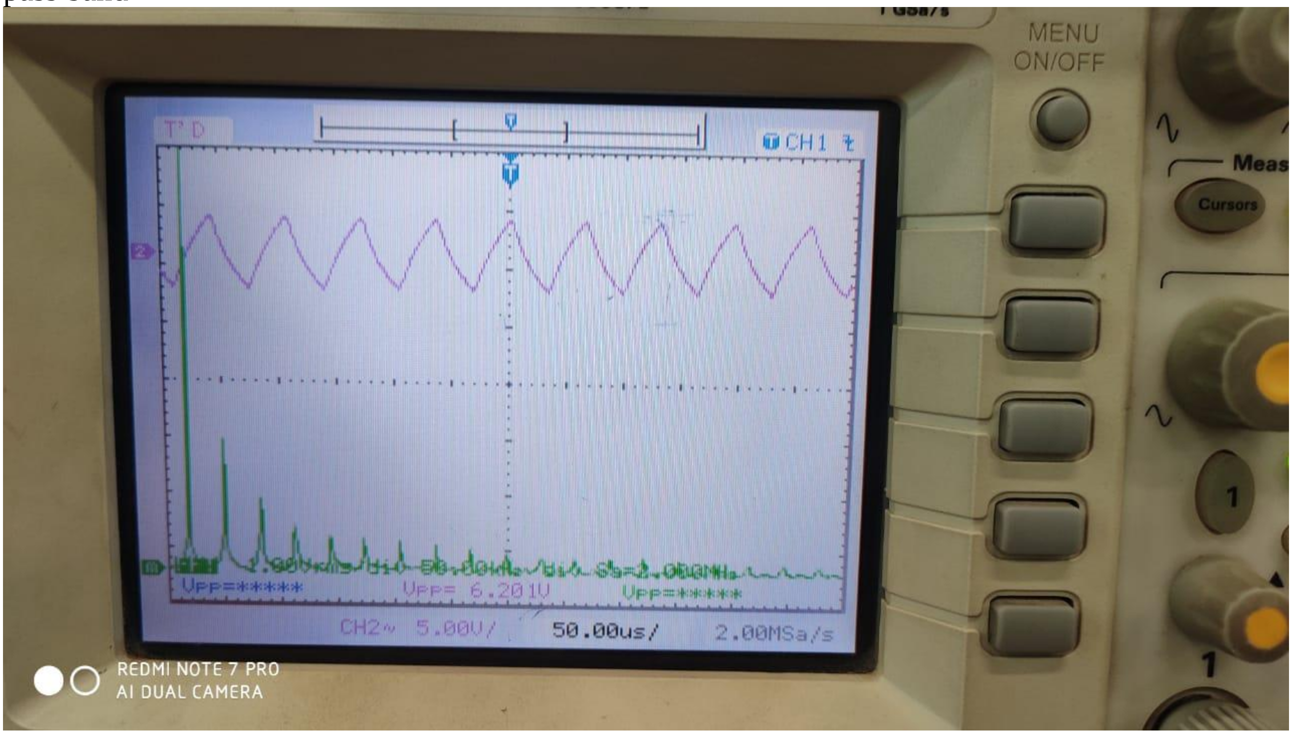


Low frequency

very high frequency



pass band



stop band

B. Sai Laxman

LAB ASSIGNMENT - 3

EE18BTECH11049

a) Pass band freq $f_p = 6$ KHz

Stop band freq $f_s = 15.5$ KHz

* Graph in images

b)

(i) Butterworth filter: The obtained order of the filter is $N>1$ and $\omega_p = \omega_c$

Transfer function is $$|H(j\omega)| = \frac{0.653}{\sqrt{1+\left(\frac{\omega}{12000\pi}\right)^2}}$$

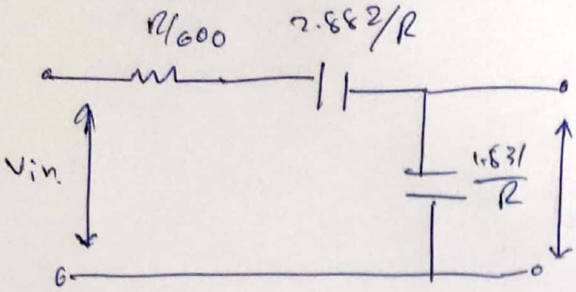
Ideally maximum gain must be 1. But in this case the maximum gain obtained was 0.653. Hence and offset factor of 0.653

Chebyshev filter: The obtained order of the filter is $N>1$, and ripple $\varepsilon = 0.027$dB

$\therefore$ Transfer fn $$|H(j\omega)| = \frac{0.653}{\sqrt{0.8631 + 0.2738\left(\frac{\omega}{1200\pi}\right)^2}}$$

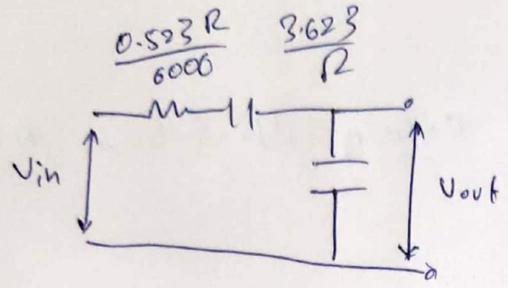
(similarly offset factor of 0.653

c.)



Butterworth :

where R is any value



Chebyshev :-

where R is any value

d.) For a sq wave as input ;

At low freq (for $f \leq 3000\,Hz$) : The shape of output wave is the same as input signal and the variation in the gain is same as for a sinosoid.

At higher freq : The shape of the output signal gets peaky and close to triangular wave

At $f \geq \omega_p$: The shape of output wave is completely distorted. This is because for fourier series of square wave

$$f(t) = \sum_{n=-\infty}^{\infty} C_n e^{-nj\omega t}$$

The output is

$$f_{out}(t) = \sum_{n=-\infty}^{\infty} |H(njw)| \, C_n e^{-njwt}$$

So higher freq components are attenuated and thus the obtained Fourier series of the output signal mimics a triangular wave.

a) At stop band freq

a) Output:-

is as shown in fig

At pass band

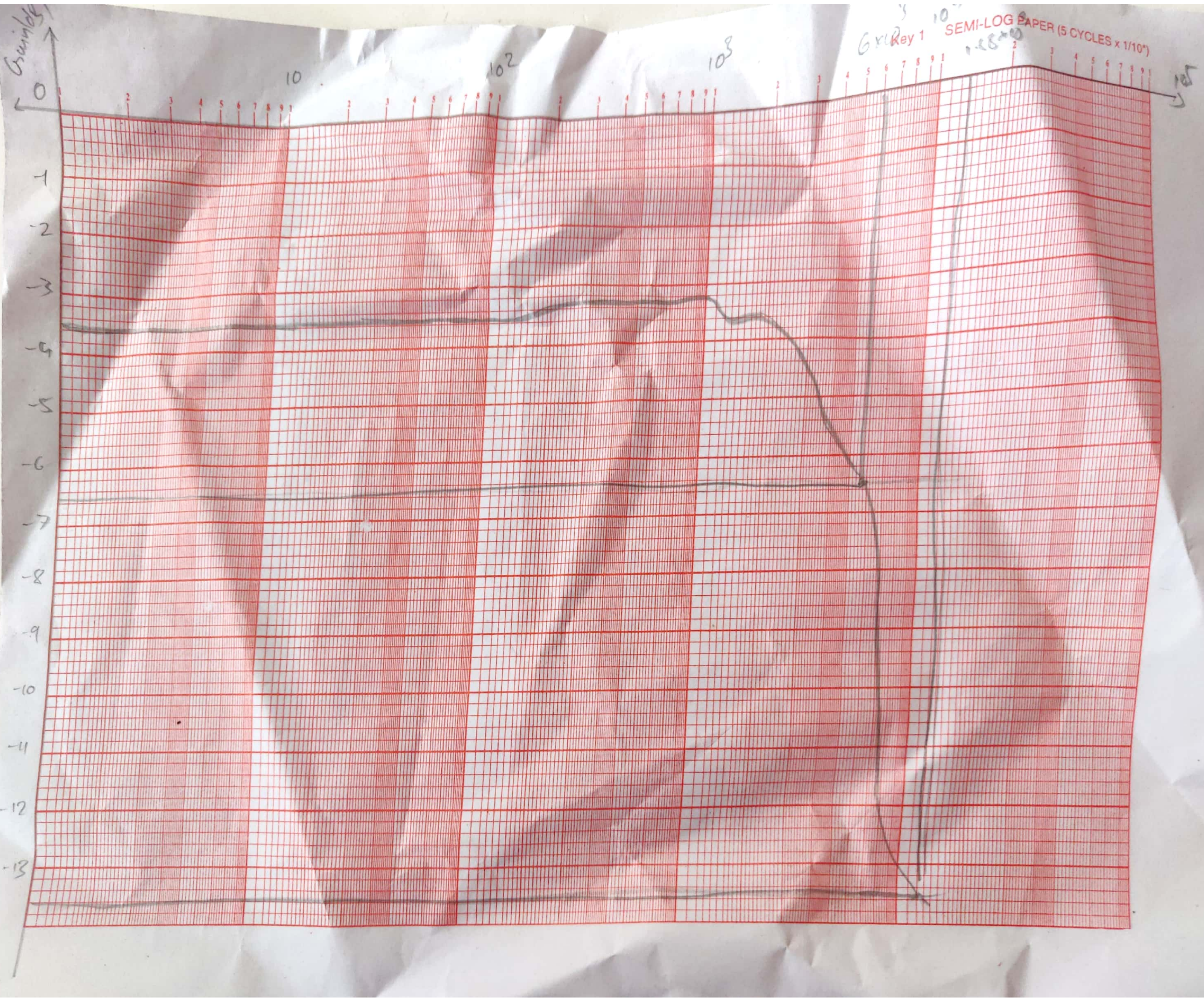
b) output

c) Measuring the phase:

To measure the phase difference, we can measure the delay in time between output and input.

e.g. we have $\Delta t = -32\,\mu sec$

$$\Delta\phi = 2\pi f \Delta t = -0.179 \text{ rad} \quad (\text{for } f = 1300\,Hz)$$



Gain(dB)
SEMI-LOG PAPER (5 CYCLES x 1/10")
Key 1
10
10^2
10^3
10^4
10^5
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13