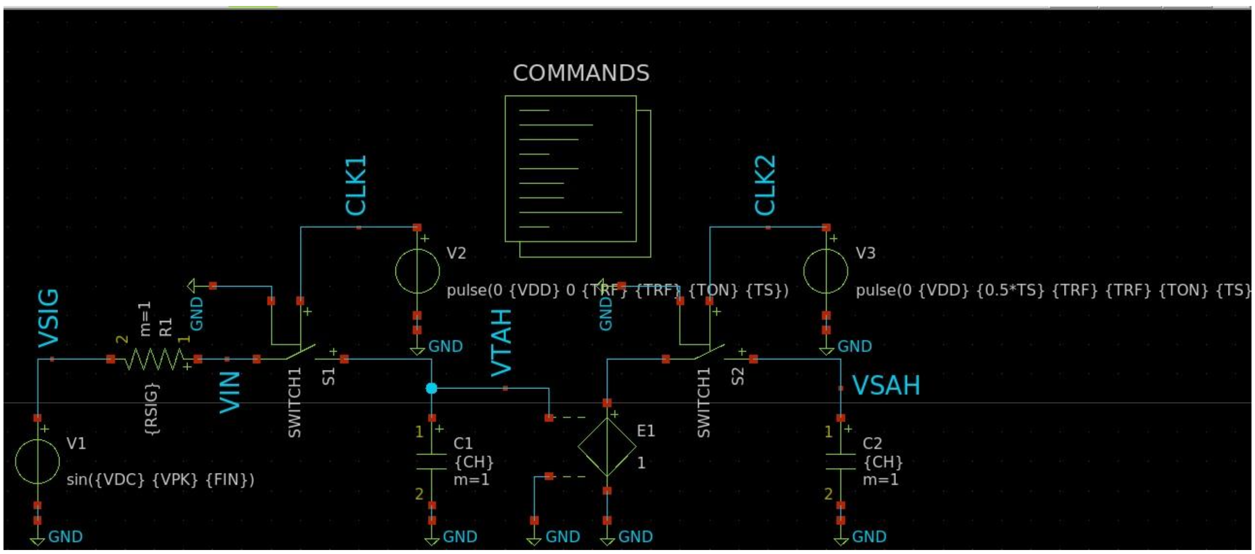
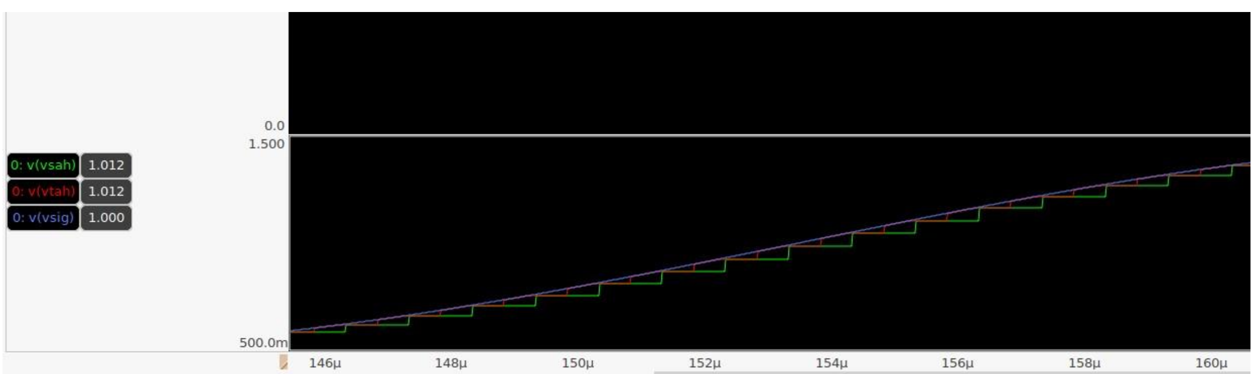
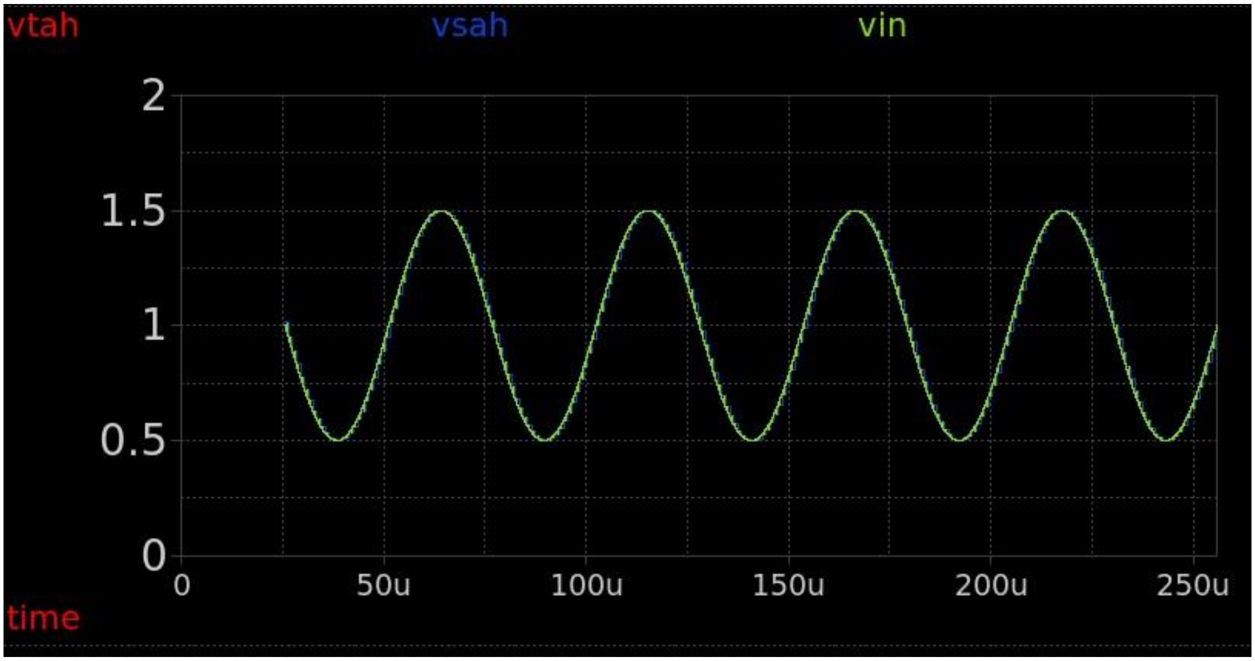
Lab 2

Part 1

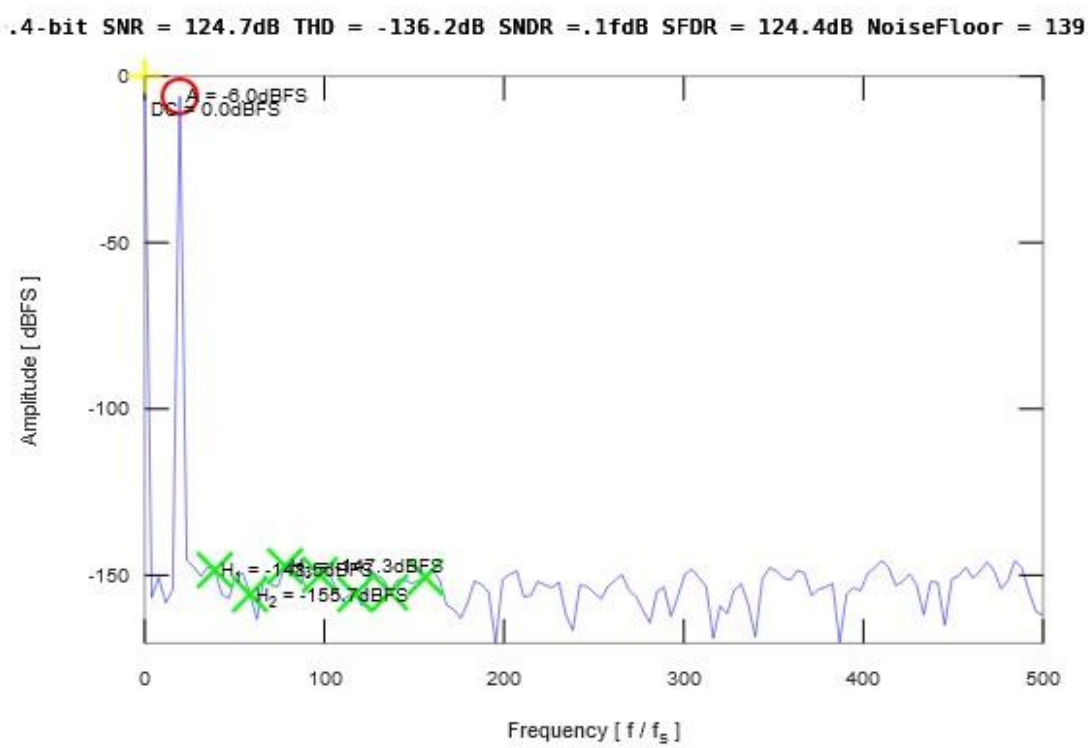
For Ncyc=5:



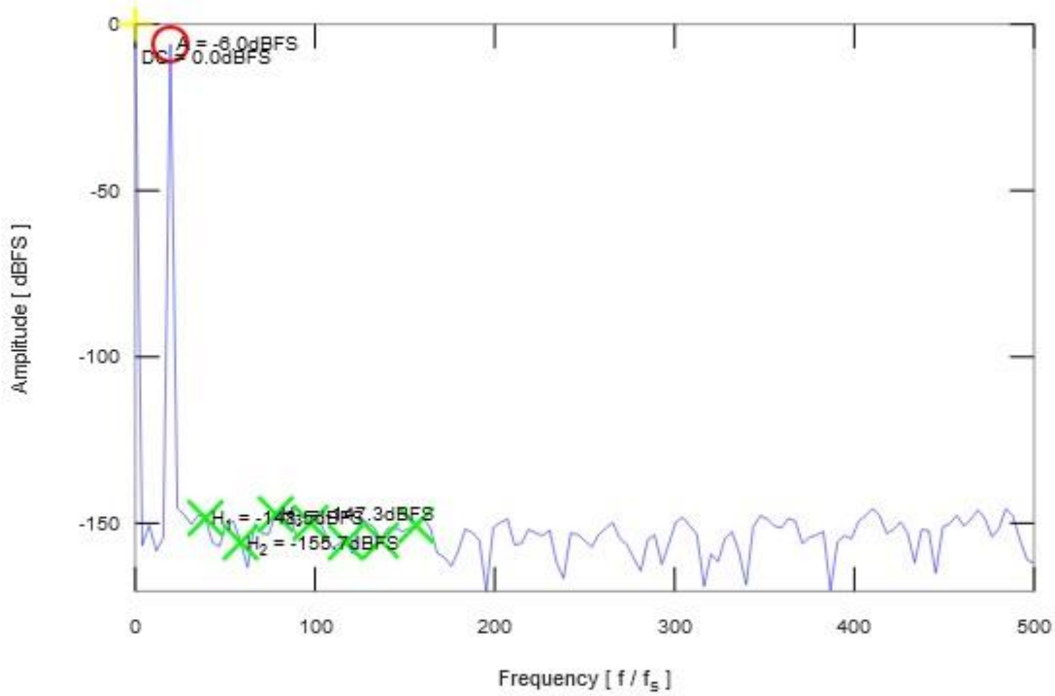



vtah
vsah
vin
2
1.5
1
0.5
0
0
50u
100u
150u
200u
250u
time

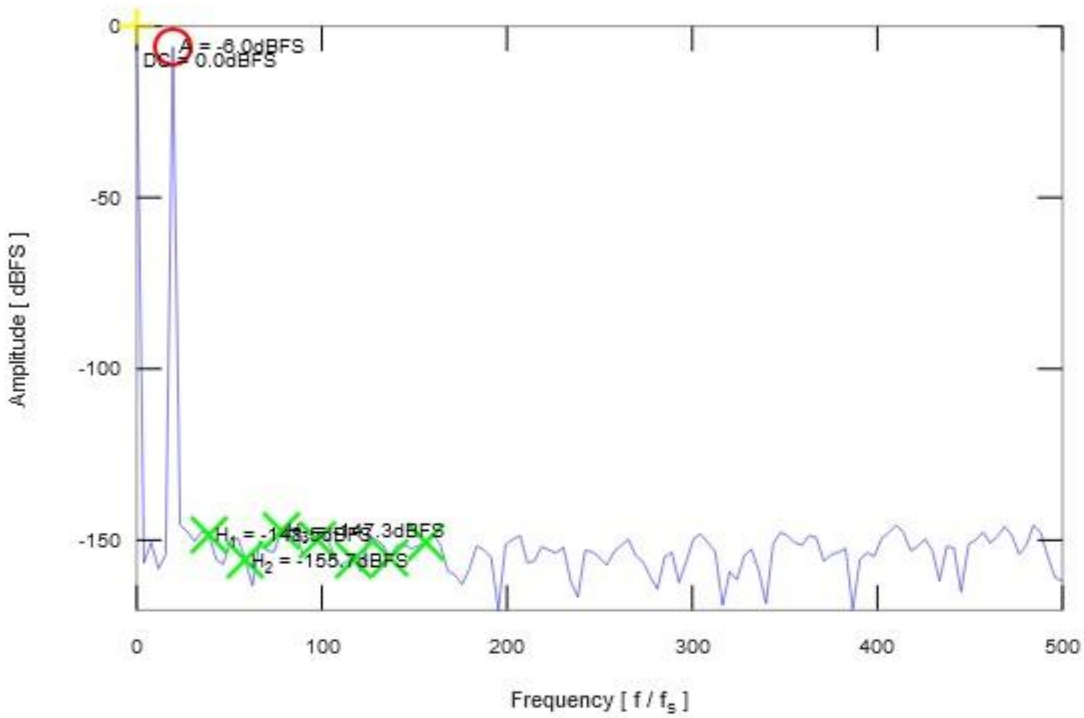
<u>FFt</u>


.4-bit SNR = 124.7dB THD = -136.2dB SNDR =.1fdB SFDR = 124.4dB NoiseFloor = 139.
A = -6.0dBFS
DC = 0.0dBFS
H_2 = -155.7dBFS
Amplitude [dBFS]
0
-50
-100
-150
0
100
200
300
400
500
Frequency [f / f_s]

.4-bit SNR = 124.7dB THD = -136.2dB SNDR =.1fdB SFDR = 124.4dB NoiseFloor = 139.



ENOB = 20.4-bit SNR = 124.7dB THD = -136.2dB SNDR =124.4dB SFDR = 139.5dB NoiseF



What is the power of the peak signal (in dB)? Why?

DC COMPONENT = 0dB (1 in linear scale)

Single tone =-6dB (0.5 in linear scale)

Single tone is sin wave with power = A**2/2 =0.25/2=0.125

P=10log(0.125)= 9 dB

How many bins are occupied by the test signal?

1 bin

What is the noise floor (in dBFS)?

About 139 dBFS from plot

What is the relation between the SNR, NFFT, Signal Power, and Noise Floor?

Noise Floor (dB)=SNR−10log10(NFFT)

And SNR = (Signal Power/Noise power)

If the sampling is ideal, what is the source of error that causes the noise floor?

There is no leakage but noise floor can be because of quantization error if signal is digitalized or mathematical issues due to FFT

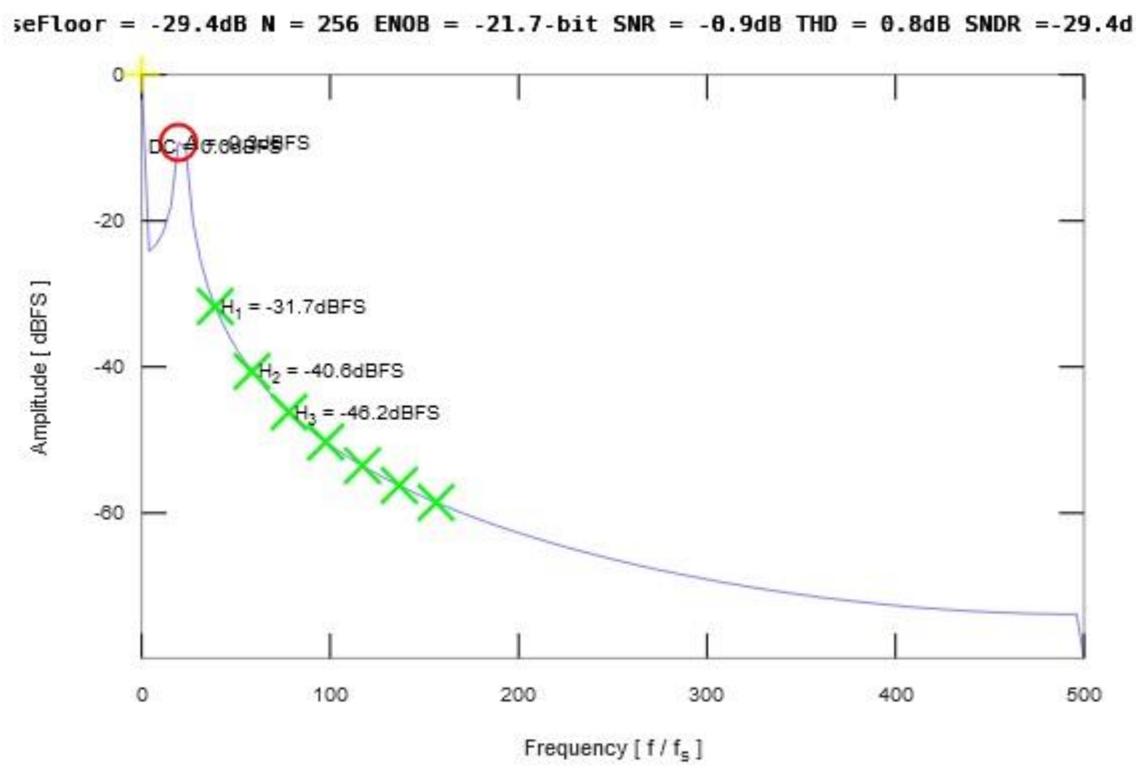
Note that if you made the reltol and vntol options in the spice code smaller, ENOB will increase.Why?

reltol and vntol control the numerical accuracy of the solver. When you decrease these tolerances the Effective Number of Bits (ENOB) increases.

When reltol and vntol are made smaller:

1. Reduced numerical noise: SPICE uses iterative solvers, and reducing tolerances minimizes rounding errors and convergence inaccuracies.
2. More accurate voltage calculations: This leads to less distortion in transient and frequency-domain simulations.
3. Lower simulation-induced noise: Since ENOB is affected by SNR, reducing numerical noise increases the SNR, thereby improving ENOB.

FOR Ncyc = 5.5

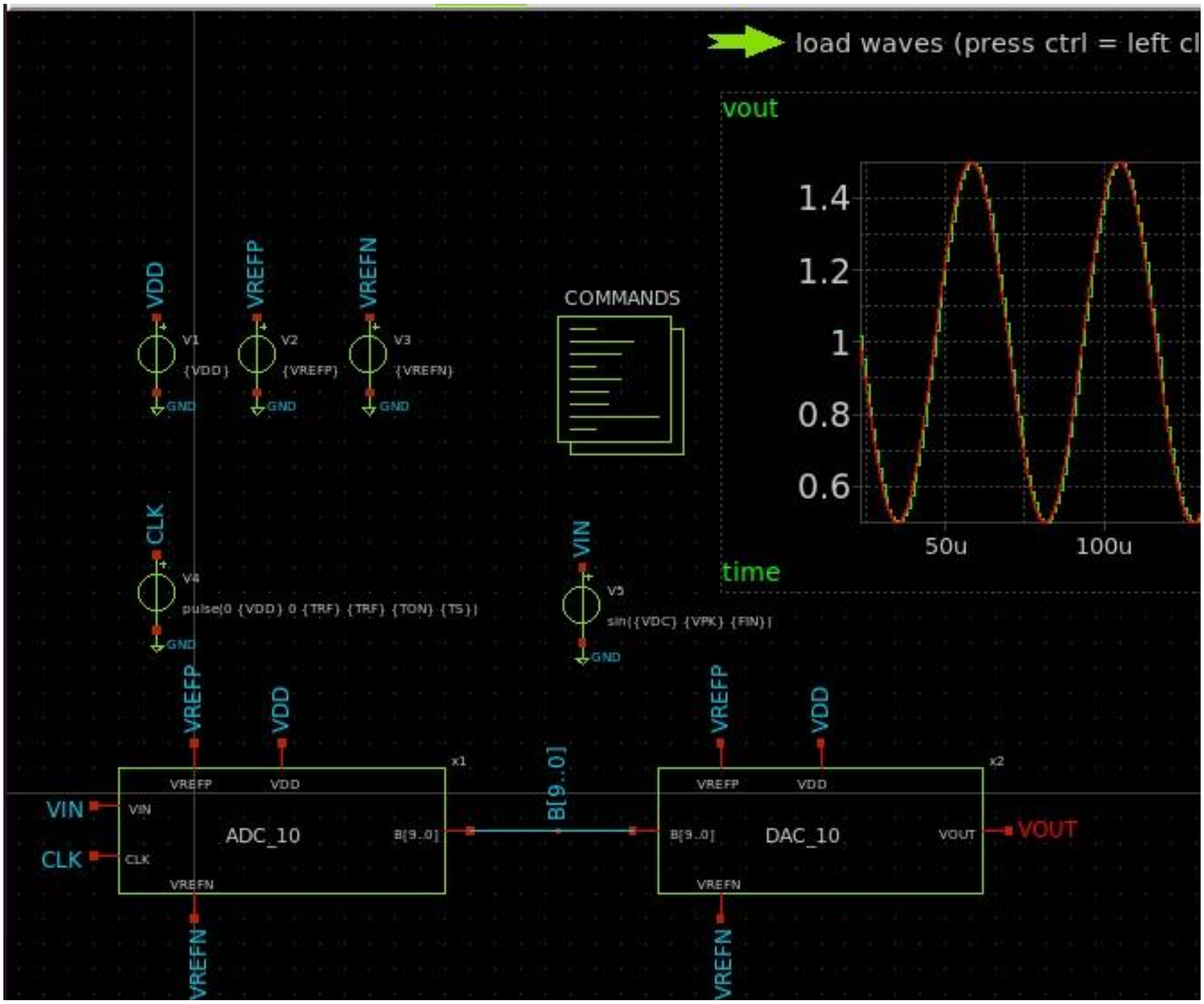


We can obseve the spectral leakage increasing the number of bins (nearly 7).

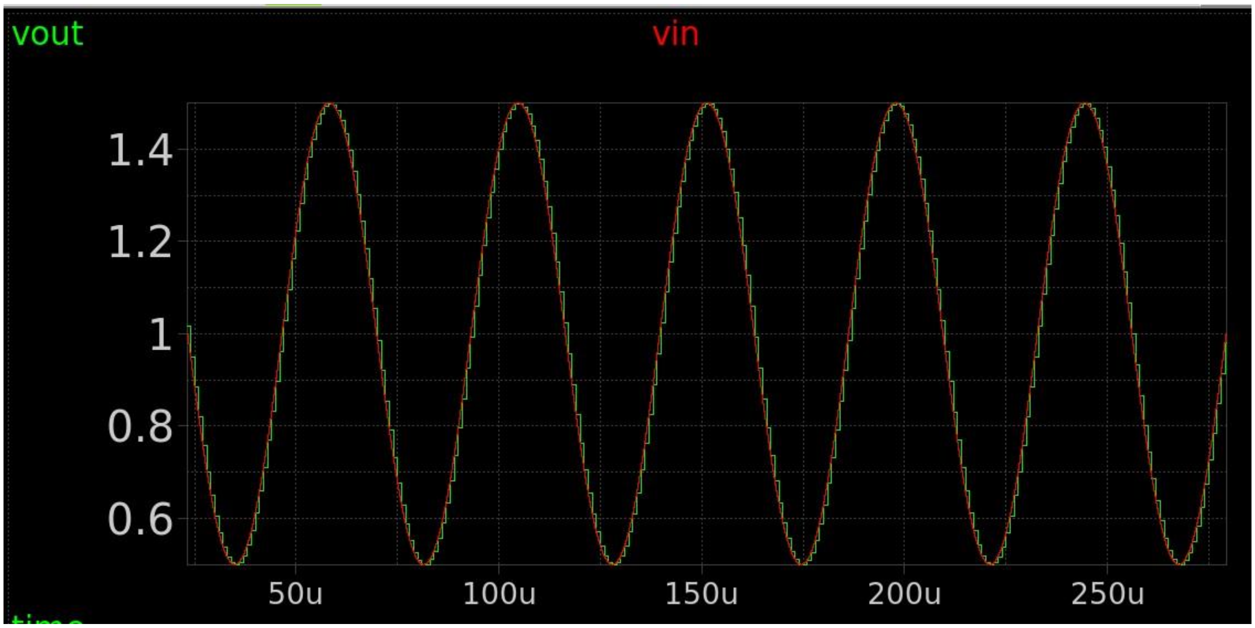
SNR decreased , noise floor is now about 75 dB as the specral leakage effet is added to the fft noise and quantization noise

Part 2

Ncyc=5:

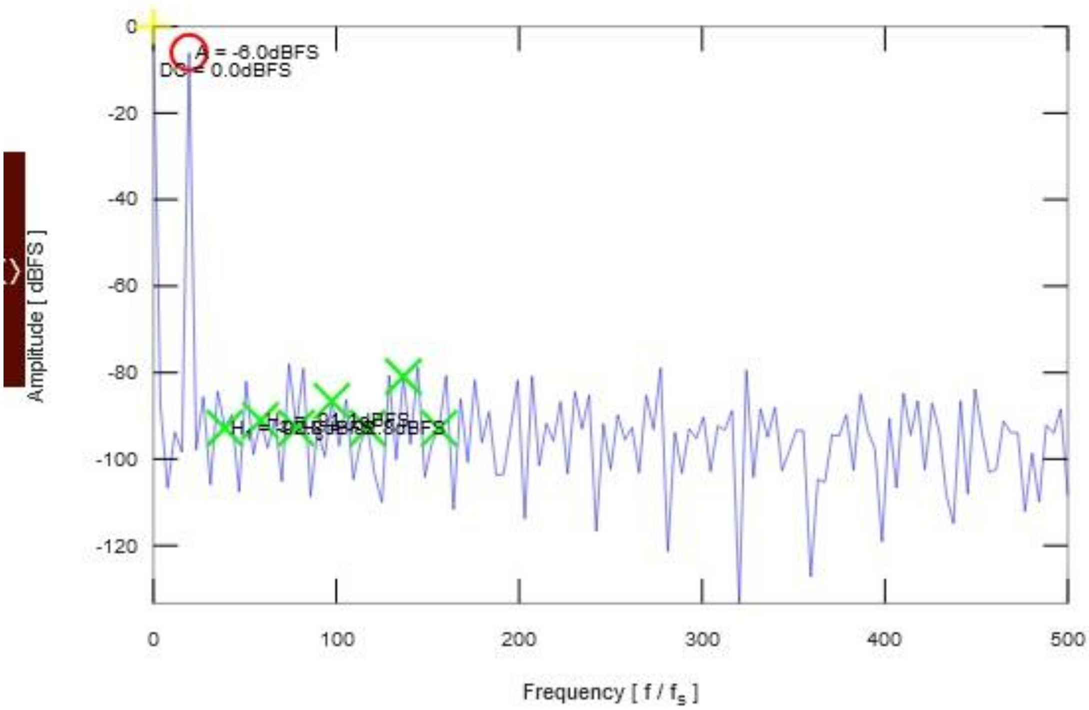


load waves (press ctrl = left cl
vout
1.4
1.2
1
0.8
0.6
50u
100u
time
VDD
VREFP
VREFN
V1
{VDD}
V2
{VREFP}
V3
{VREFN}
GND
COMMANDS
CLK
V4
pulse(0 {VDD} 0 {TRF} {TRF} {TON} {TS})
VIN
V5
sin({VDC} {VPK} {FIN})
VREFP
VDD
x1
B[9..0]
x2
VIN
CLK
ADC_10
DAC_10
VOUT
VREFN



FFT

56 ENOB = 9.9-bit SNR = 61.4dB THD = -72.8dB SNDR =61.1dB SFDR = 72.0dB NoiseFlo



N = 256 NoiseFloor = -88.1dB

(3)When observing the timing analysis the two signals are continuous in time but we can say that the quantized signal is discrete as it takes the shape of steps

(5) SNR

from plot : SNR = 61.4 dB

analytically : SNR = 6.02*10+1.76 = 61.96 dB

ENOB

from plot : ENOB =9.9 bit

analytically : ENOB = (SINAD-1.76)/6.02 = (61.1-1.76)/6.02 = 9.85 bits

SIGNAL POWER

DC COMPONENT = 0dB (1 in linear scale)

Single tone =-6dB (0.5 in linear scale)

Single tone is sin wave with power = A**2/2 =0.25/2=0.125

P=10log(0.125)= 9 dB

DC POWER

from plot Pdc =0 db

analytically : Vdc = VDD/2 = 1V

Pdc = 10 log (1*squared) =0 db

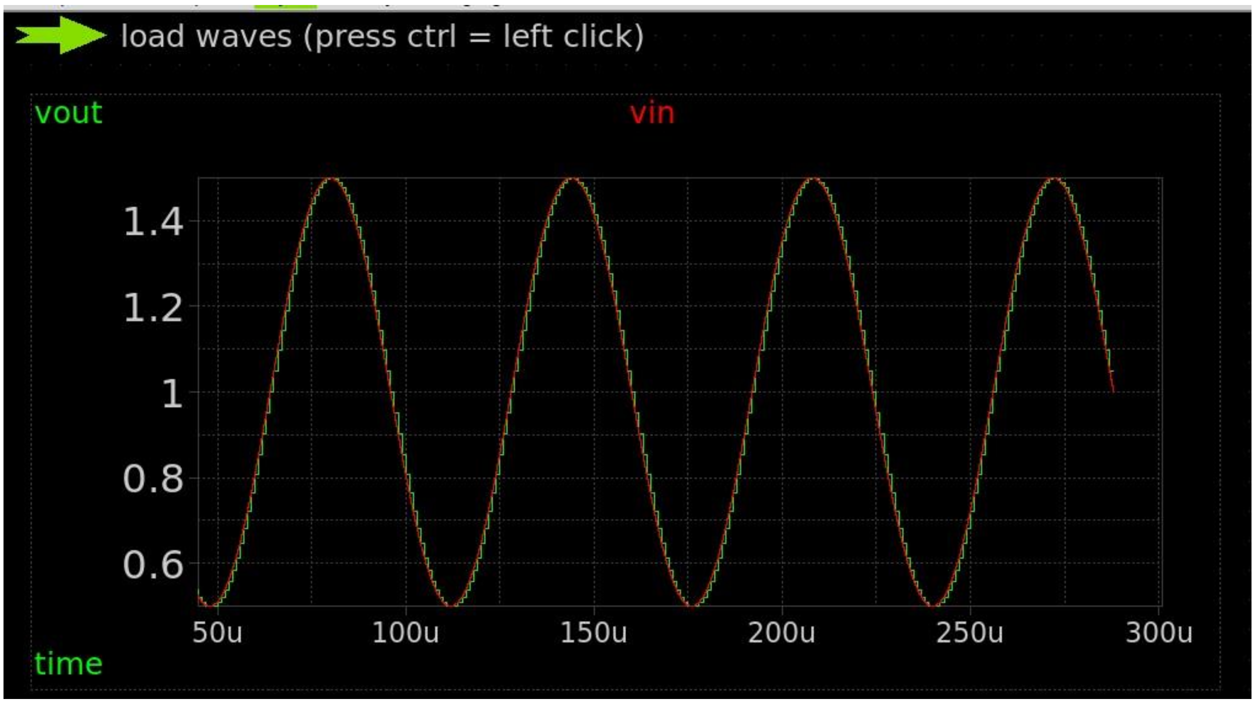
NOISE FLOOR

From plot : noise floor = -88.1dB

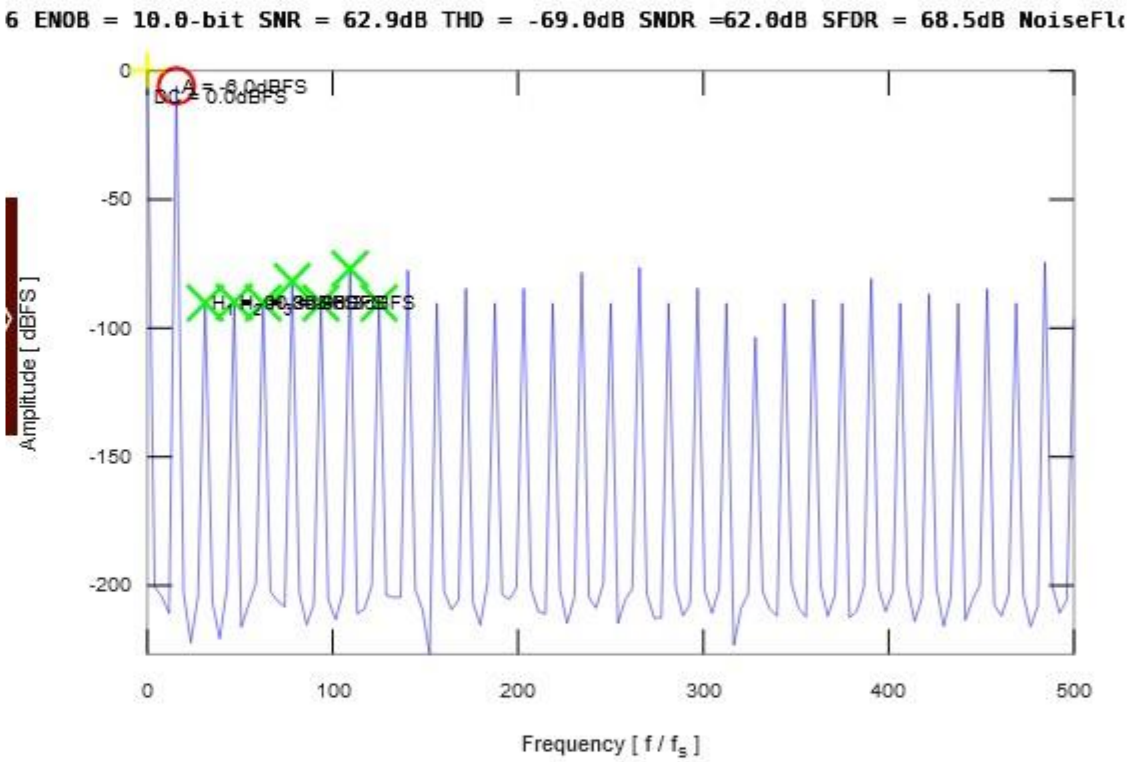
Analytically : noise floor =SNR + 10log(M)= 61.96 + 10log(256) = 86.1 dB

(6)SFDR = 72 dB (from plot)

For Ncyc = 4



FFT



N = 256 NoiseFloor = -89.7dB

New SFDR = 68.5 dB from plot

Comment :

SFDR increased when Ncyc =4 as now (Ndft/Ncyc) is an integer number so the harmonics effect increased as the plot shows which lead to decreasing SFDR