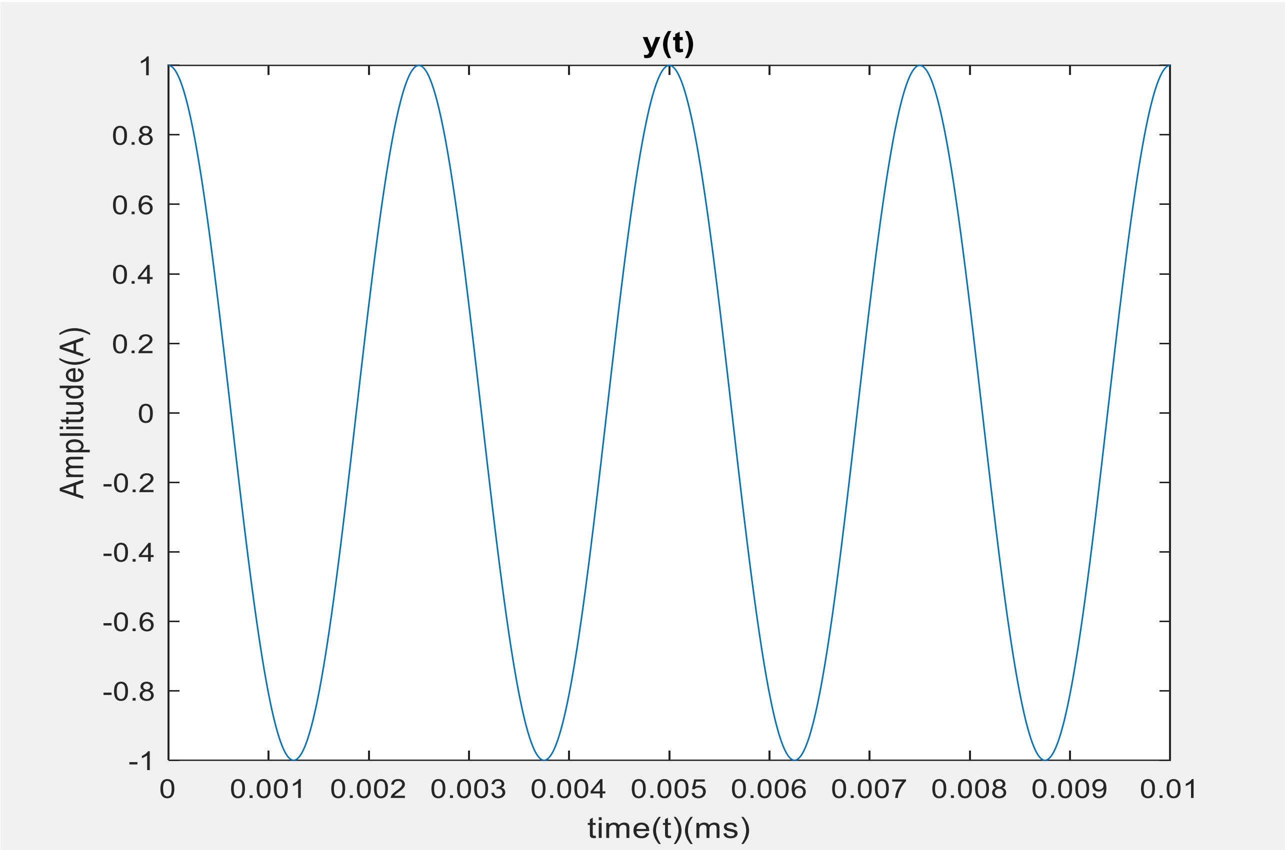
Assignment 1 **180427N**

1.



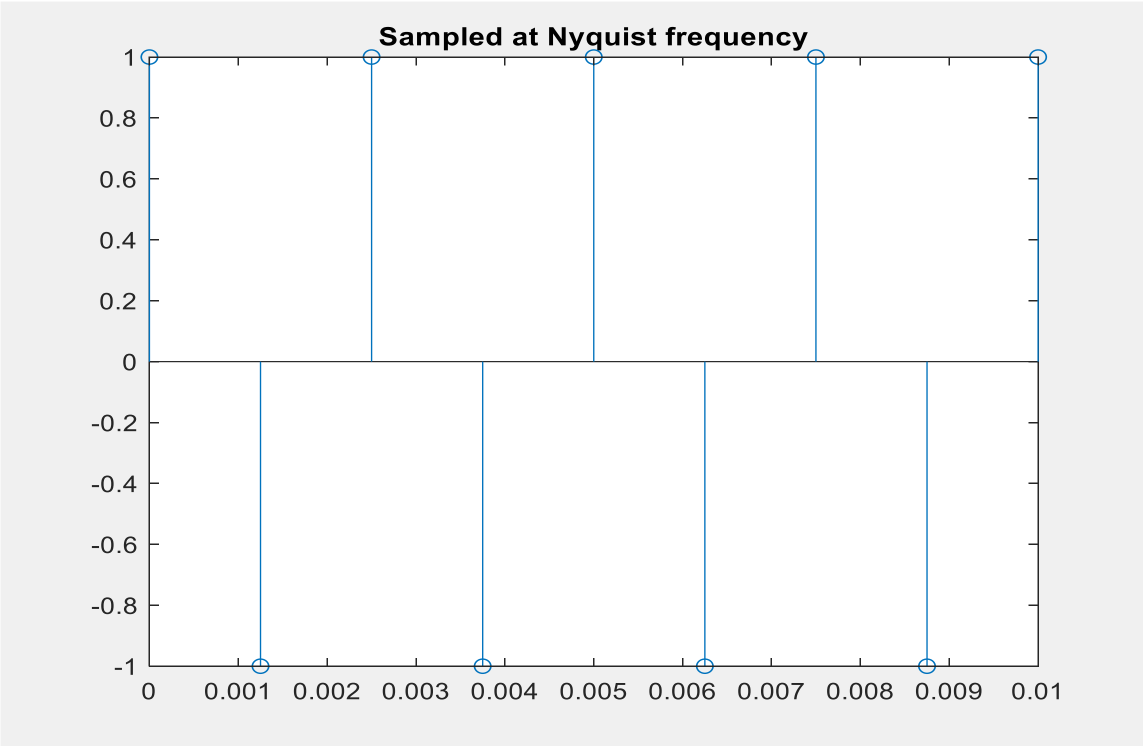
2.

Nyquist Sampling frequency (f_{nq}) $= 2 \times f$

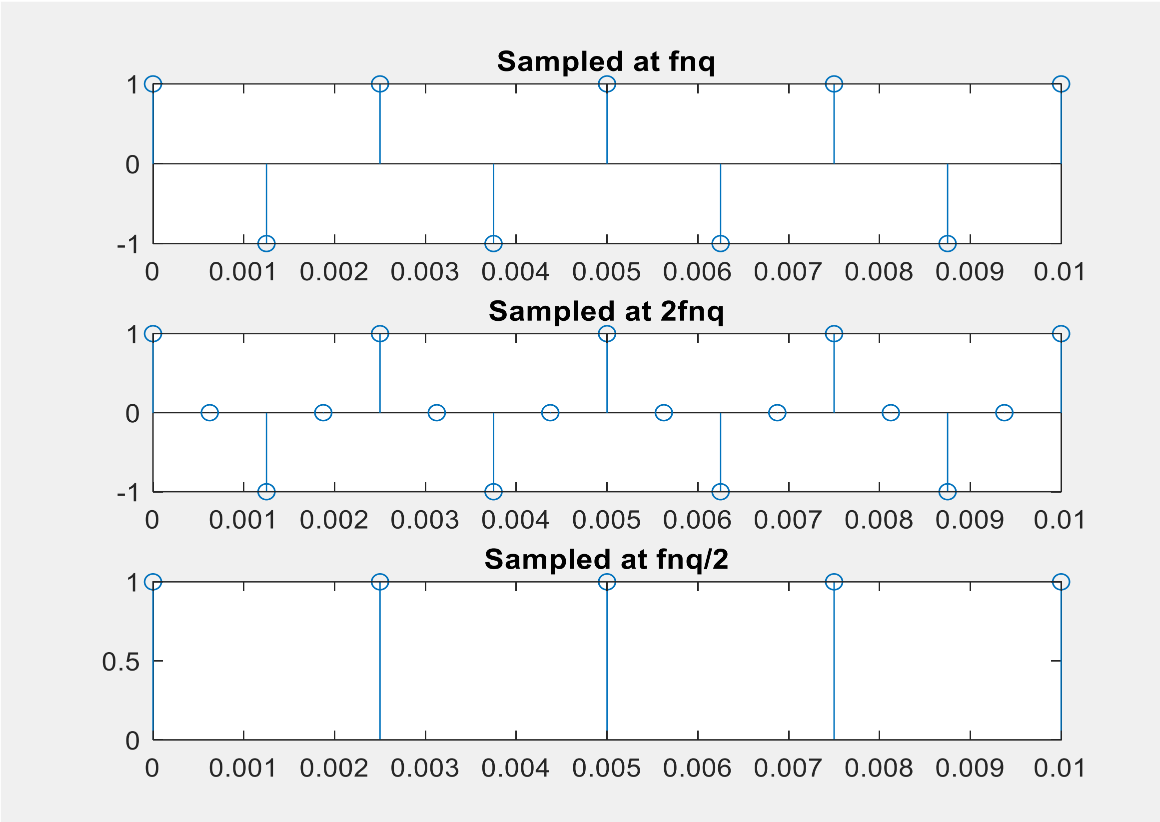
$$= 2 \times 400 = 800\ Hz$$

s

3. Sampled signal



4.



When the sampling frequency increases from fnq to 2fnq the number of samples increases. Since sampling frequency is doubled the number of samples also doubled.

On the other hand, when sampling frequency decreases from fnq to fnq/2 the number of samples decreases. Since sampling frequency is halved the number of samples also halved. Further there is no negative value samples when sampling frequency is halved(fnq/2).

5.

Q5)

Let's assume that quantization error is equally likely distributed over the range of $\left\{-\frac{\Delta v}{2}, \frac{\Delta v}{2}\right\}$.

$\Delta v \rightarrow$ gap between two quantized levels.

In this case SN_qR can be derived as.

$$SN_qR = \frac{3L^2\overline{y^2(t)}}{A^2}$$

$$y(t) = A\cos(2\pi f t) = 1.\cos(2\pi f t)$$

$$\overline{y^2(t)} = \frac{A^2}{2} = \frac{1}{2}$$

$L =$ No.of intervals (levels)

$$SN_qR \geq 25dB$$

$$\frac{3L^2\overline{y^2(t)}}{A^2} \geq 10^{2.5}$$

$$L^2 \geq \frac{10^{2.5} \times 1}{3 \times 1/2} \qquad (L = 2^n)$$

n = no. of bits

$$L^2 \geq 210.81$$

$$L \geq 14.5$$

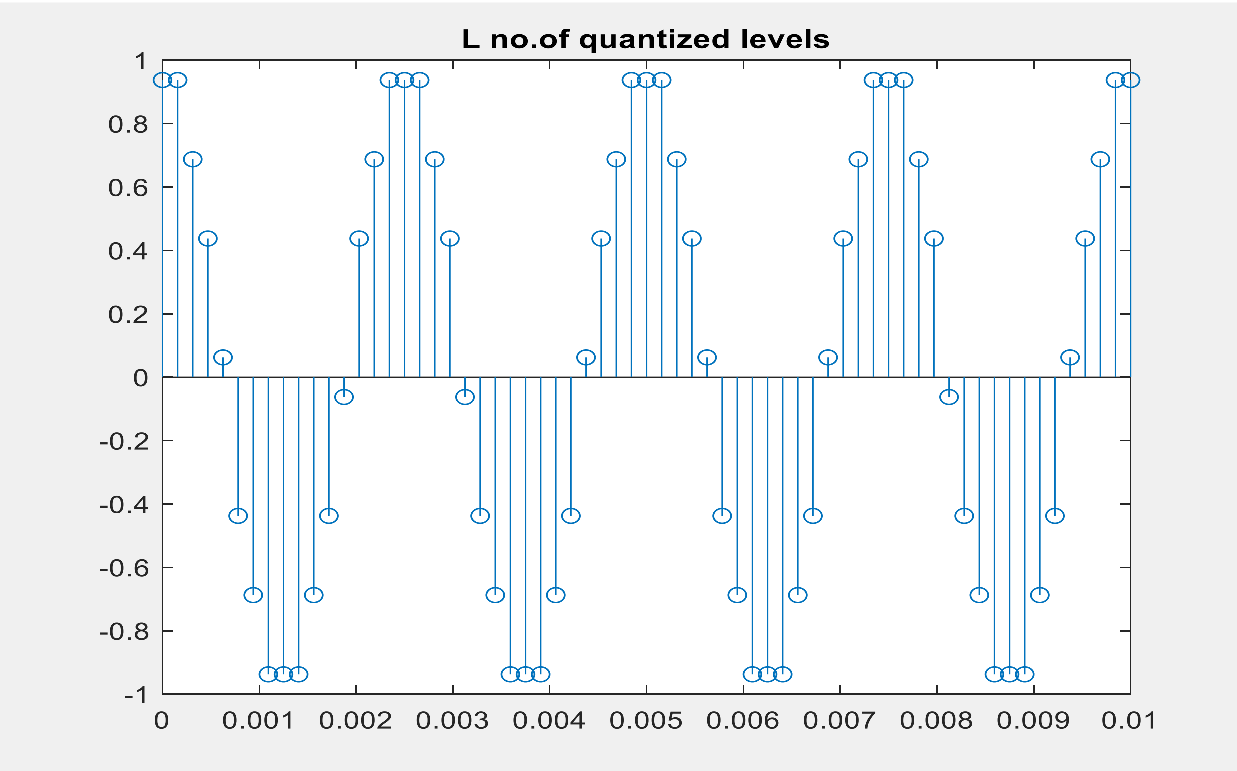
So, the number quantization level is 16 (minimum)

Minimum Quantization levels(L) = 16. , number of bits = 4

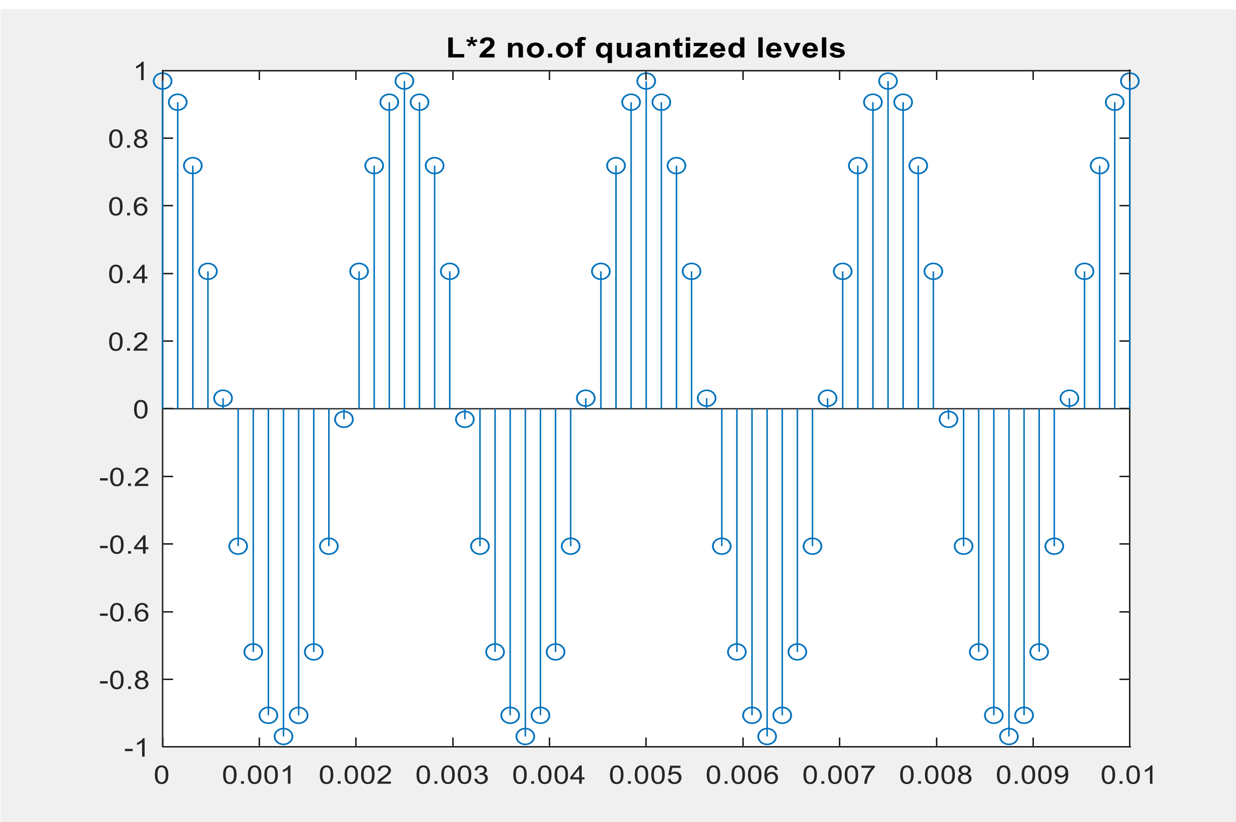
6.

```
function [q_values] = Quantized_value(sampled_val,L, range)
% no.of quantized value
pp = range(1); % positive  peak
np = range(2); % negative peak
delta_v = (pp - np)/L; % gap between levels
q_level = np+ delta_v/2: delta_v : pp - delta_v/2; %quantized levels
q_index = round((sampled_val - np)/delta_v + 0.5); %indices
q_index = min(q_index, L); % removing L+1 index
q_values = q_level(q_index);
end
```

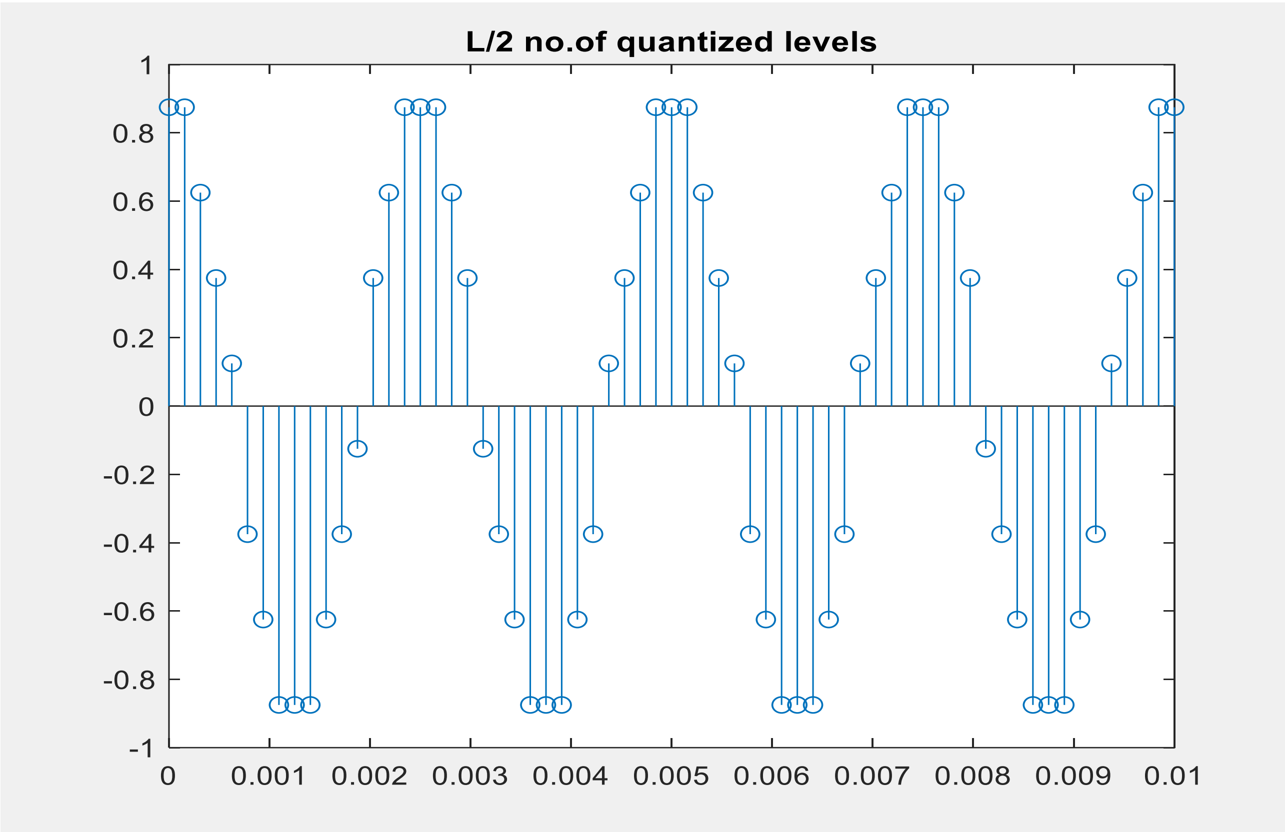
7. Quantized signal. L = 16.



8. Quantized signal with L*2 (32) levels.



Quantized signal with L/2 (8) levels.



When the number of levels increases from L to L*2 the quantized signal is more likely our input signal. So, the quantization error is very low.

Similarly, we can see when the number of levels decreases from L to L/2 the quantized signal is not more likely our input signal. In this case quantization error is high.

Code

```
% Assignment 01
t = 0:10e-6:10e-3;
f = 400;
A = 1;
figure(1);
y = A*cos(2*pi*f*t);
plot(t,y);
xlabel("time(t) (ms)");
ylabel("Amplitude(A)");
title("y(t)");

fnq = 400*2;
n = 0:1/fnq:10e-3;
figure(2);
stem(n, cos(2*pi*f*n));
title("Sampled at Nyquist frequency");
figure;
n1 = 0:1/(2*fnq):10e-3;
n2 = 0:2/fnq:10e-3;
subplot(3,1,1); stem(n,cos(2*pi*f*n)); title("Sampled at fnq");
subplot(3,1,2); stem(n1,cos(2*pi*f*n1)); title("Sampled at 2fnq");
subplot(3,1,3); stem(n2,cos(2*pi*f*n2)); title("Sampled at fnq/2");
```

```
n_vec = 0:1/(8*fnq):10e-3;
samples = A*cos(2*pi*f*n_vec);
L = 16;
figure;
stem(n_vec, samples);
range = [1,-1]; % positive and negative peak
q_values_1 = Quantized_value(samples, L, range);

L1 = L*2;
q_values_2 = Quantized_value(samples, L1, range);

L2 = L/2;
q_values_3 = Quantized_value(samples, L2, range);
```

```
figure;
stem(n_vec, q_values_1); title("L no.of quantized levels");
figure;
stem(n_vec, q_values_2); title("L*2 no.of quantized levels");
figure;
stem(n_vec, q_values_3); title("L/2 no.of quantized levels");
```