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Assingment 1

1. $x_c(t) = \cos(50\pi t)$ $\quad f_s = 30Hz$

a). $x_c(t)$ after sampled at $f_s = 30\,Hz$

$$x(n) = \cos 50\pi \times \frac{n}{30}$$

$$= \cos\left[2\pi n\left(\frac{5}{6}\right)\right] = \cos\left[2\pi n - \frac{\pi n}{3}\right] = \cos\left[\frac{\pi n}{3}\right]$$

Therefore

$$x(n) = \cos\left[2\pi n\left[\frac{5}{6}\right]\right] = \cos\left[\frac{\pi n}{3}\right]$$

b) Since $x(n)$ can be written as.

$$x(n) = \cos(\omega_0 n)$$

$$\omega_0 n = \frac{\pi n}{3}$$

$$\omega_0 = \frac{\pi}{3} \text{ rad / sample.}$$

c) for fundamental frequency.

$$\omega_0 n = 2\pi$$

$$\frac{\pi}{3} n = 2\pi$$

$$n = 6$$

fundamental period $n = 6$

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c). according to the nyquist theorem $f_s \geq 2|f|$ to be not aliasing

Therefore since $30 < 2 \times 25$ Hz the sampling will cause aliasing.

if we reconstruct the signal back

$$x(t) = \cos\left(\frac{\pi t}{3} \times 30\right)$$

$$= \cos(10\pi t)$$

$$= \cos(2\pi\, 5.t)$$

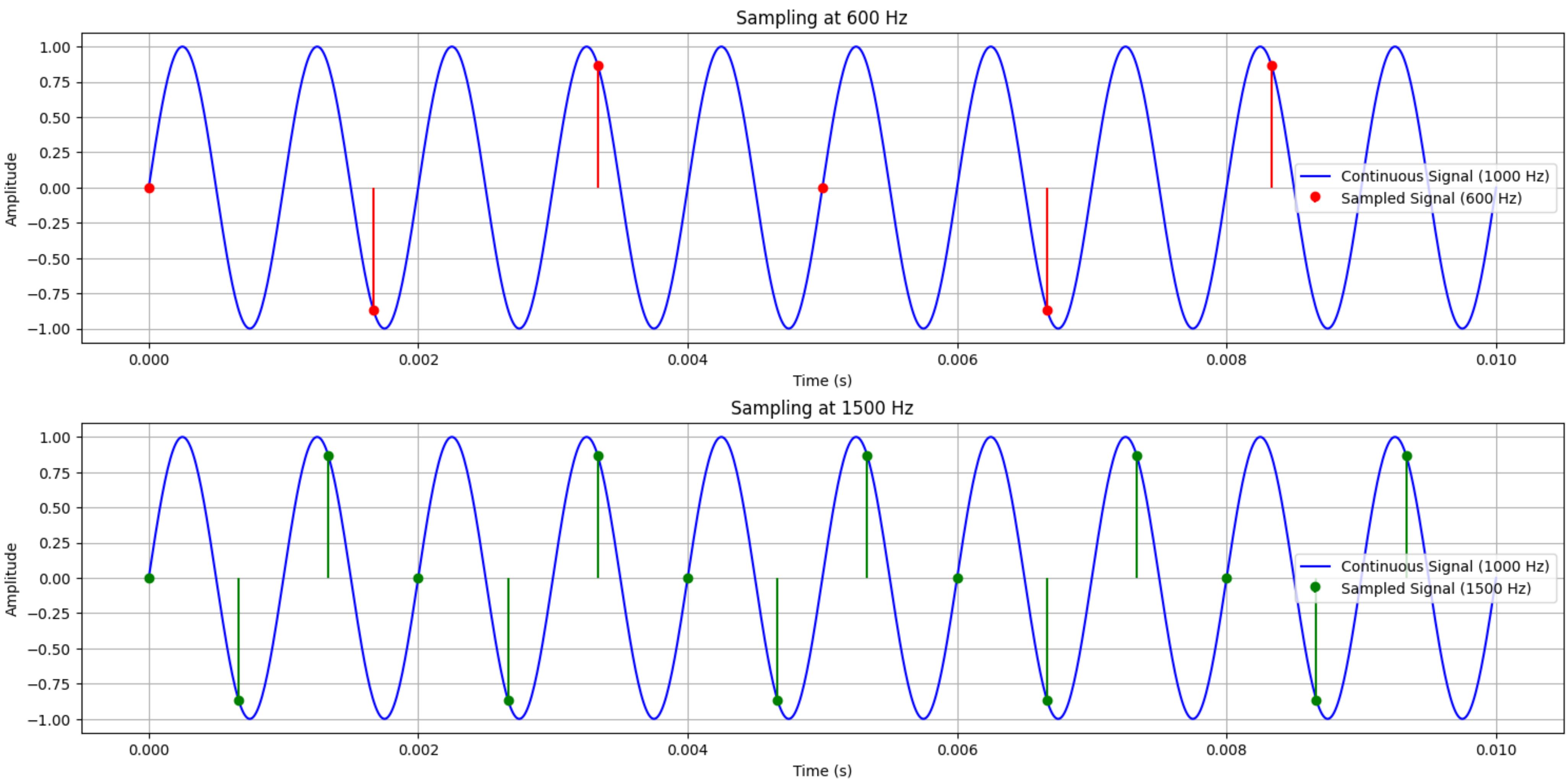
Therefore aliased frequency $= \underline{\underline{5 Hz}}$

3.

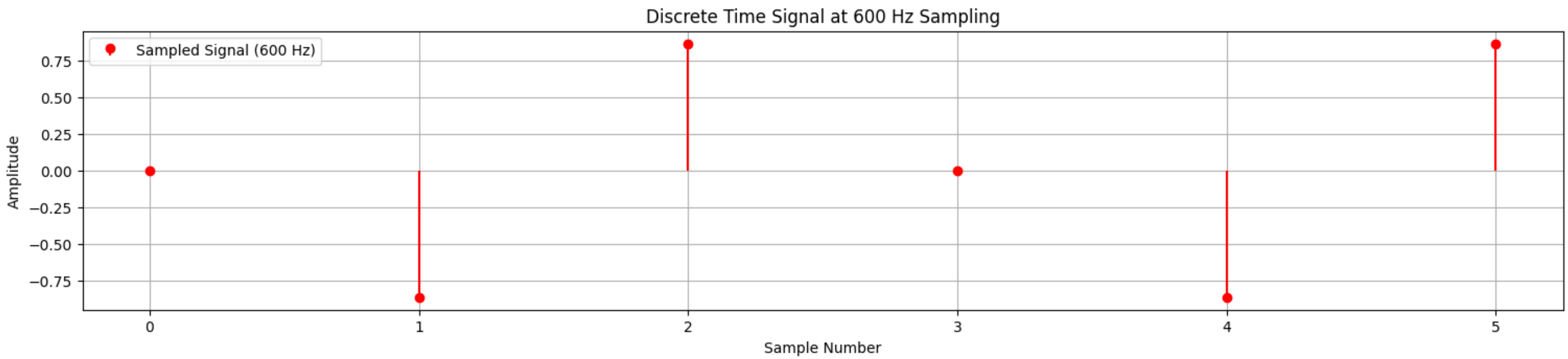
a). according to the nyquist theorem if a signal has frequency components upto 5 kHz minimal sampling frequency should be 10 kHz to stop aliasing

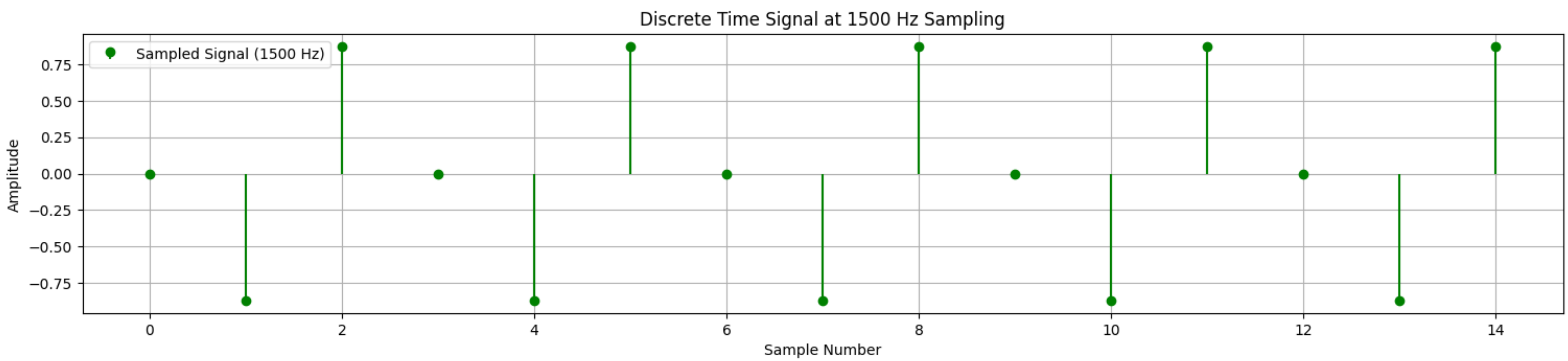
b). if 15 kHz and 5 kHz components are available $f_s = 30$ kHz

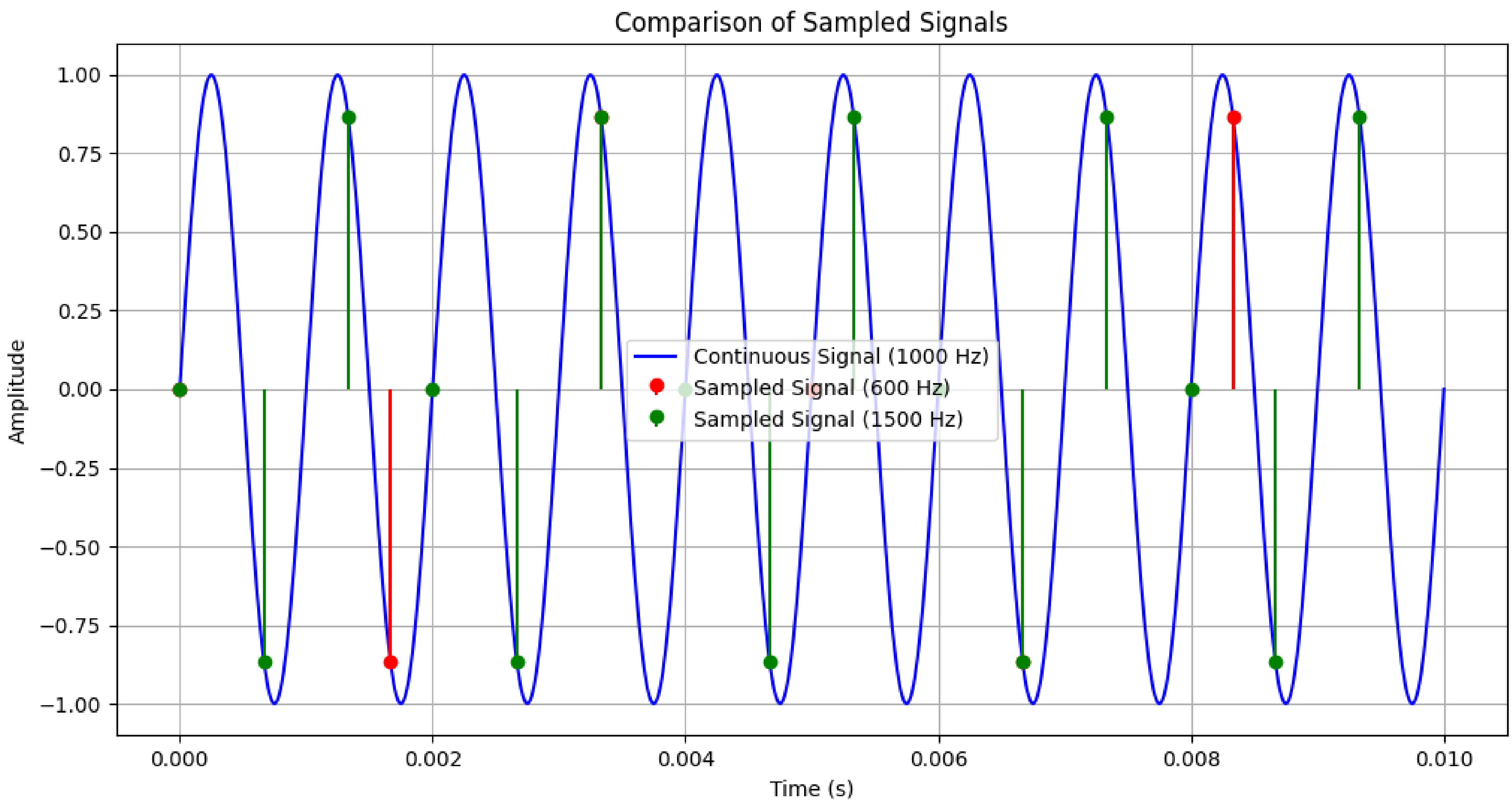
c). zero order hold is a reconstruction method where the value of the sample is kept constant when reconstructing until the next sample which will last for T_s time.



Sampling at 600 Hz
Amplitude
Time (s)
Continuous Signal (1000 Hz)
Sampled Signal (600 Hz)
Sampling at 1500 Hz
Amplitude
Time (s)
Continuous Signal (1000 Hz)
Sampled Signal (1500 Hz)


Discrete Time Signal at 600 Hz Sampling
Sampled Signal (600 Hz)
Amplitude
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
0
1
2
3
4
5
Sample Number


Discrete Time Signal at 1500 Hz Sampling
Sampled Signal (1500 Hz)
Amplitude
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
0
2
4
6
8
10
12
14
Sample Number


Comparison of Sampled Signals
Amplitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.000
0.002
0.004
0.006
0.008
0.010
Time (s)
Continuous Signal (1000 Hz)
Sampled Signal (600 Hz)
Sampled Signal (1500 Hz)