(1)

LAB REPORT - 9

Submitted by→
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Q1 $x = 2\cos(2t\pi + \frac{\pi}{4})$, $t \in R$

a) $T_s = 0.2$ s/sample ; b) $T_s = 0.4$ s/sample

c) $T_s = 0.5$ s/sample ; d) $T_s = 1$ s/sample

Check whether the signal can be reconstructed for each case.

$$x(t) = 2\cos\left(2\pi t + \frac{\pi}{4}\right)$$

$$x(t+t_0) = 2\cos\left(2\pi(t+t_0) + \frac{\pi}{4}\right)$$

$$= 2\cos\left(2\pi t + \frac{\pi}{4} + 2\pi t_0\right)$$

$\Rightarrow$ $x(t) = x(t+t_0)$
when
$t_0 = 1$

$\Rightarrow$ Time period (fundamental) $T_0 = 1$ s

$$\Rightarrow f_m = \frac{1}{T_0} = 1 \text{ Hz}$$

(2)

$T_s = 0.2\,s/\text{sample}$

a) Nyquist condition:

$$f_s > 2f_m$$

$f_s = \frac{1}{0.2}$, $f_m = 1$

$= 5$ $\quad f_s > 2f_m$ is true

Signal can be reconstructed

b) $T_s = 0.4\,s/\text{sample}$

$f_s = \frac{1}{0.4} = 2.5\,Hz$, $f_m = 1\,Hz$

$$f_s > 2f_m$$

$\Rightarrow$ Signal can be reconstructed

c) $T_s = 0.5\,s/\text{sample}$

$f_s = \frac{1}{0.5} = 2\,Hz$, $f_m = 1\,Hz$

Nyquist condition: $\quad f_s \not> 2f_m$

$$f_s > 2f_m$$

$\Rightarrow$ Signal can be reconstructed.

d) $T_s = 1$ s/sample

$f_s = 1$ Hz, $f_m = 1$ Hz

$\Rightarrow f_s \not> 2f_m$

$\Rightarrow$ Signal can't be reconstructed

Q2 $x(t) = \cos(2000\pi t)$, check whether the Signal can be reconstructed for both cases:

a) $f_s = 6000$ Hz b) 800 Hz

$x(t) = \cos(2000\pi t)$

Time period $T_0 = \frac{2\pi}{2000\pi} = \left(\frac{1}{1000}\right)$ s

$\Rightarrow f_0 = f_m = \frac{1}{T_0} = 1000$ Hz

a) $f_s = 6000$ Hz

According to Nyquist Condition:

$$f_s > 2f_m$$

$\Rightarrow 2f_m = 2000$

Signal can be reconstructed.

b) $f_s = 800\,Hz$, $2f_m = 2000\,Hz$

$\Rightarrow f_s \ngtr 2f_m$

Signal cannot be reconstructed

Q3 Plot $x_r(t)$

$$x(t) = 2 - \cos(f_0 \pi t) - \sin(2 f_0 \pi t)$$

for $f_0 = 500\,Hz$, and

(i) for $f_s = 6000\,Hz$

(ii) for $f_s = 800\,Hz$

$$x(t) = 2 - \cos(f_0 \pi t) - \sin(2 f_0 \pi t)$$

Time period of cos $= T_1 = \frac{2\pi}{f_0 \pi} = \frac{2}{f_0}$ s

Time period of sin $= T_2 = \frac{2\pi}{2 f_0 \pi} = \frac{1}{f_0}$ s

Actual time period $= \left(\frac{2}{f_0}\right)$ s $= \left(\frac{1}{250}\right)$ s

(i) $f_s = 6000\ Hz$ (sample/s)

$f_m = 250$ sample/s

$f_s > 2 f_m$ (Follows Nyquist condition)

Signal can be reconstructed.

(ii) $f_s = 800\ Hz$ (sample/s)

$f_m = 250$ sample/s

$f_s > 2 f_m$ (Follows Nyquist condition)

Signal can be reconstructed.