Lecture 6 Sampling Theorem

The University of Texas at Austin
EE 313 Linear Systems and Signals
Prof. Brian L. Evans Fall 2018
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$\boxed{\text{slide } 6\text{-}4}$

$f_s > 2f_0 \Rightarrow f_0 < \frac{1}{2} f_0 \Rightarrow -\frac{1}{2} f_s \leq f_0 < \frac{1}{2} f_s$

$\hat{\omega} = 2\pi \frac{f_0}{f_s}$

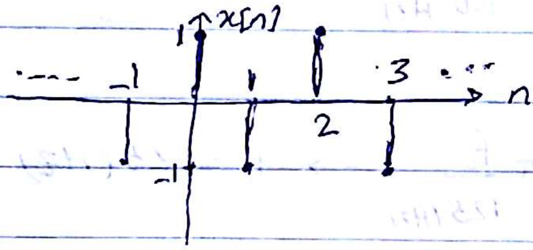
Sampling at a sampling rate fs cannot correctly capture frequencies above fs/2.

$x(t) = \cos(2\pi f_0 t) \longrightarrow x[n] = \cos(2\pi f_0 (nT_s))$

$= \cos\left(2\pi \frac{f_0}{f_s} n\right)$

Sampling at sampling rate fs will correctly capture frequency fs/2 in certain cases but not in others

when $f_0 = \frac{1}{2} f_s \longrightarrow x[n] = \cos(\pi n) = (-1)^n$



when $f_0 = \frac{1}{2} f_s$ and $y(t) = \sin(2\pi f_0 t)$

$\longrightarrow y[n] = \sin\left(2\pi \frac{f_0}{f_s} n\right) = \sin(\pi n) = 0$

f_0	$\hat{\omega} = 2\pi \frac{f_0}{f_s}$
$-\frac{1}{2} f_s$	$-\pi$
$\frac{1}{2} f_s$	π

$\boxed{\text{Slide 6-5}}$ Nyquist rate $= 2 f_{max}$

$$\cos(\theta) = \frac{e^{-j\theta} + e^{j\theta}}{2} \quad ; \quad X = A e^{j\phi}$$

$\boxed{\text{Slide 6-6}}$

$$0.5\pi = 2\pi \frac{f_0}{80\,(Hz)} \longrightarrow f_0 = 20\,(Hz)$$

$\boxed{\text{slide 6-7}}$ $0.4\pi = 2\pi \frac{f_0}{125\,(Hz)} \longrightarrow f_0 = 25\,(Hz)$

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