ECE 447 Fall 2025

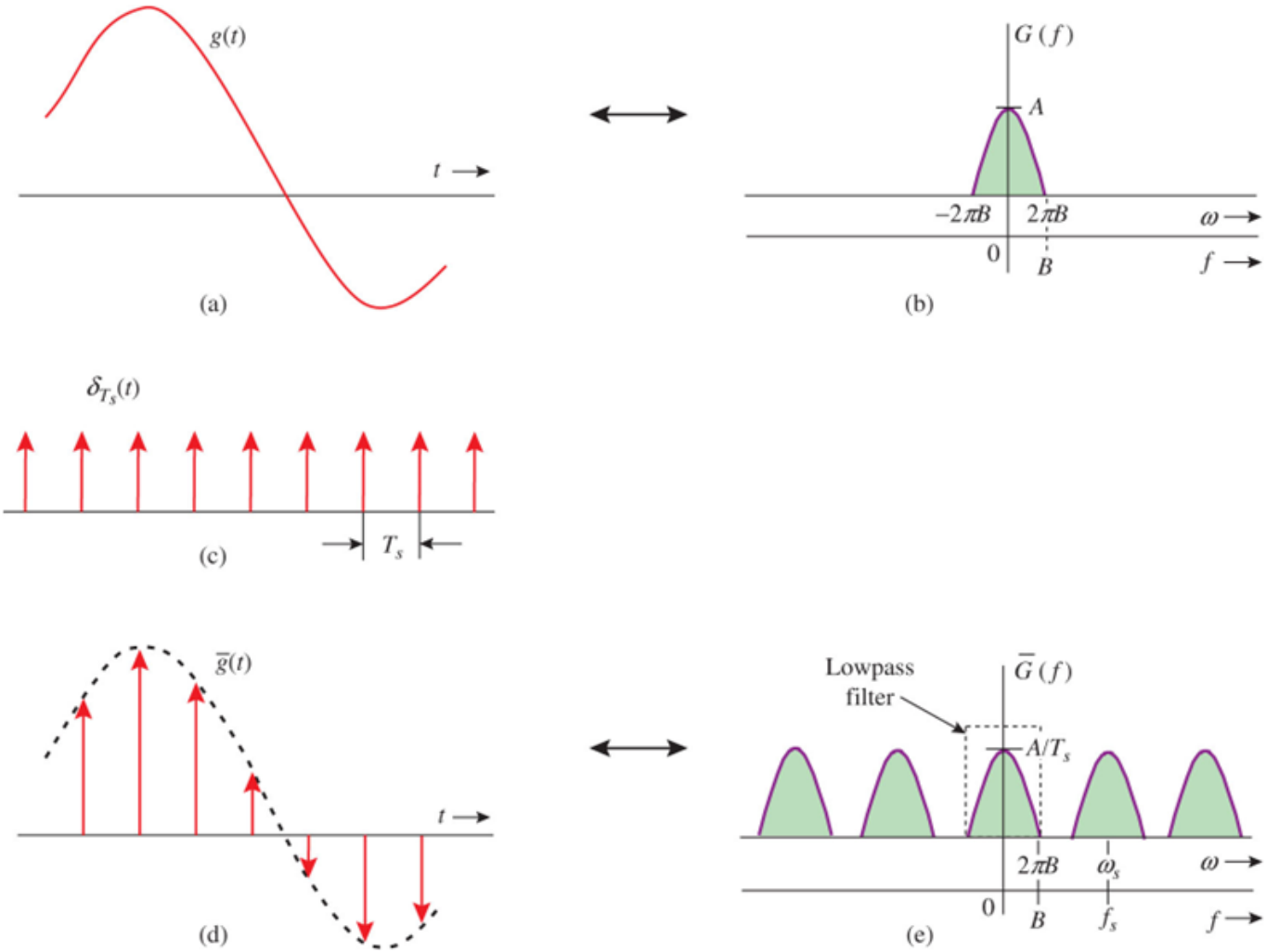
Lesson 18
Signal sampling and reconstruction

UNITED STATES
AIR FORCE
ACADEMY

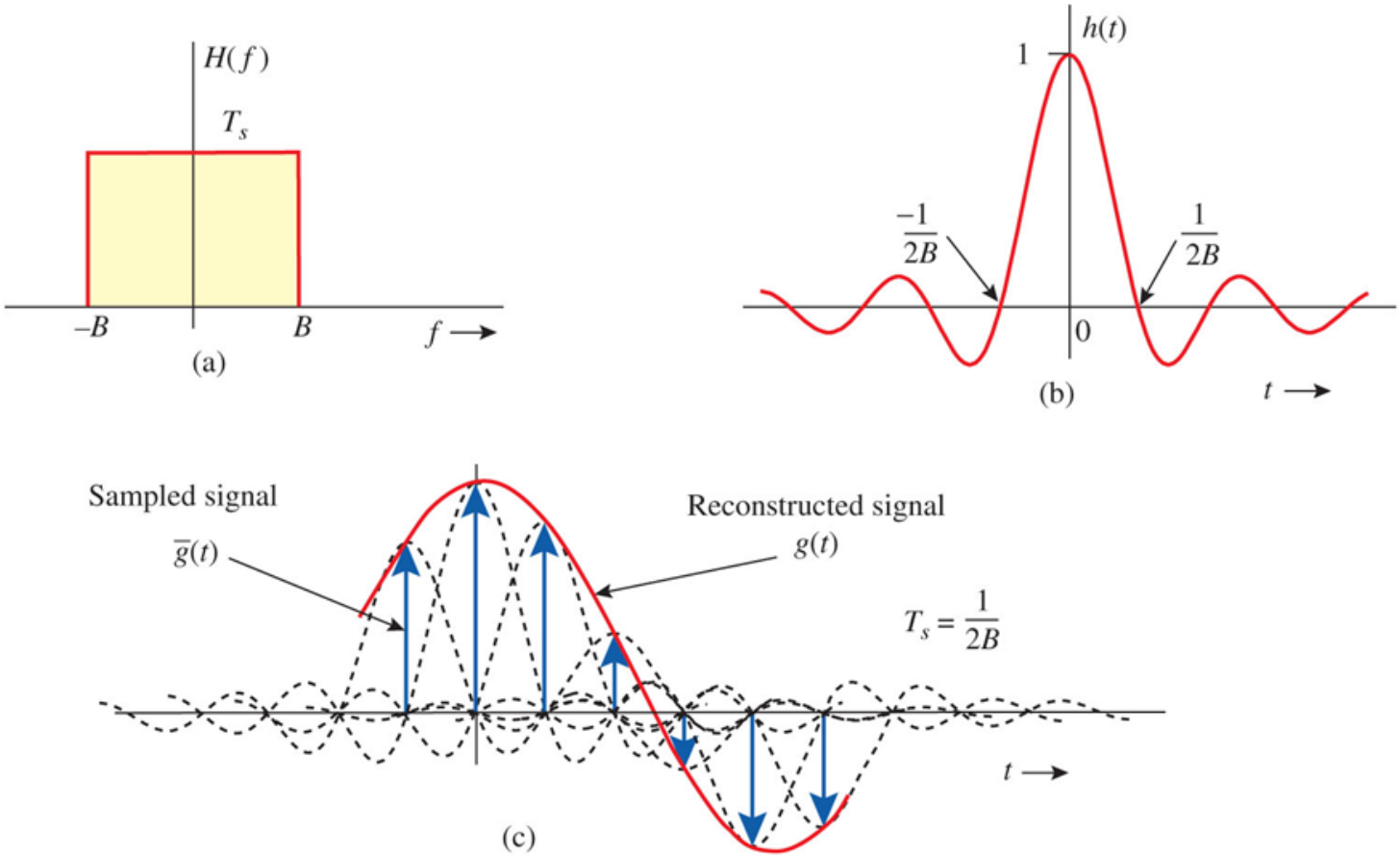
Schedule and Admin

- Schedule
- Admin
  - **HW3**. Posted on course website. Due Lesson 20 (1 Oct)
  - HW1-2 graded. Labs 2-3 and GR1 will be finished by Friday.

SAMPLING

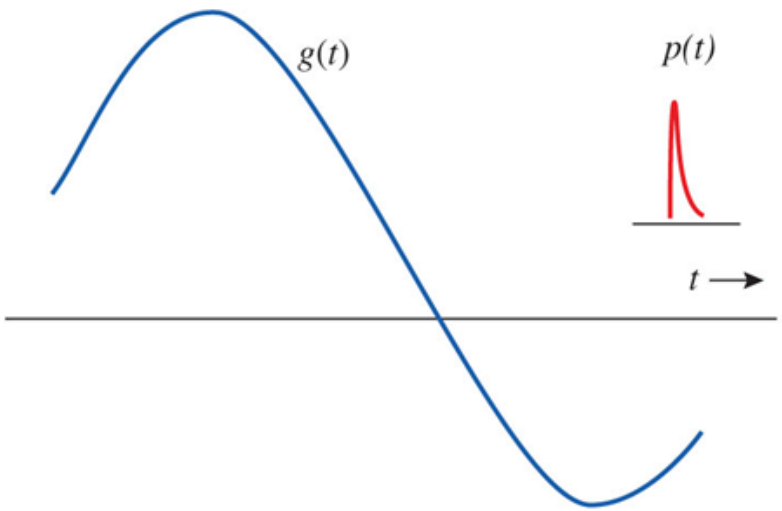

g(t)
t
(a)
G(f)
A
−2πB
2πB
ω
0
B
f
(b)
δ_Ts(t)
T_s
(c)
ḡ(t)
t
(d)
Lowpass filter
Ḡ(f)
A/T_s
2πB
ω_s
ω
0
B
f_s
f
(e)

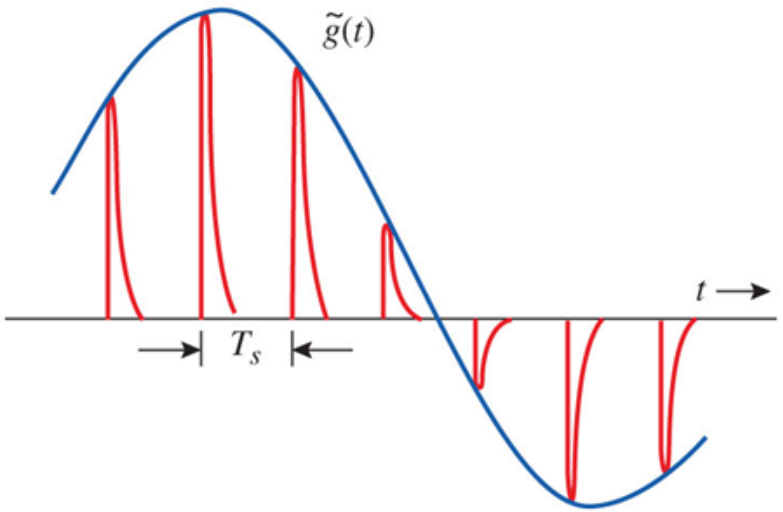
Ideal Reconstruction



Nonideal Reconstruction (Interpolation)

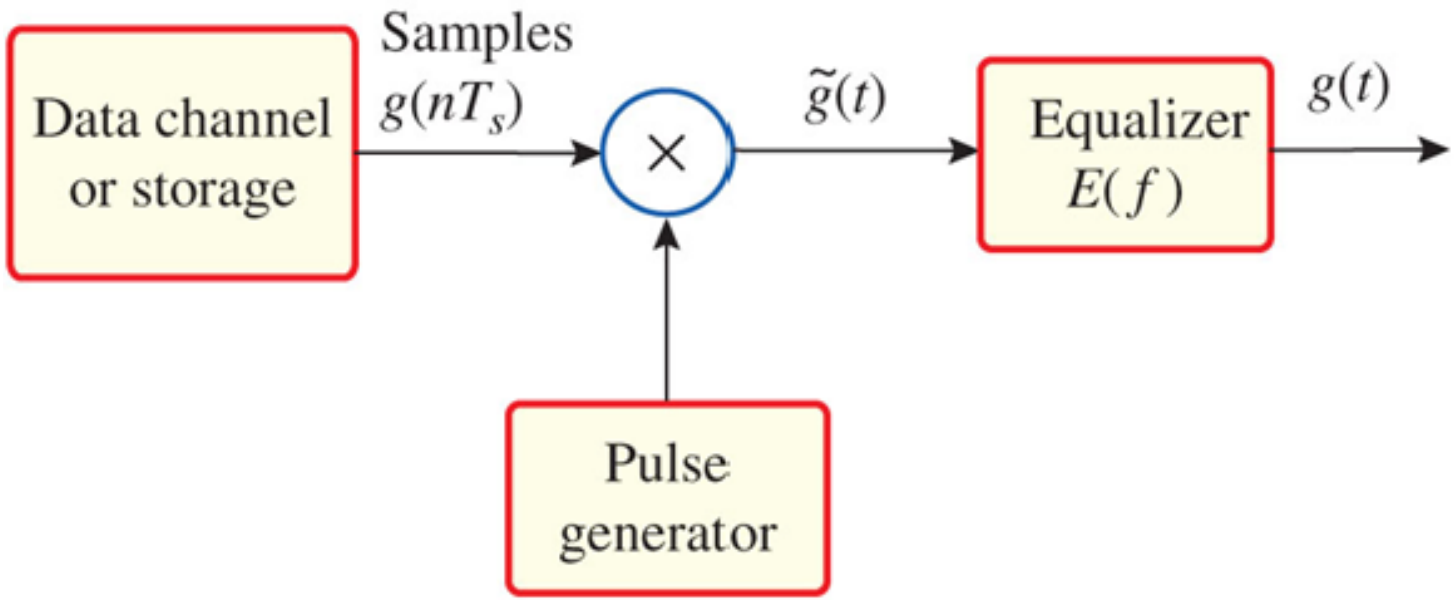
- Interpolation pulse $p(t)$
- $\tilde{g}(t) = p(t) * \bar{g}(t)$
- $\tilde{G}(f) = P(f)\bar{G}(f) = P(f)\frac{1}{T_s}\sum_n G(f - nf_s)$





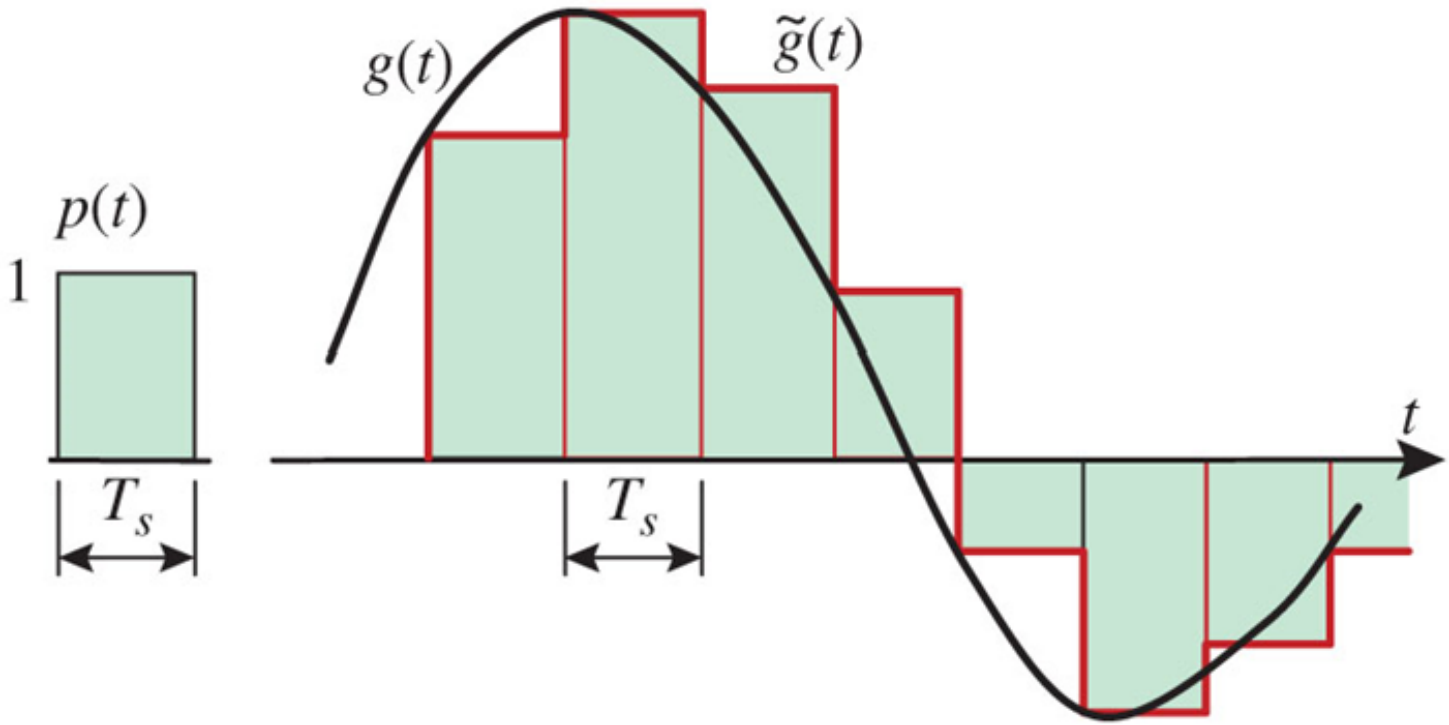
EQUALIZERS

- $P(f)$ filters sampled signal - need to reverse filtering to obtain original
- Use equalizers!



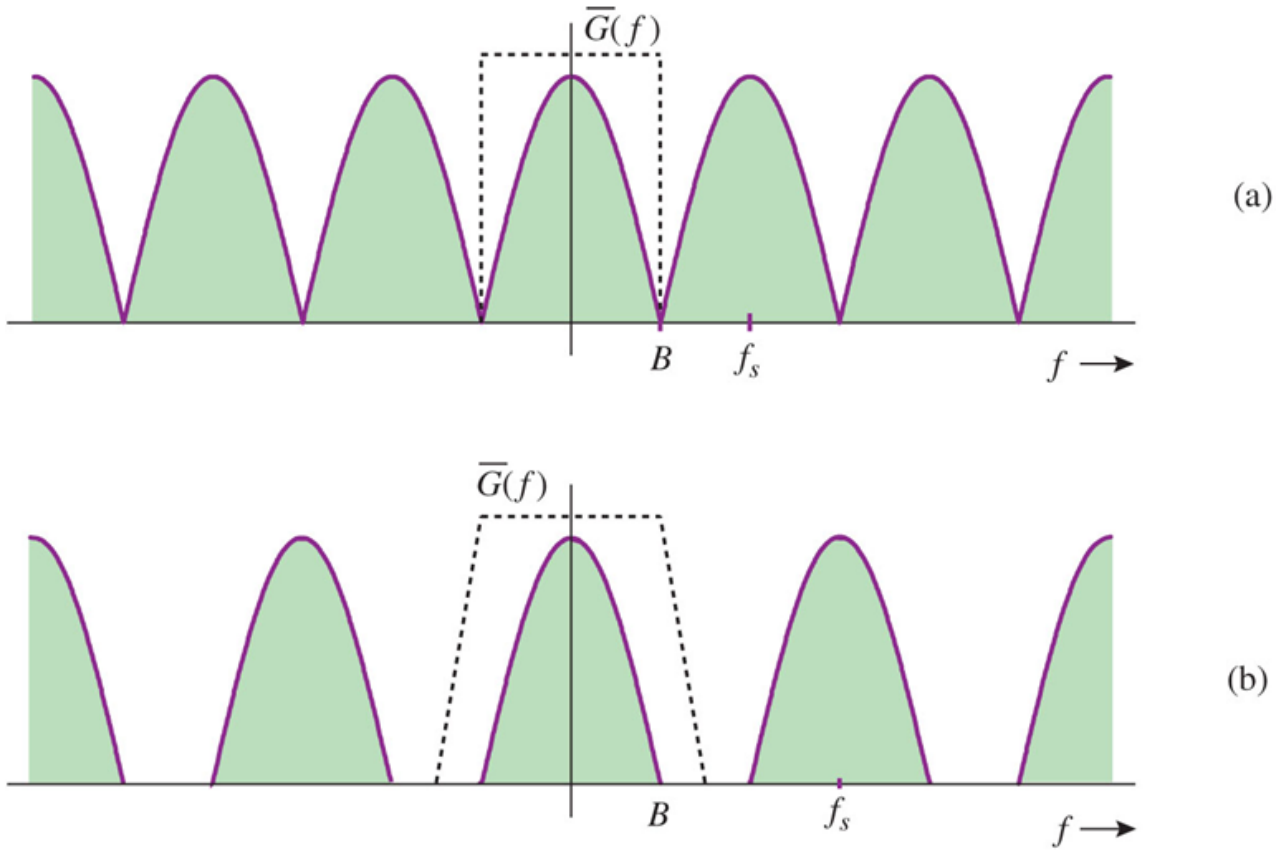
Interpolator Example - Flat Top Pulses

- Also known as a zero-order-hold pulse
- Samples signal and holds that value for T_s

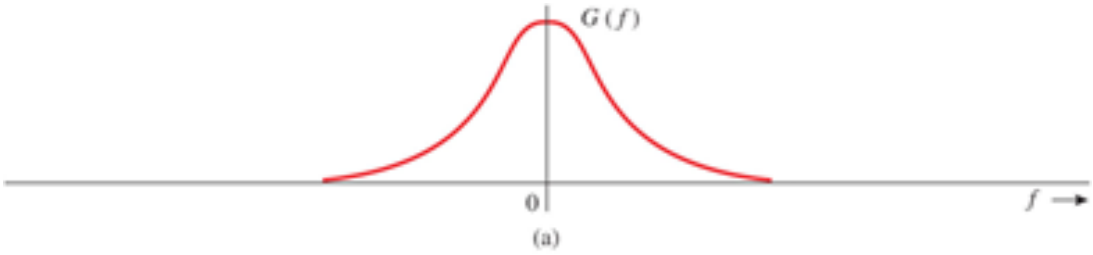


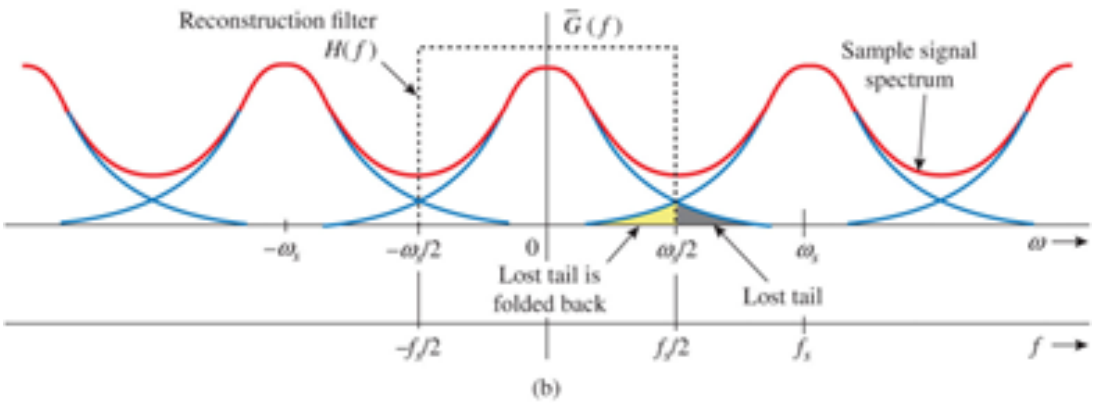
Realizable Reconstruction Filters

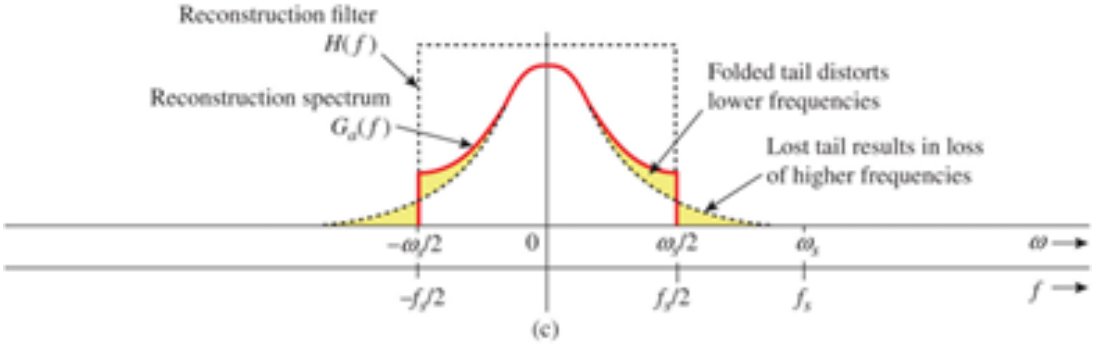
- Can't use ideal LPFs
- Need space between samples in spectra



ALIASING


G(f)
0
f
(a)


Reconstruction filter
H(f)
$\overline{G}(f)$
Sample signal spectrum
$-\omega_s$
$-\omega_s/2$
0
$\omega_s/2$
ω_s
ω
Lost tail is folded back
Lost tail
$-f_s/2$
$f_s/2$
f_s
f
(b)


Reconstruction filter
H(f)
Reconstruction spectrum
$G_a(f)$
Folded tail distorts lower frequencies
Lost tail results in loss of higher frequencies
$-\omega_s/2$
0
$\omega_s/2$
ω_s
ω
$-f_s/2$
$f_s/2$
f_s
f
(c)


Antialiasing filter
g(t)
$H_{aa}(f)$
$g_{aa}(t)$
Sampler
$\overline{g}_{aa}(t)$
$\delta_T(t)$

Example Problem - 5.1-7