Lecture 26

FIR Filter Design

What is an FIR filter?

$$H(z) = 1 + b_1 z^{-1} + b_2 z^{-2} + \dots$$

$$\frac{Y(z)}{X(z)} = 1 + b_1 z^{-1} + \dots$$

$$Y(z) = X(z) + b_1 z^{-1} X(z) + \dots$$

$$y(n) = x(n) + b_1 x(n-1) + \dots$$

The Filter Design problem:

(1) Specifications (e.g. cutoff freq.)

(2) Design a filter ⇒ produce a transfer function (e.g FIR)

(3) Efficient Implementation

(4) Fixed point implementation

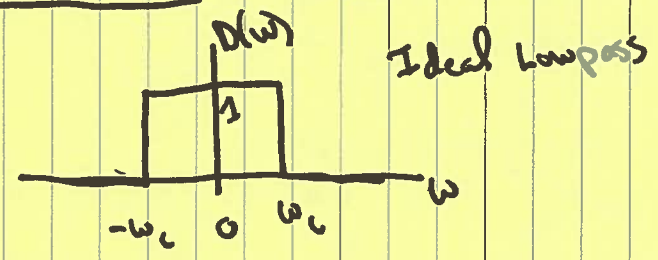
1.2345 ⇒ 1.23

How do we design a filter?

Generate a transfer function.

one approach: leverage analog filter design

Window method: Ideal filters

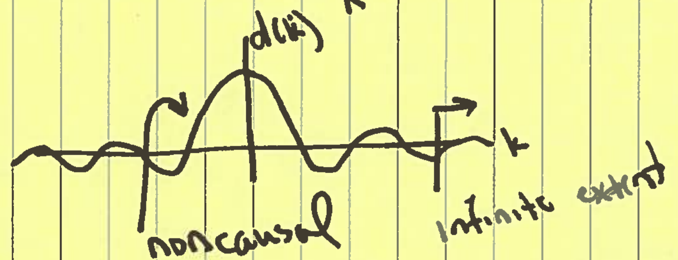


$$\Downarrow$$

$$\mathcal{I}^{-1}\{\}$$

$$\Downarrow$$

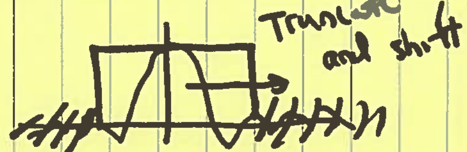
$$d(k) = \frac{\sin(\omega_c k)}{k} \quad -\infty < k < \infty$$

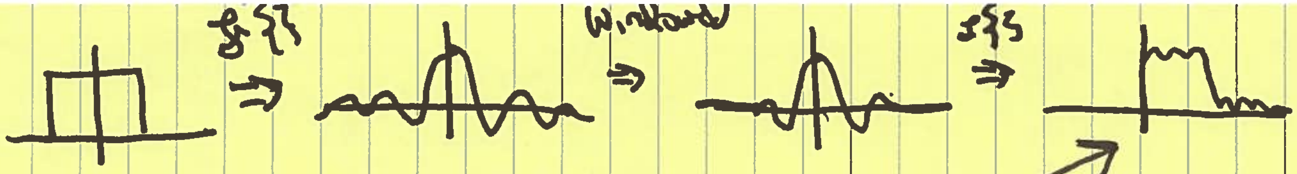


Simple strategy:

(1) Take the Inverse DFT

(2) Window:





Gibbs Phenomena:

Ripple!

Given we want an N-point FIR,
is this the best we can do?

Spec:

Constraint: N-pt. FIR filter
linear phase?

Is the rectangular window optimal?
could we use a Hamming window?

What is the best window function?

We want small ripple in the freq. domain
<u>and</u> narrow width in the time domain

Can a function be time-limited and frequency limited? No!

Kaiser windows are generally regarded as the closest approximation

Crossover filters