Oct, 8, 03

Filter Design

- FIR.
  - Determine coeff. of $h(n)$.
- IIR.
  - Rational Transfer fn $H(z) = \frac{P(z)}{Q(z)}$
    - Determine coeff of polynomial.
    - implemented. D.E.
  - NOT a Rational Transfer fn

3 steps of designing filters:

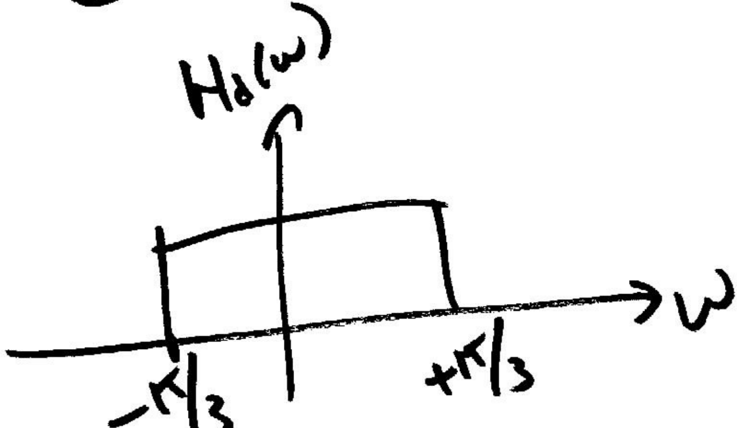
1. Specification → Application dependent.
2. Design – Determine coeff.
3. Realization Direct form 1, 2, cascade, parallel.
4. Implementation
   - C program on PC. / matlab
   - Program DSP chip
   - Xilinx FPGA — programmable ASICs
   - ASIC.

FIR → window, optim

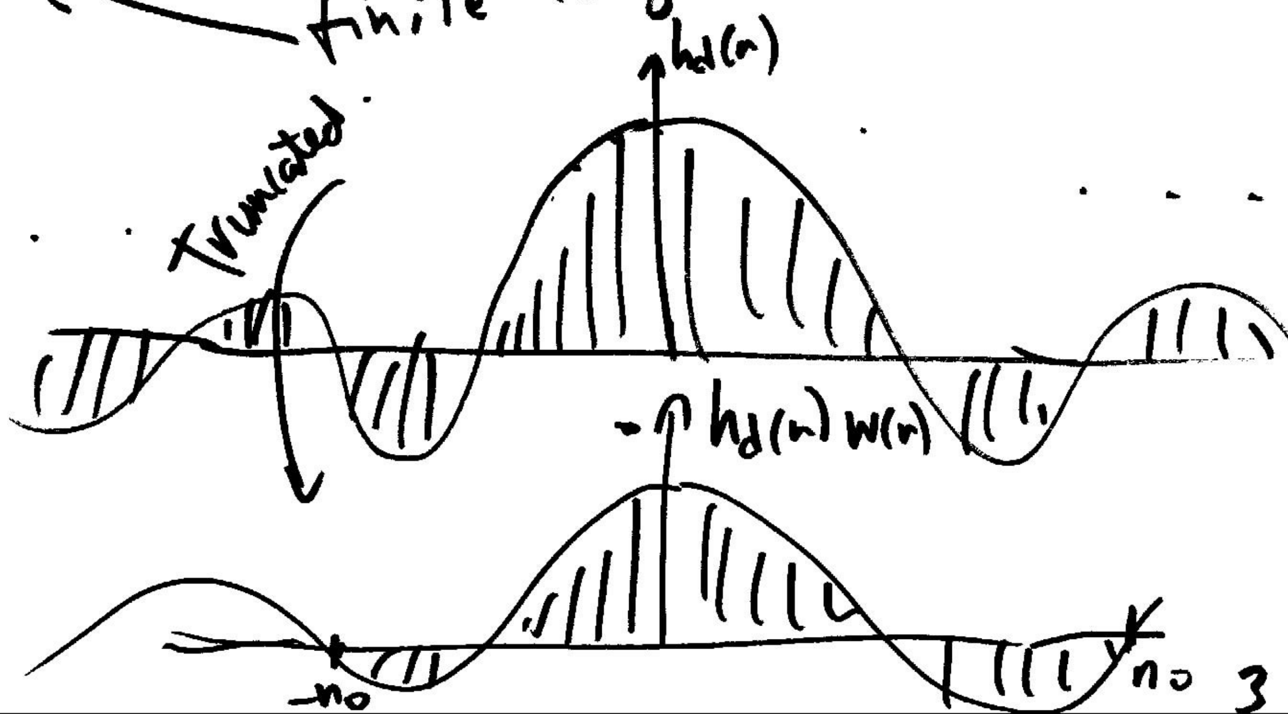
window

FIR filter Design Using Windows:

1. Start with desired freq. response. $H_d(\omega)$.
2. Compute $\text{IDTFT}\{H_d(\omega)\} = h_d(n)$
3. $h(n) = h_d(n)\, w(n)$ ← finite length window function.

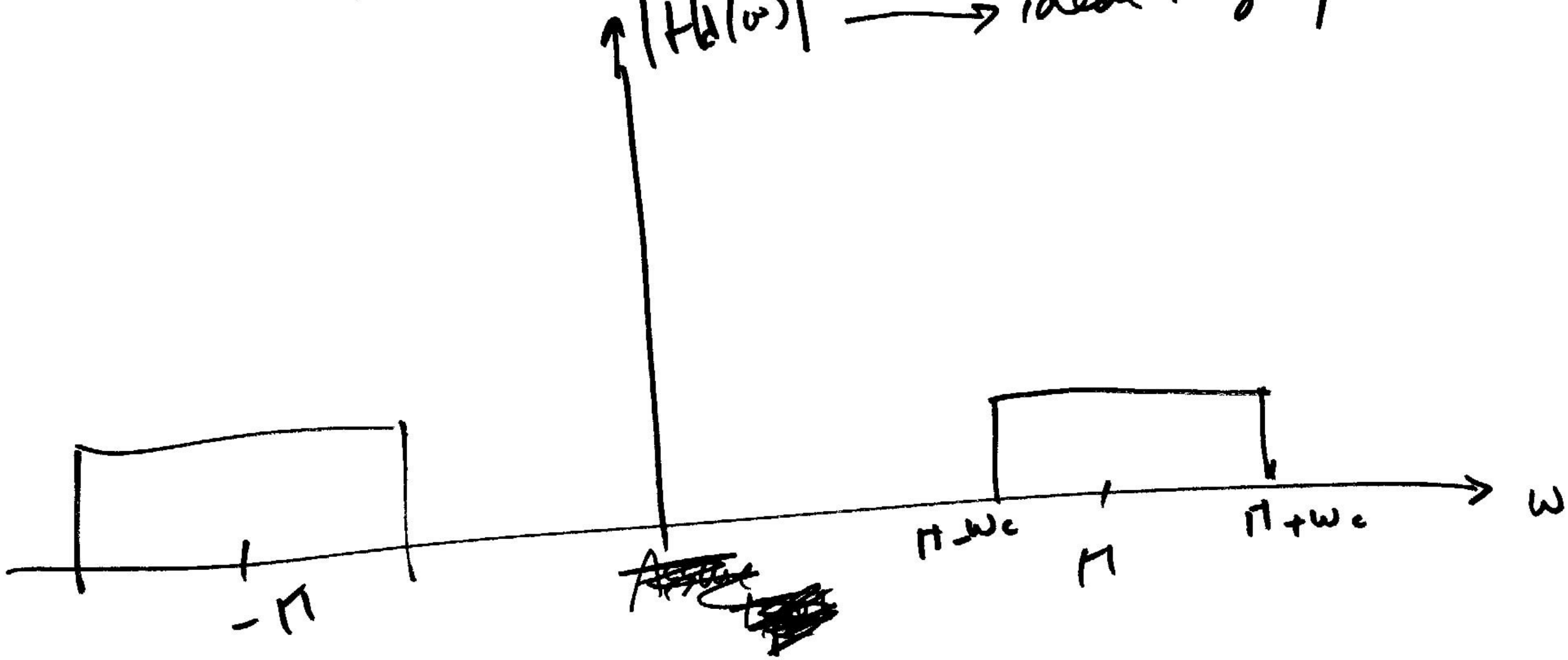


$w(n)$ = rectangular window of duration $2n_0$



High pass filter :

$|H_d(\omega)|$ → ideal High pass filter.



② Compute $IDTFT\{H_d(\omega)\} =$

Assume Type I, $\beta = 0$
# of Taps odd.
$\alpha = \frac{N-1}{2}$

→ $H_d(\omega) = H_m(\omega) e^{-j\alpha\omega}$

$$|H_d(\omega)| = \begin{cases} 1 & \pi - \omega_c < \omega < \pi \\ 0 & \text{otherwise.} \end{cases}$$

$$H_d(\omega) = \begin{cases} e^{-j\alpha\omega} & \pi - \omega_c < \omega < \pi \\ 0 & \text{otherwise.} \end{cases}$$

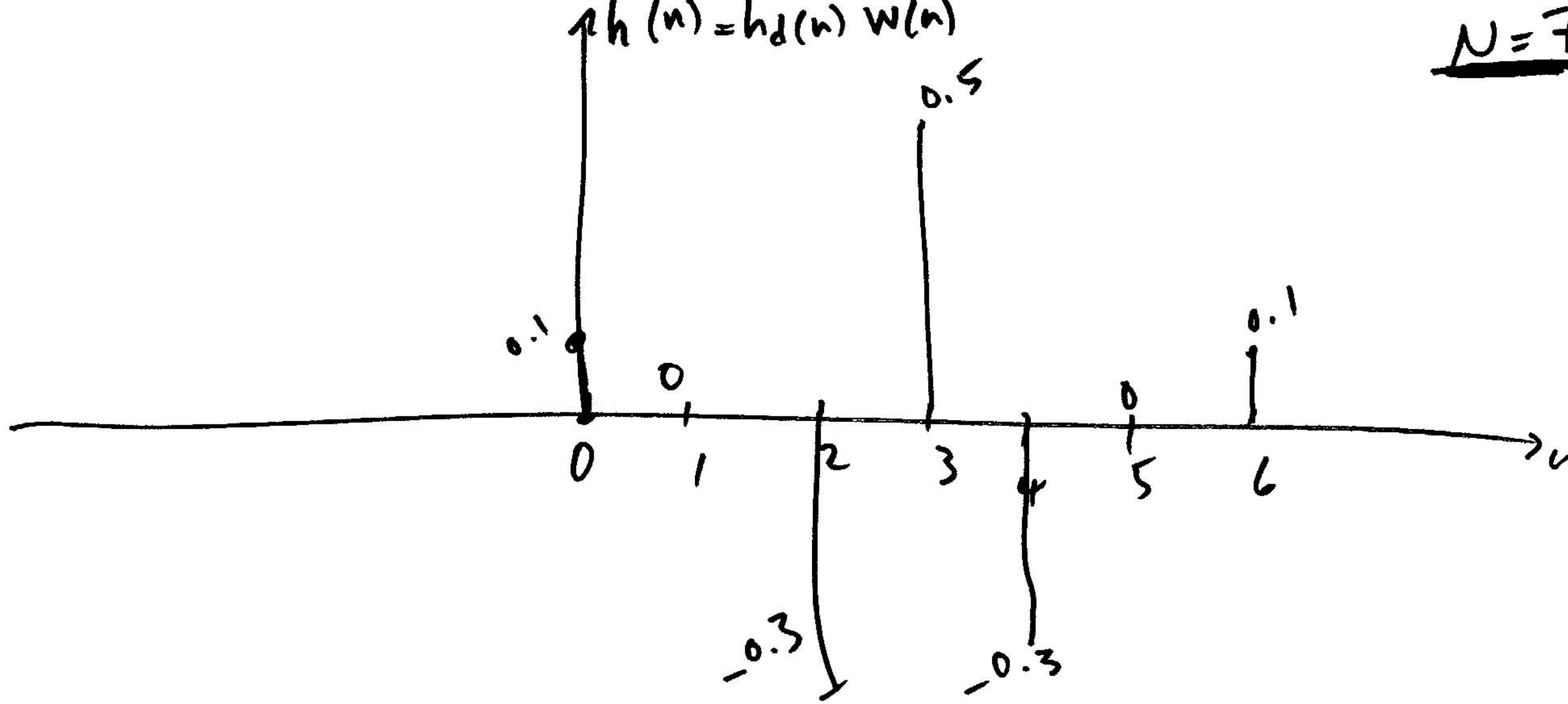
$$\text{IDTFT}\{H_d(\omega)\} = \frac{1}{2\pi} \int_{\pi-\omega_c}^{\pi+\omega_c} e^{-j\alpha\omega} e^{j\omega n} \, d\omega$$

$$h_d(n) = \frac{(-1)^{n-\alpha}}{\pi(n-\alpha)} \sin\left(\omega_c (n-\alpha)\right)$$

← of ∞ duration

③ multiply by a finite length window of duration T.

$\underline{N = 7}$



Time domain $h(n) = h_d(n)\ W(n)$ ← window

$$H_d(\omega) * W(\omega) = H(\omega)$$