4/10/24 KAISER WINDOWS, FREQUENCY SAMPLING DESIGN FREQUENCY TRANSFORMATIONS, COMPARISONS OF FILTER TYPES

(OSAP 7.6, 7.4, NOTES FROM OS 7.5)

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## KAISER WINDOWS

FIR WINDOW DESIGN

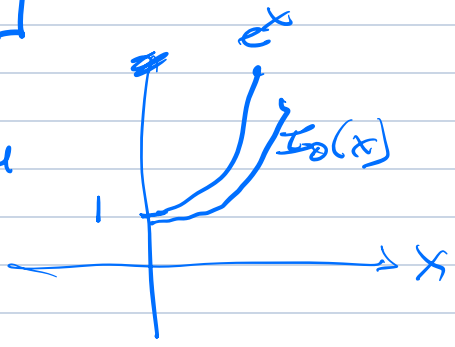
$$h[n] = h_d[n - \tfrac{M}{2}]\, w[n]$$ NONZERO FOR $0 \le n \le M = N-1$

KAISER WINDOW

$$w[n] = \begin{cases} \dfrac{I_0\left[\beta\left(1 - \left(\frac{n-\alpha}{\alpha}\right)^2\right)^{1/2}\right]}{I_0(\beta)}, & 0 \le n \le M \\ 0, & \text{ELSE} \end{cases}$$

$\alpha = \frac{M}{2}$

$\beta$ = TAPER PARAM




DESIGN PROCEDURE

$\Delta\omega = .05\pi$

$\delta_s = -60\,dB$

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TO DESIGN let $A = -20\log_{10}\delta_s = 60$

$$M = \frac{A-8}{\Delta\omega\,(2.285)} = \frac{52}{(.05\pi)(2.285)} \approx 145$$

$$\beta = \begin{cases} .1102(A-8.7), & A \geq 50 \\ .5842(A-21)^{.4} + .07886(A-21), & 21 \leq A \leq 50 \\ 0, & A < 21 \end{cases}$$

FOR US, $\beta = (.1102)(60-8.7) \cong 5.65$

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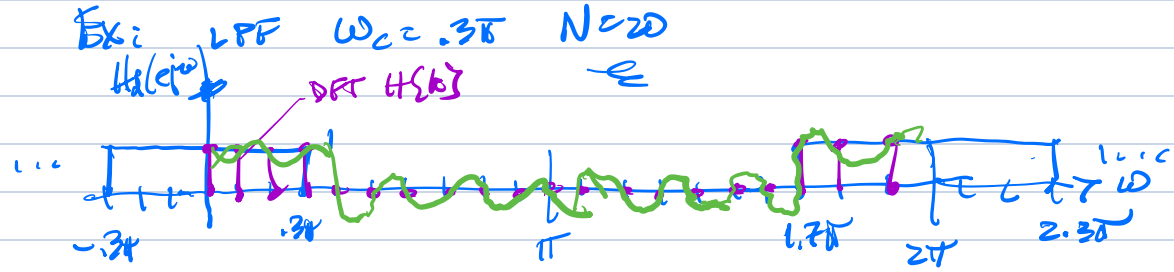
FREQUENCY SAMPLING DESIGN PROCEDURE

TAKE IDEAL FILTER TRANSFER FUNCTION, SAMPLE IN FREQ. @ DFT POINTS

EX: LPF $\omega_c = .3\pi$ $N = 20$

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IMPLEMENTATION COMPARISON, IIR VS FIR FILTERS

$\omega_p = .4\pi$, $\omega_s = .45\pi$, PASSBAND RIPPLE $\pm 1$ dB, STOPBAND RIPPLE $-60$ dB

FIR { KAISER 146 (?)
PARKS McCLELLAN 79

IIR ELLIPTICAL 8

MULTS / OUTPUT POINT

IIR $8+8+1 = 17$ COEFFS $\Rightarrow$ 17 MULTS / OUTPUT

FIR $\leq$ 79 MULTS / OUTPUT POINT

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FFT #2

$10^4$ INPUT POINTS

DFT 1024, $F = 79$

OLS SECTION $1024 - 78 = 946$ POINTS

$$\frac{10{,}000}{946} \approx 11 \text{ SECTIONS}$$

$$\text{MULTS/DFT} = \frac{N}{2}\log_2(N) = (512)(10) = 5120$$

MULTS FOR $10^4$ INPUT POINTS

$$11\left((2)(5120) + 1024\right) + 5120 \quad \text{MULTS FOR } 10{,}000 \text{ SAMPLES}$$

$$\Rightarrow \approx 12.9 \text{ MULTS/OUTPUT POINT}$$