Design of Digital Filters FIR

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How to select the filter
that best matches the application and
satisfies the design requirements ?

Causality and its implications

$$H(\omega) = \begin{cases} 1, & |\omega| \le \omega_c \\ 0, & \omega_c < \omega \le \pi \end{cases} \qquad h(n) = \begin{cases} \dfrac{\omega_c}{\pi}, & n = 0 \\ \dfrac{\omega_c}{\pi} \dfrac{\sin \omega_c n}{\omega_c n}, & n \neq 0 \end{cases}$$

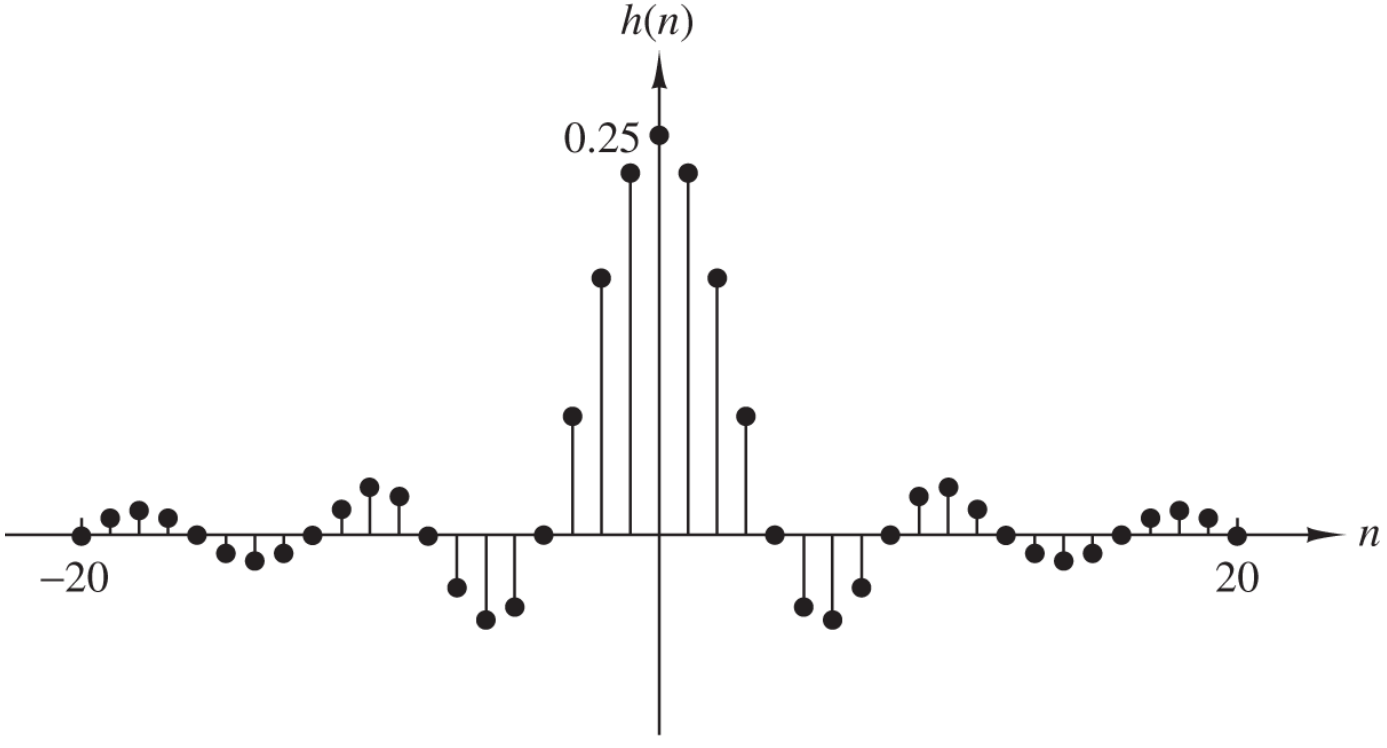

Figure 10.1.1 Unit sample response of an ideal lowpass filter.

Characteristics of Practical Frequency-Selective Filters

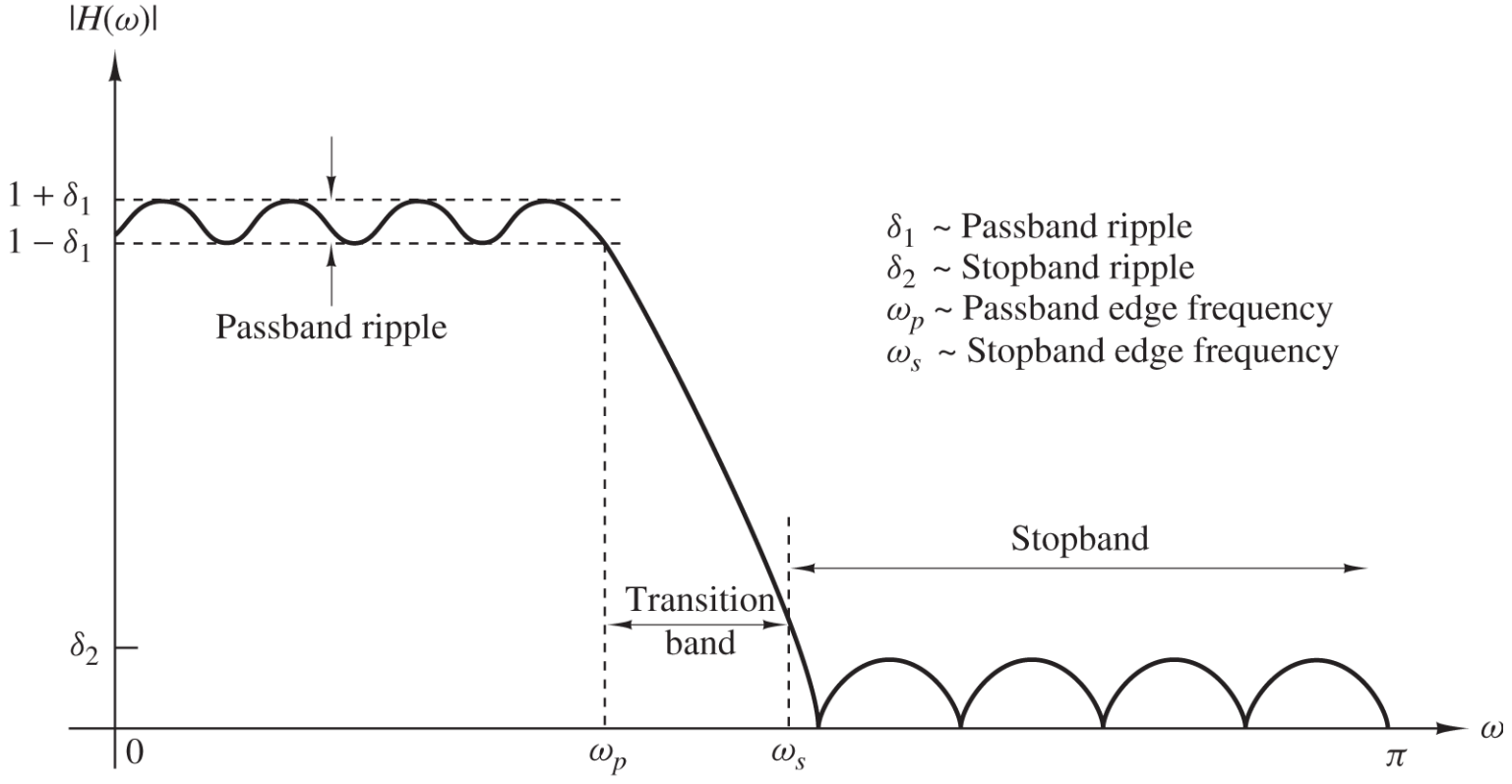

Figure 10.1.2 Magnitude characteristics of physically realizable filters.

Symmetric and Antisymmetric FIR Filters

Linear phase $h(n) = \pm h(M-1-n)$

Symmetric

Antisymmetric

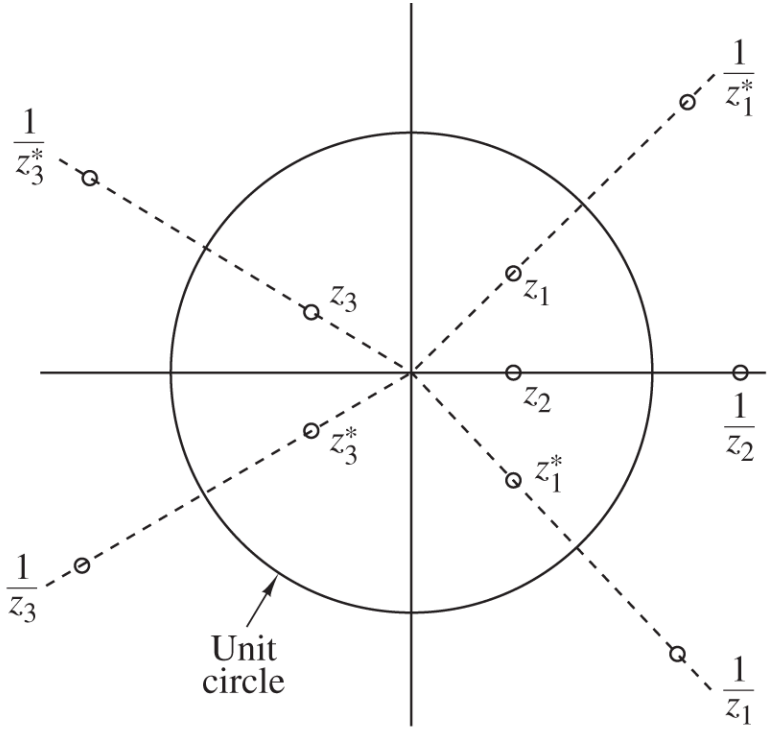

Figure 10.2.1 Symmetry of zero locations for a linear-phase FIR filter.

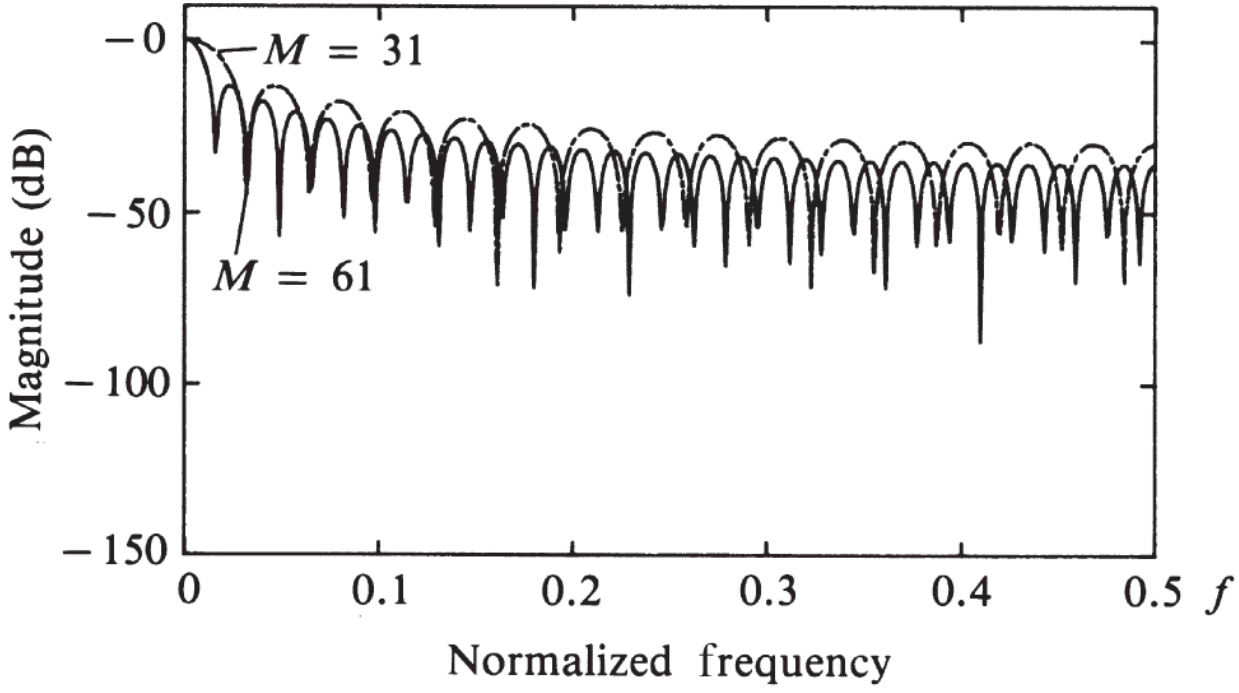

Figure 10.2.2 Frequency response for rectangular window of lengths (a) $M = 31$, (b) $M = 61$.

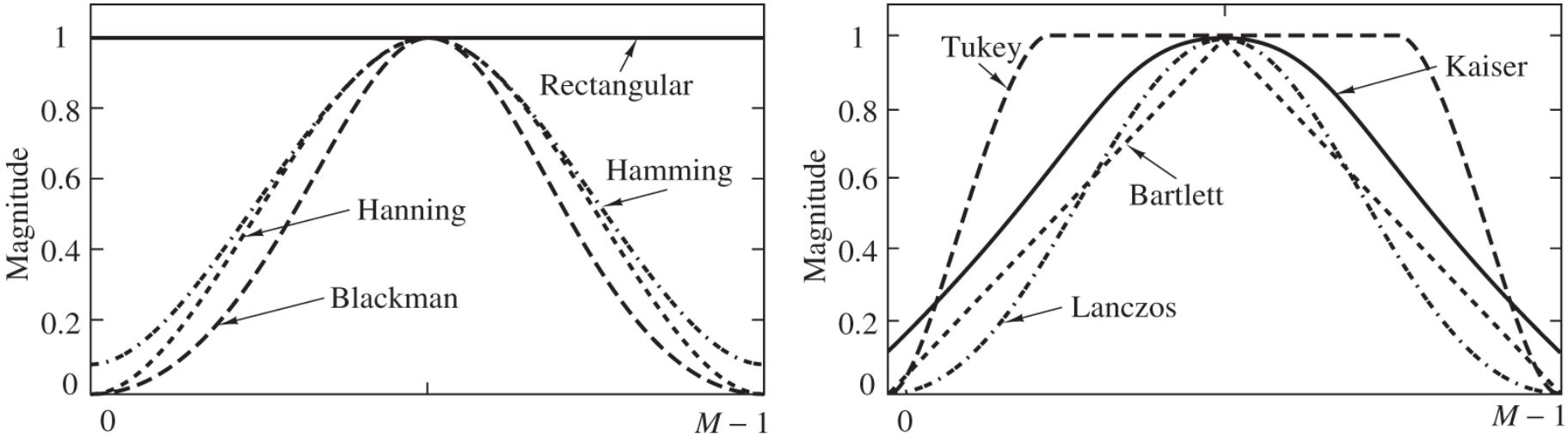

Figure 10.2.3 Shapes of several window functions.

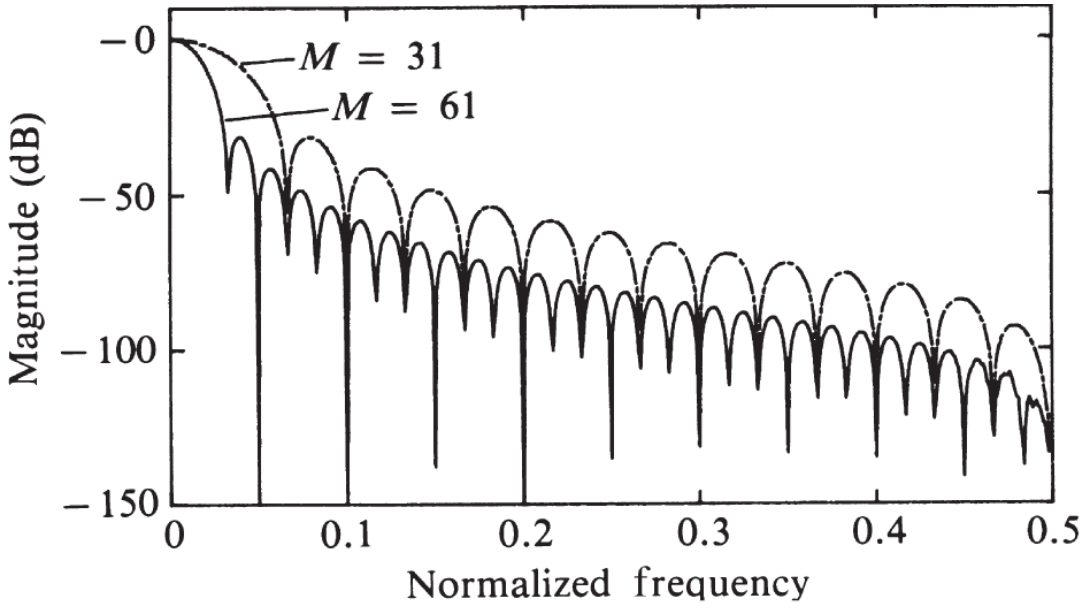

Figure 10.2.4 Frequency responses of Hanning window for (a) $M = 31$ and (b) $M = 61$.

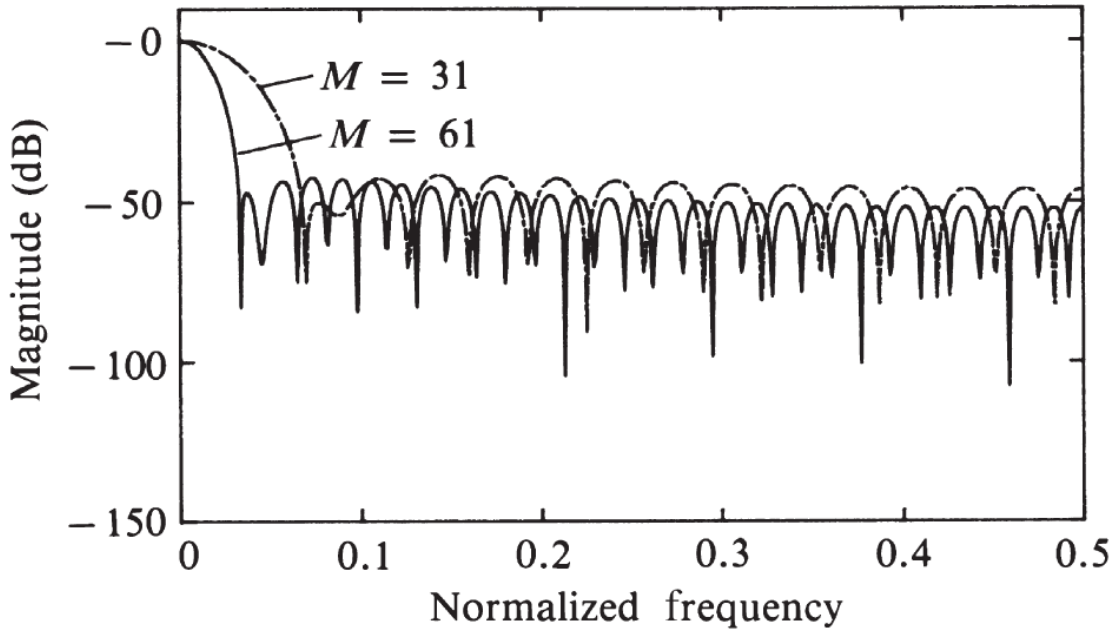

Figure 10.2.5 Frequency responses for Hamming window for (a) $M = 31$ and (b) $M = 61$.

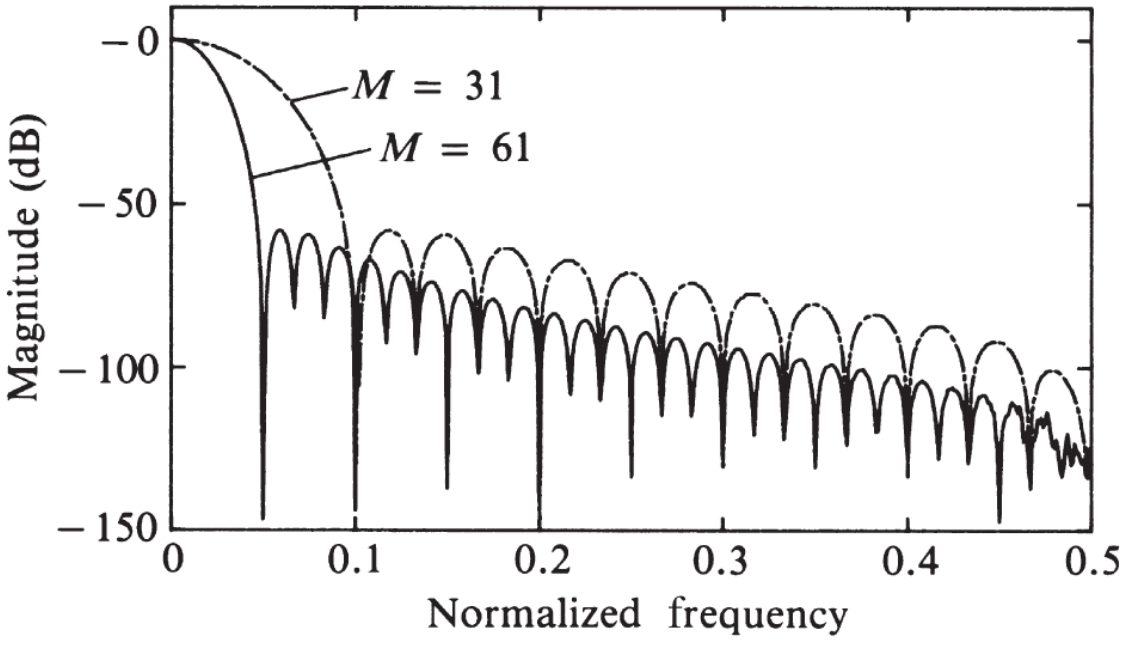

Figure 10.2.6 Frequency responses for Blackman window for (a) $M = 31$ and (b) $M = 61$.

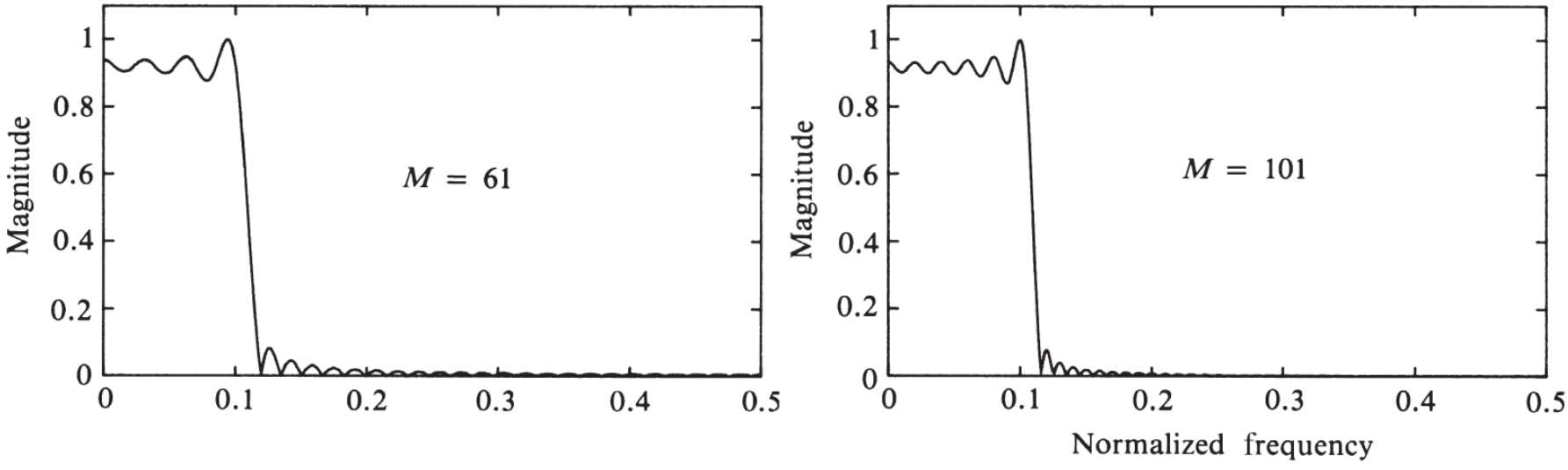

Figure 10.2.7 Lowpass filter designed with a rectangular window: (a) $M = 61$ and (b) $M = 101$.

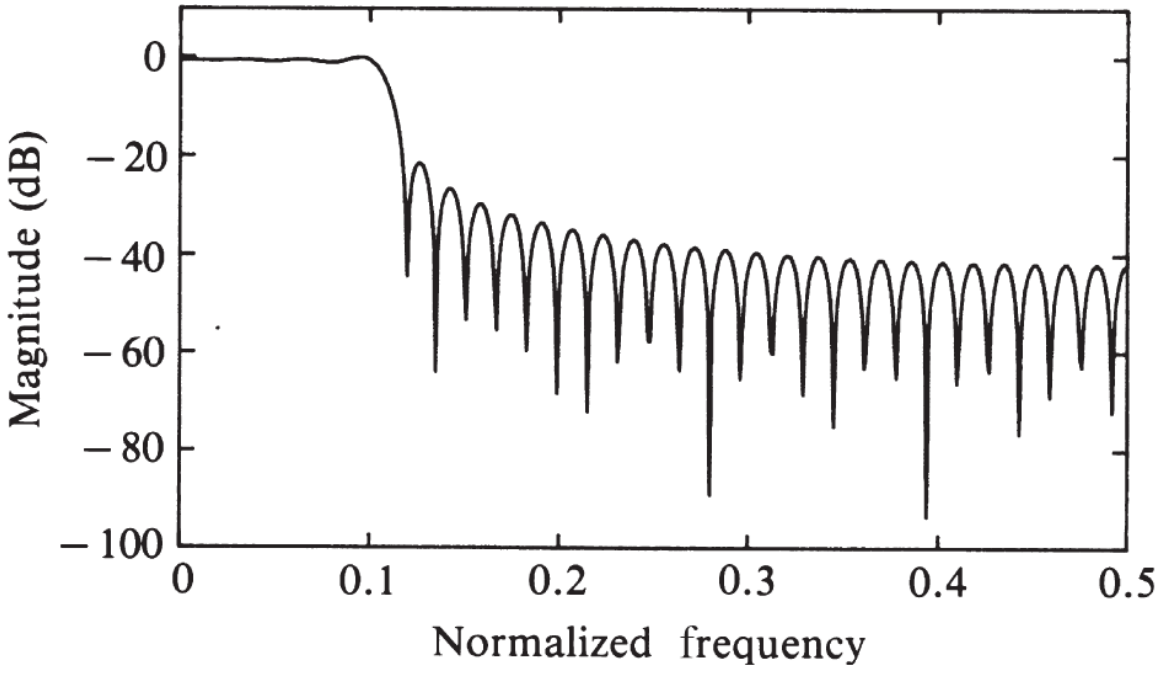

Figure 10.2.8 Lowpass FIR filter designed with rectangular window ($M = 61$).

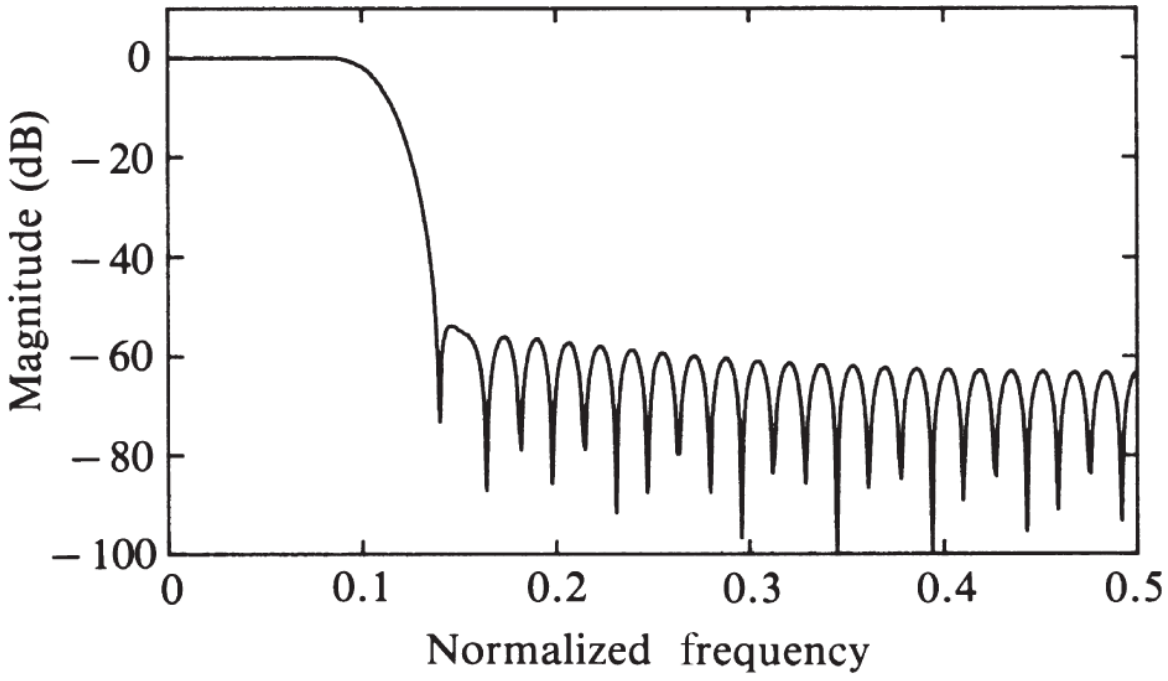

Figure 10.2.9 Lowpass FIR filter designed with Hamming window ($M = 61$).

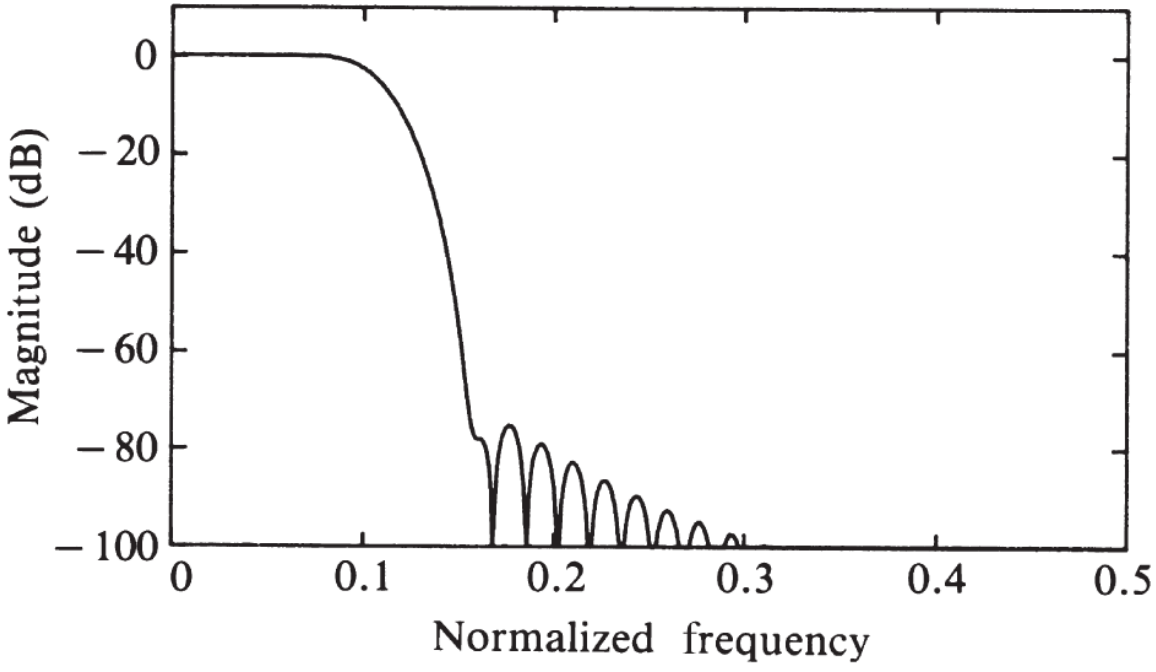

Figure 10.2.10 Lowpass FIR filter designed with Blackman window ($M = 61$).

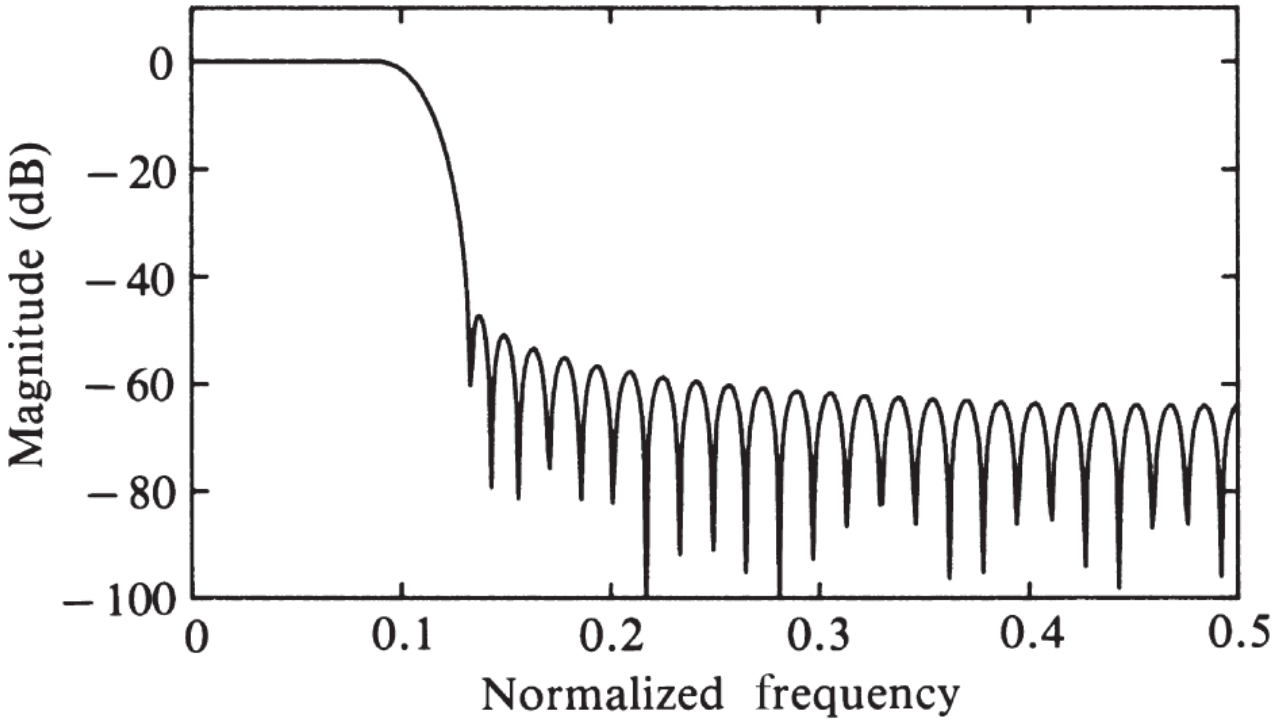

Figure 10.2.11 Lowpass FIR filter designed with $\alpha = 4$ Kaiser window $(M = 61)$.