CHAPTER 10

Design of FIR Filters

Basic Problems

21.

22.

23. (a) Solution:
The impulse response is:

$$h_{\mathrm{lp}}[n] = \mathrm{sinc}(n - n_d)$$

(b)

24. tba

25. (a) Solution:

$$W\big(\mathrm{e}^{\mathrm{j}\omega}\big) = \frac{1}{2}W_R\big(\mathrm{e}^{\mathrm{j}\omega}\big) - \frac{1}{4}W_R\big(\mathrm{e}^{\mathrm{j}(\omega-\frac{2\pi}{M})}\big) + \frac{1}{4}W_R\big(\mathrm{e}^{\mathrm{j}(\omega+\frac{2\pi}{M})}\big)$$

(b) Comments:
The second and third terms widen the mainlobe of Hann window and the sidelobes are lowed by the scaling factor.

26. (a) See plot below.

(b) See plot below.

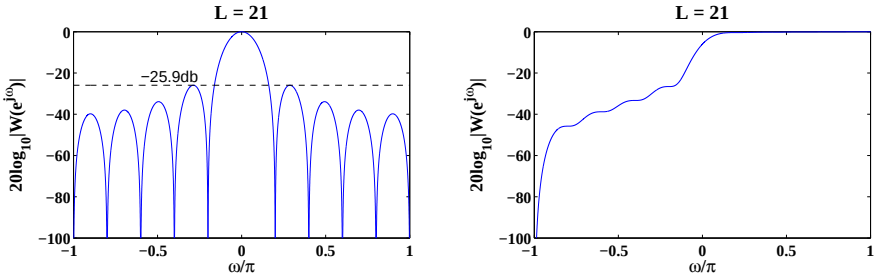

FIGURE 10.1: Log-magnitude response in dB and accumulated amplitude response in dB when window length is $L = 21$.

(c) See plot below.

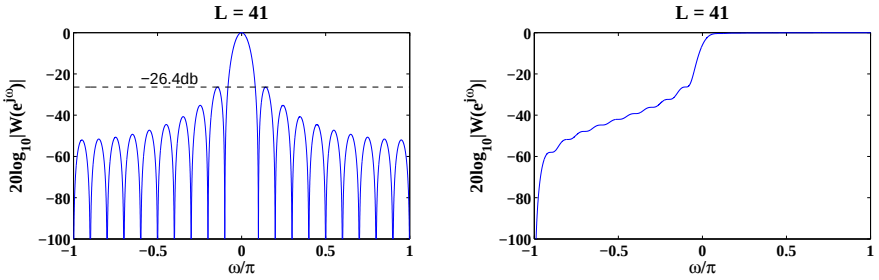

FIGURE 10.2: Log-magnitude response in dB and accumulated amplitude response in dB when window length is $L = 41$.

27. (a) See plot below.

(b) See plot below.

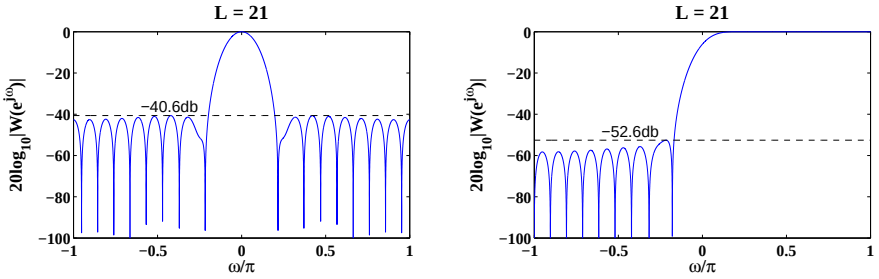

FIGURE 10.3: Log-magnitude response in dB and accumulated amplitude response in dB when window length is $L = 21$.

(c) See plot below.

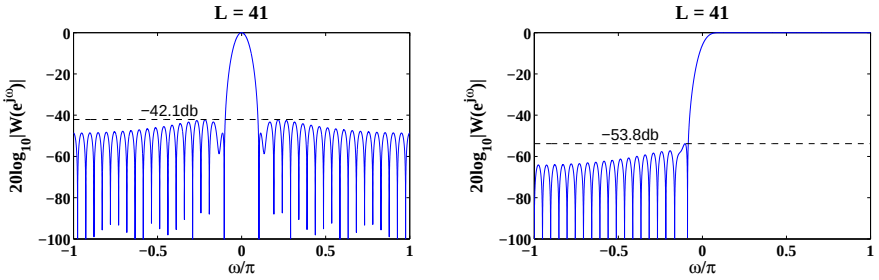

FIGURE 10.4: Log-magnitude response in dB and accumulated amplitude response in dB when window length is $L = 41$.

28. (a) See plot below.

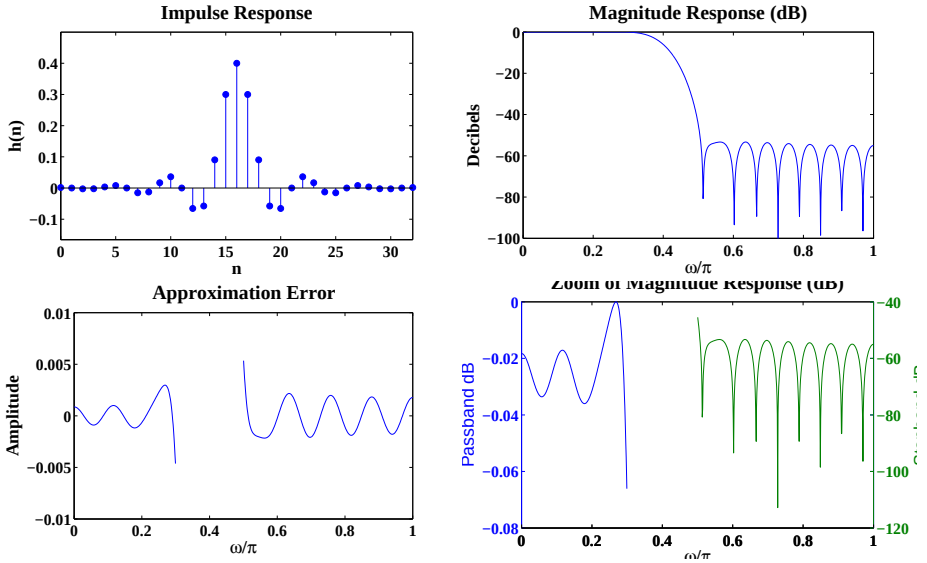

FIGURE 10.5: Plots of impulse response, magnitude response, approximation error and zoom magnitude plot using fixed window design technique.

(b) See plot below.

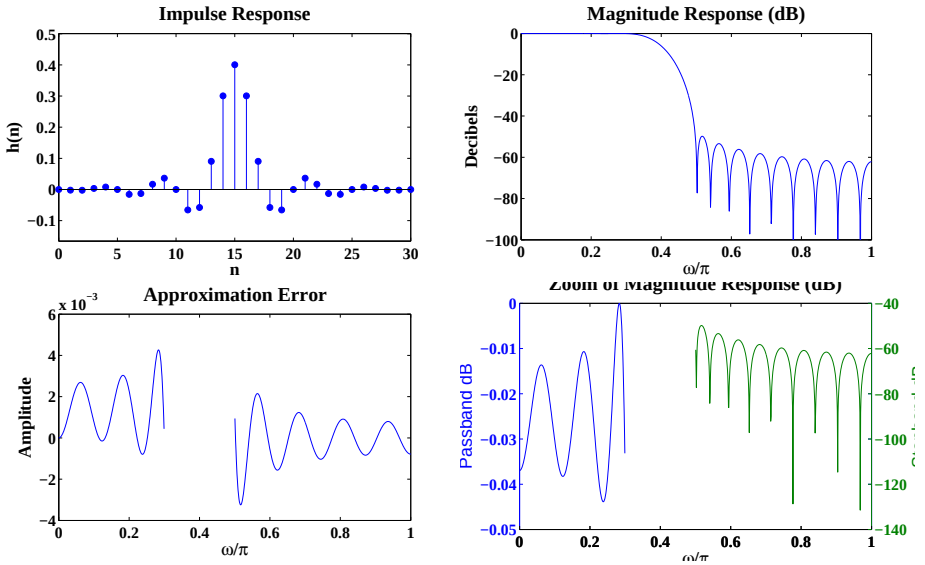

FIGURE 10.6: Plots of impulse response, magnitude response, approximation error and zoom magnitude plot using Kaiser window design technique.

29. (a) See plot below.

(b) See plot below.

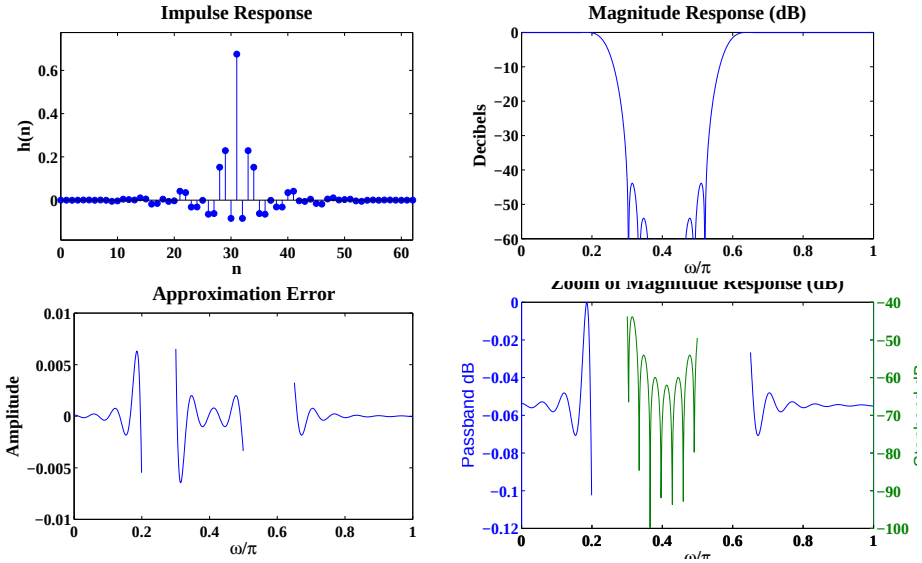

FIGURE 10.7: Plots of impulse response, magnitude response, approximation error and zoom magnitude plot using Hann window design technique.

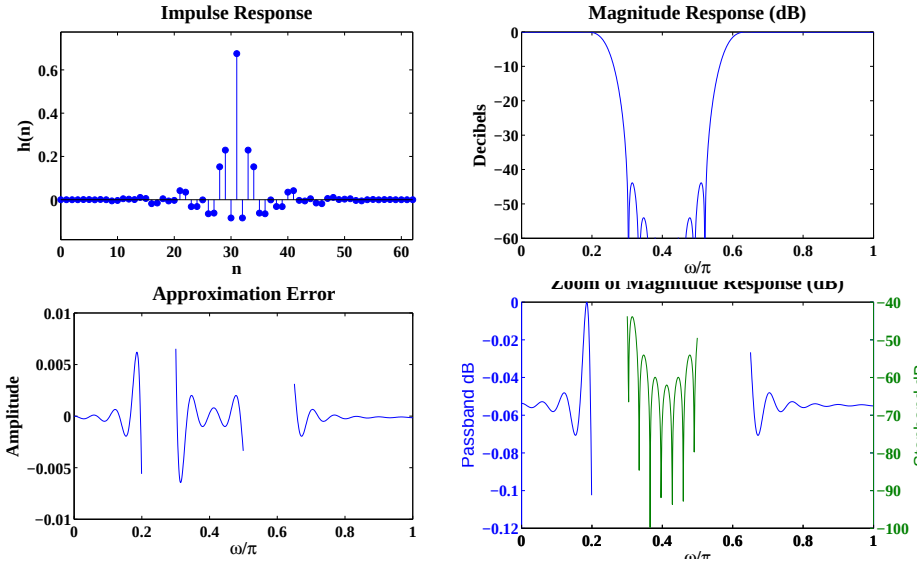

FIGURE 10.8: Plots of impulse response, magnitude response, approximation error and zoom magnitude plot using `fir1` function.

30. (a) See plot below.

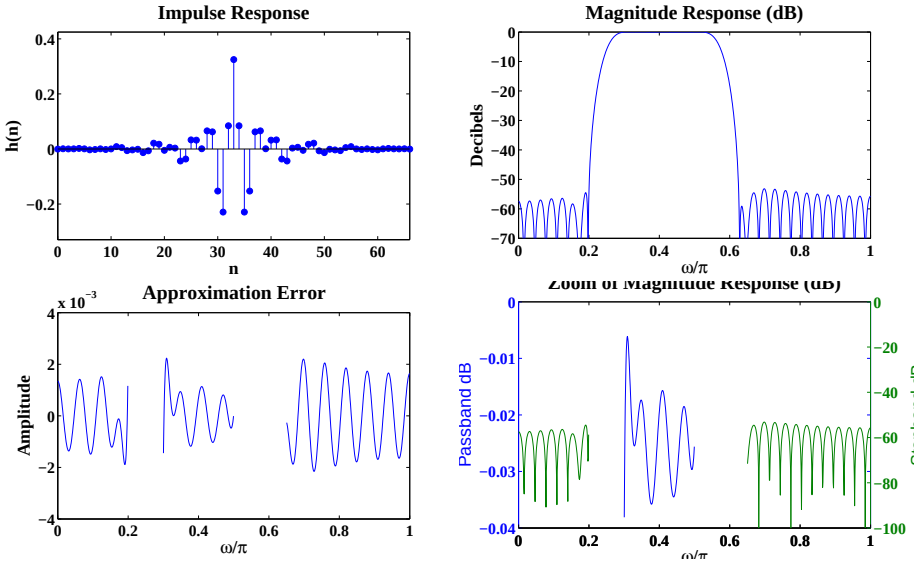

FIGURE 10.9: Plots of impulse response, magnitude response, approximation error and zoom magnitude plot using fixed window design technique.

(b) See plot below.

(c) See plot below.

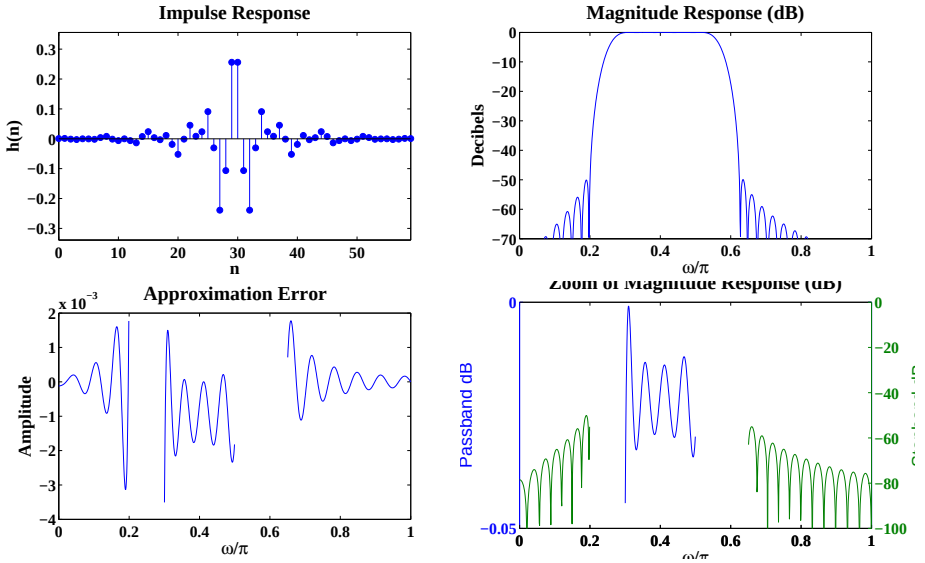

FIGURE 10.10: Plots of impulse response, magnitude response, approximation error and zoom magnitude plot using Kaiser window design technique.

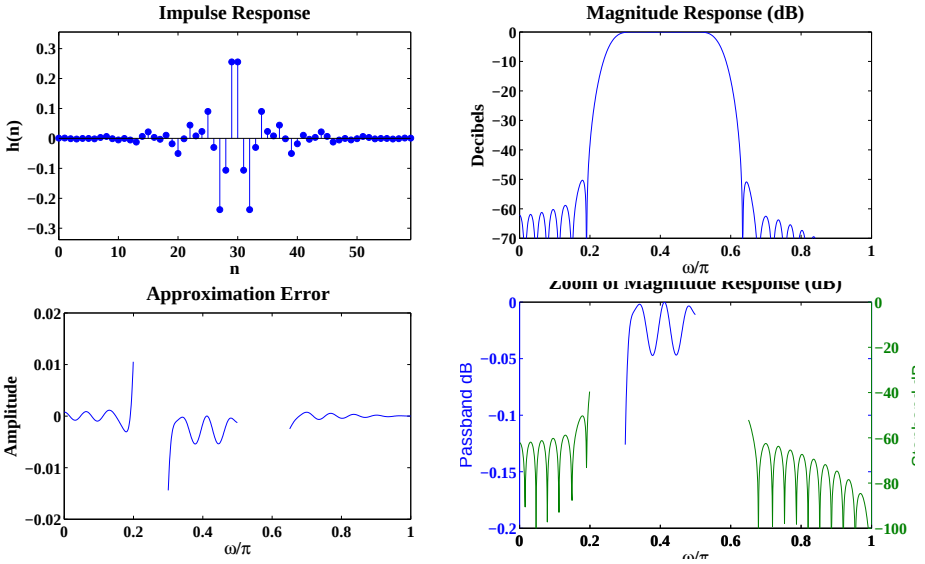

FIGURE 10.11: Plots of impulse response, magnitude response, approximation error and zoom magnitude plot using `fir1` function.

31. See plots below.

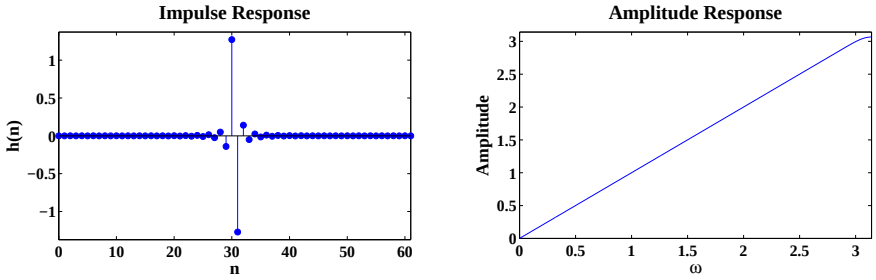

FIGURE 10.12: Plots of impulse response and amplitude response of designed type-IV differentiator using the Blackman window.

32. (a) See plot below.

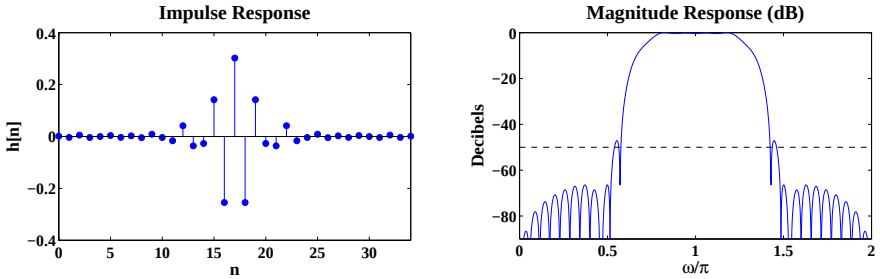

FIGURE 10.13: Plots of impulse response and log-magnitude response of designed highpass filter using linear transition.

(b) See plot below.

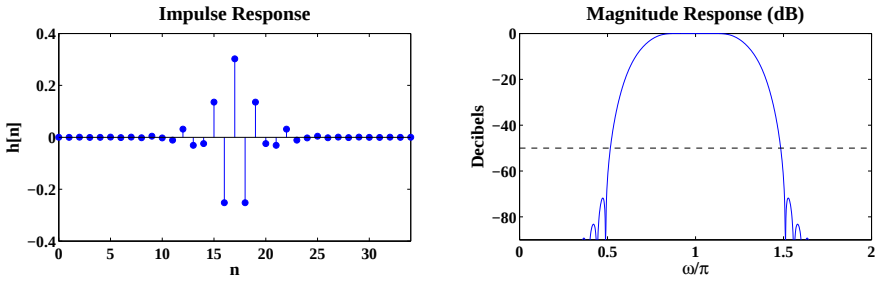

FIGURE 10.14: Plots of impulse response and log-magnitude response of designed highpass filter using the `fir2` function and the Hamming window.

33. (a) See plot below.

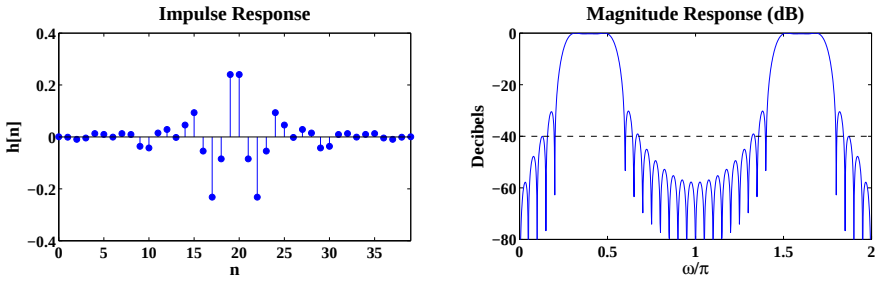

FIGURE 10.15: Plots of impulse response and log-magnitude response of designed bandpass filter using a raised-cosine transition.

(b) See plot below.

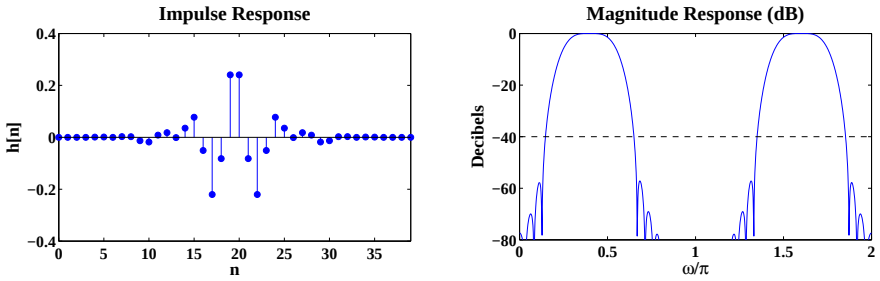

FIGURE 10.16: Plots of impulse response and log-magnitude response of designed bandpass filter using the `fir2` function and the Hann window.

34. (a) See plot below.

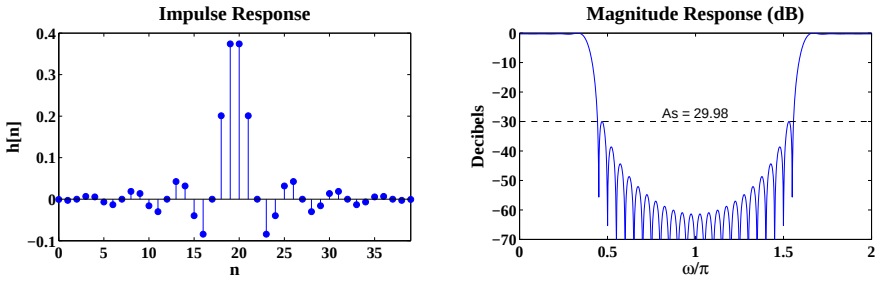

FIGURE 10.17: Plots of impulse response and log-magnitude response of designed lowpass filter when the sample at ω_c be equal to 0.5.

(b) See plot below.

(c) See plot above.

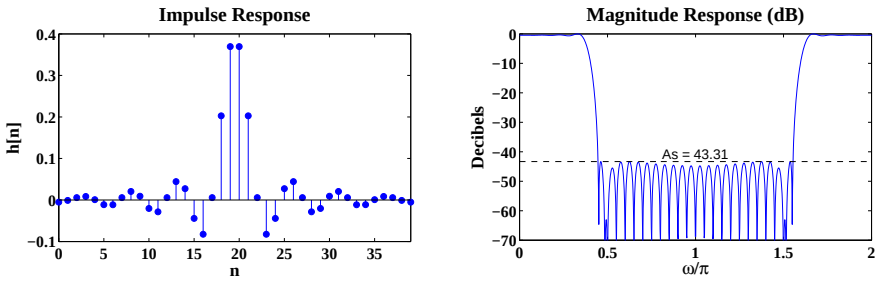

FIGURE 10.18: Plots of impulse response and log-magnitude response of designed lowpass filter when the sample at ω_c be chosen as optimal one.

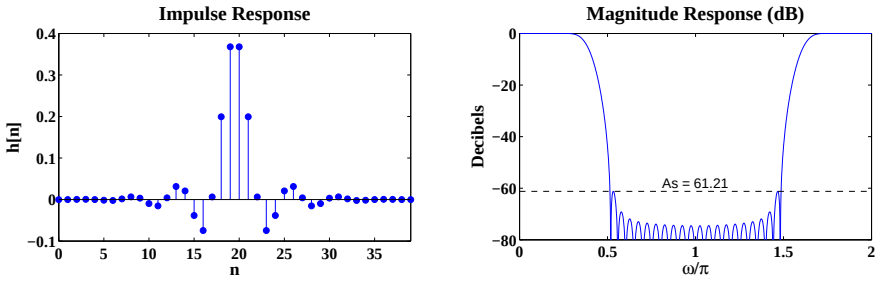

FIGURE 10.19: Plots of impulse response and log-magnitude response of designed lowpass filter using the `fir2` function.

35. (a) See plot below.

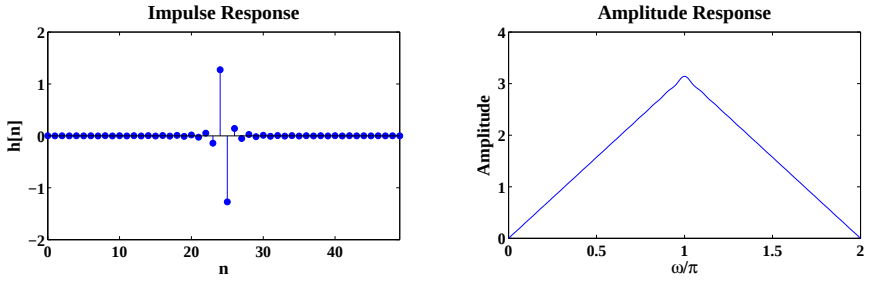

FIGURE 10.20: Plots of impulse response and amplitude response of designed differentiator.

(b) See plot below.

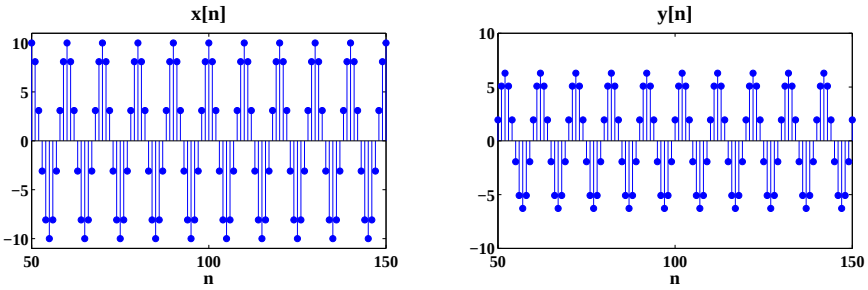

FIGURE 10.21: Subplots of $x[n]$ and $y[n]$ for $50 \leq n \leq 100$.

(c) tba

36.

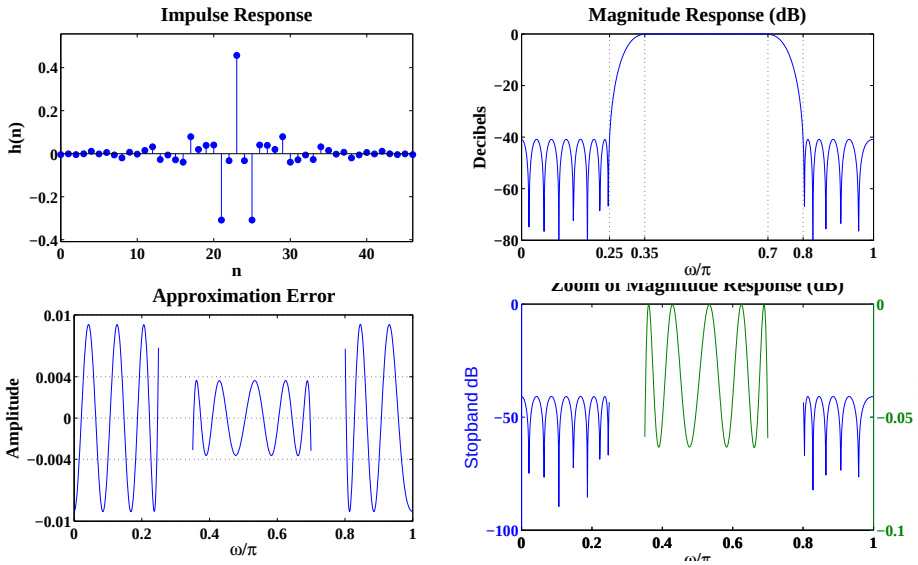

FIGURE 10.22: Plots of impulse response, magnitude response, approximation error and zoom magnitude response of the designed bandpass digital filter.

37.

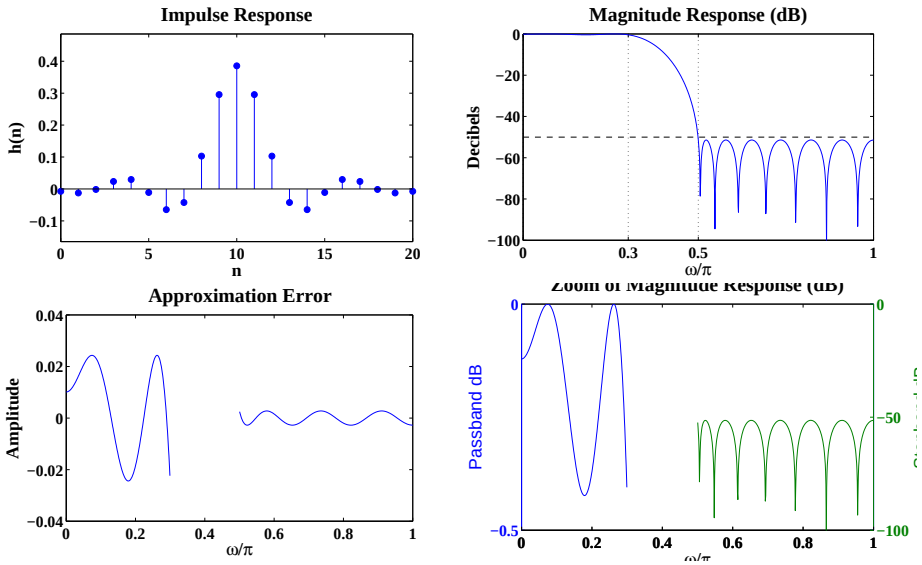

FIGURE 10.23: Plots of impulse response, magnitude response, approximation error and zoom magnitude response of the designed lowpass FIR filter.

38.

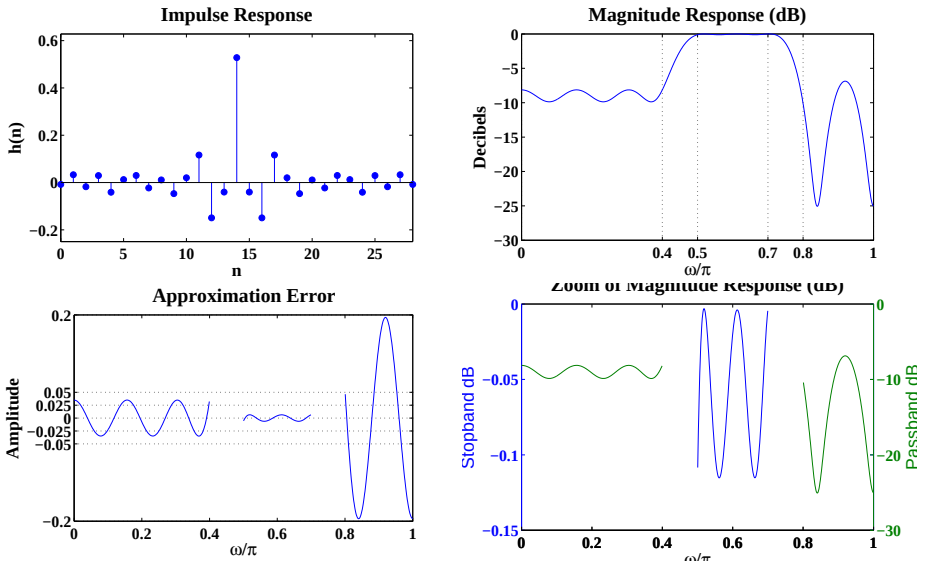

FIGURE 10.24: Plots of impulse response, magnitude response, approximation error and zoom magnitude response of the designed multiband filter.

39. (a) See plot below.

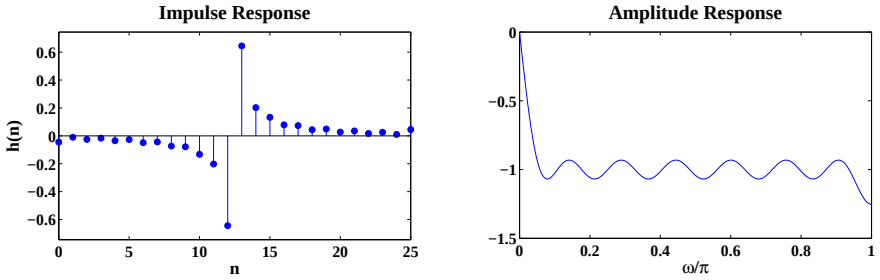

FIGURE 10.25: Plots of impulse response and magnitude response of the designed FIR Hilbert transformer.

(b) See plot below.

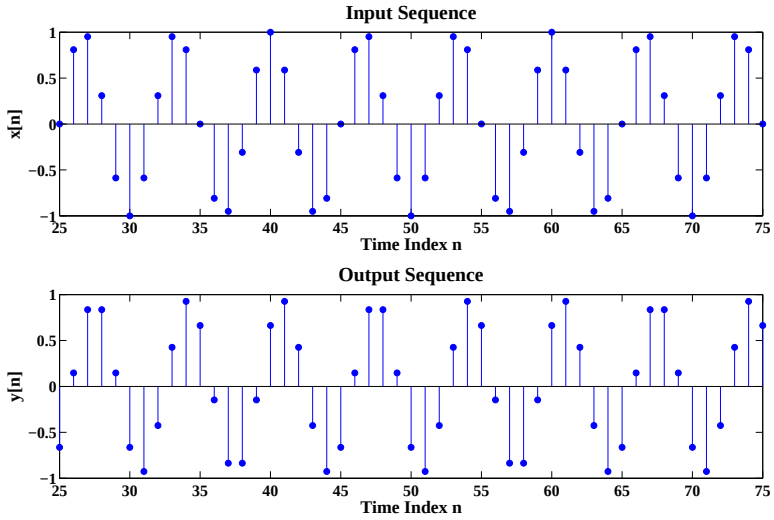

FIGURE 10.26: Stem subplots of both $x[n]$ and $y[n]$ for $25 \leq n \leq 75$.

(c) tba.

40.

41.

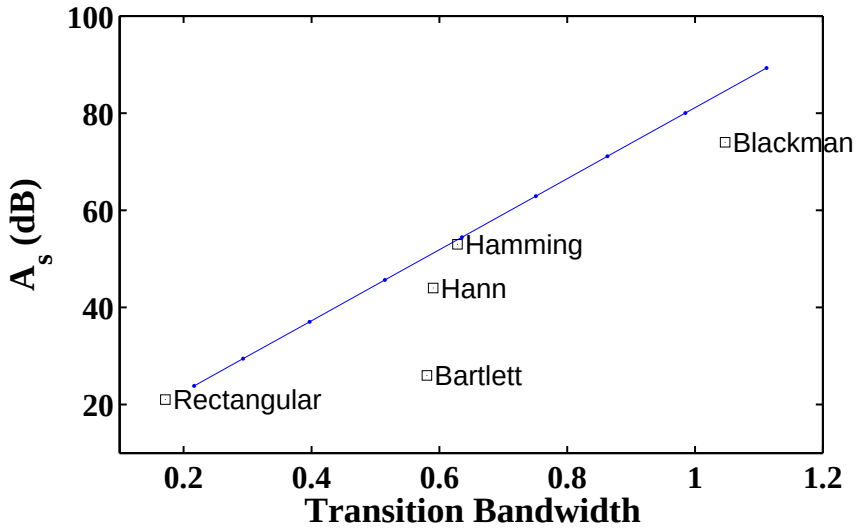

FIGURE 10.27: Plot of A_s versus transition-widths obtained in part (b) and the corresponding pairs for the fixed windows obtained in part (a).