

CHAPTER 14

Random Signal Processing

Basic Problems

23.

24. (a)

(b) See plot below.

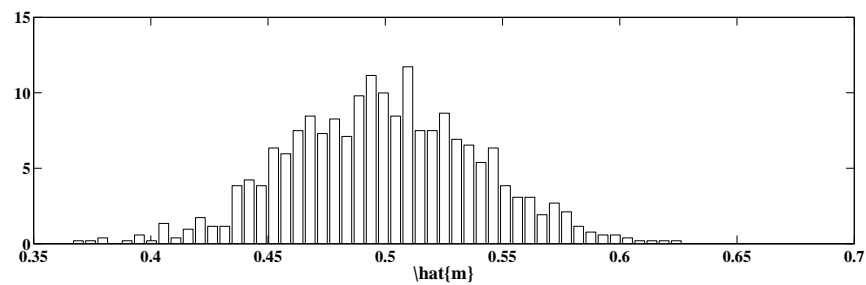


FIGURE 14.1: Plot of empirical pdf of the sample mean.

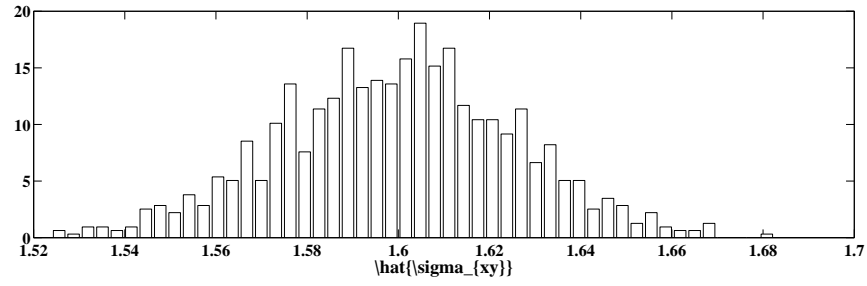
25.

26. (a)

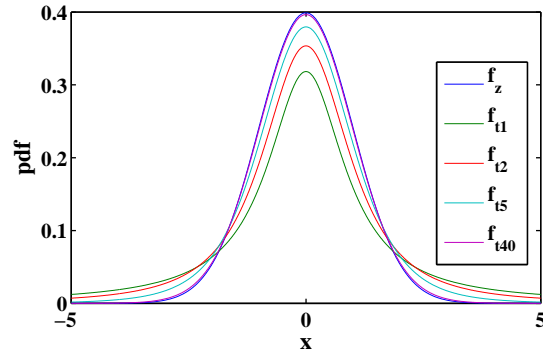
(b)

(c) See plot below.

(d) tba.

FIGURE 14.2: Plot of histogram of the estimate $\hat{\sigma}_{xy}$.

27. (a) See plot below.

FIGURE 14.3: Plot of pdf of t_ν for $\nu = 1, 2, 5, 40$ and the pdf of z .

(b) See plot below.

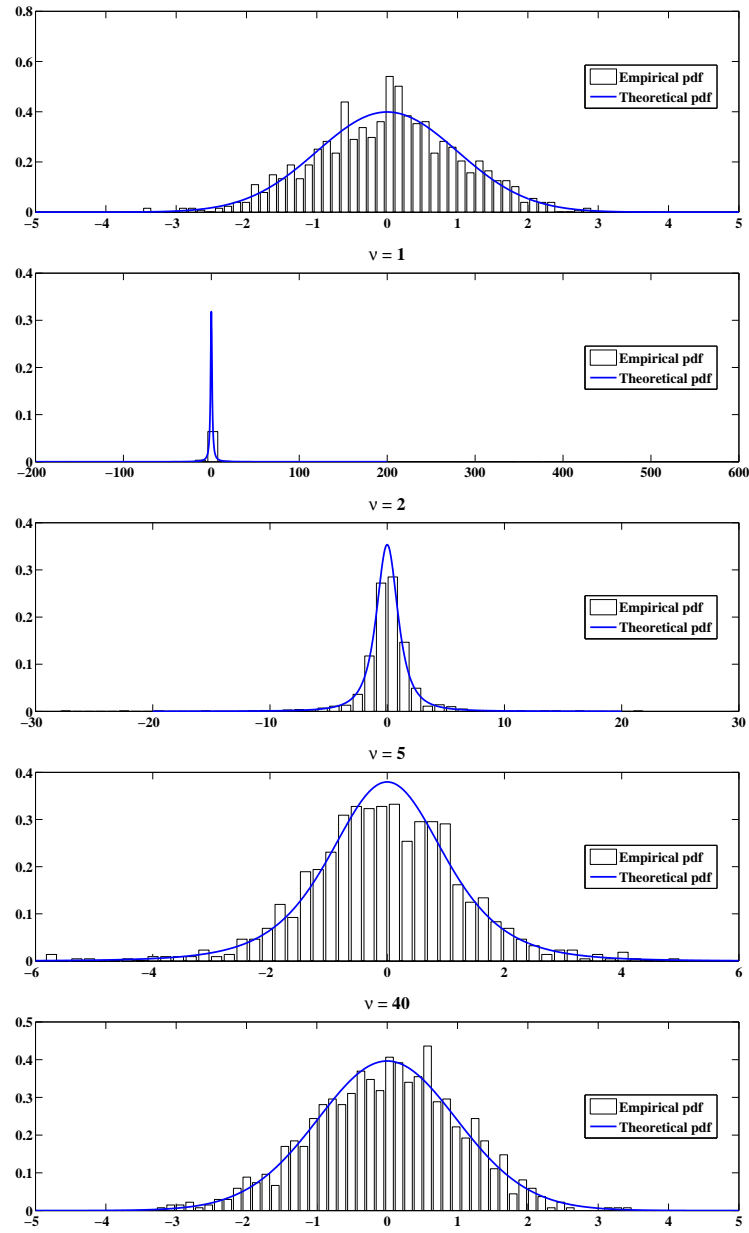


FIGURE 14.4: Comparisons between empirical pdf and the theoretical pdf.

28. See plots below.

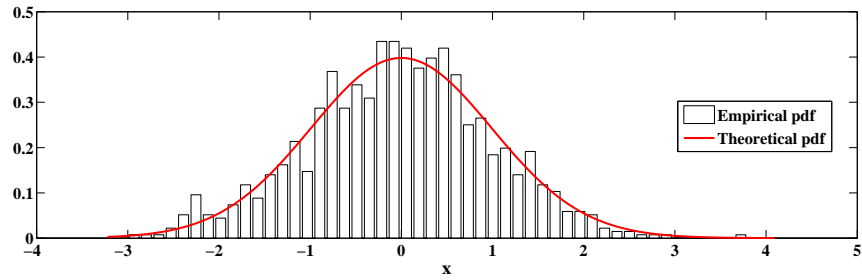


FIGURE 14.5: Empirical and theoretical pdfs of random variable $x_i \sim t_\nu$ for $\nu = 100$.

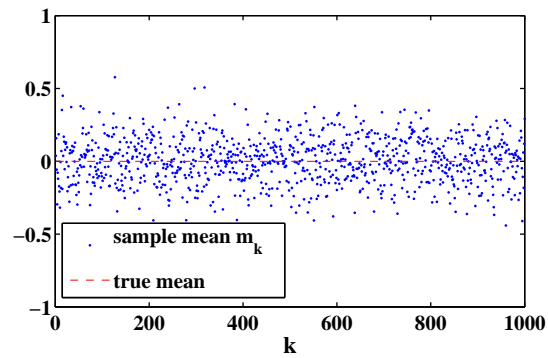


FIGURE 14.6: Plot of the true mean μ and the K sample means.

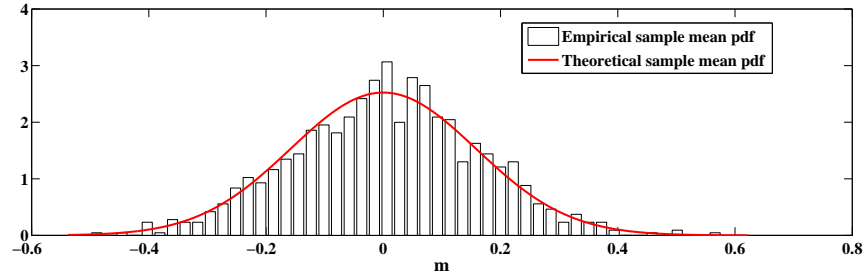
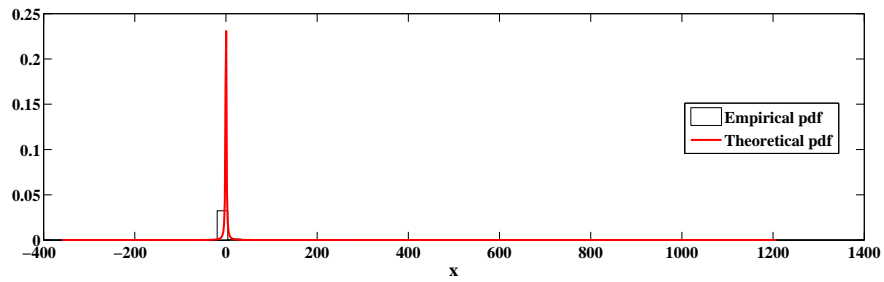
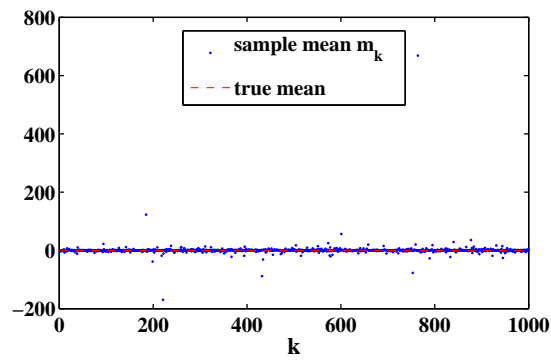


FIGURE 14.7: Empirical and theoretical pdfs of the sample mean.

FIGURE 14.8: Empirical and theoretical pdfs of random variable $x_i \sim t_\nu$ for $\nu = 1$.FIGURE 14.9: Plot of the true mean μ and the K sample means.

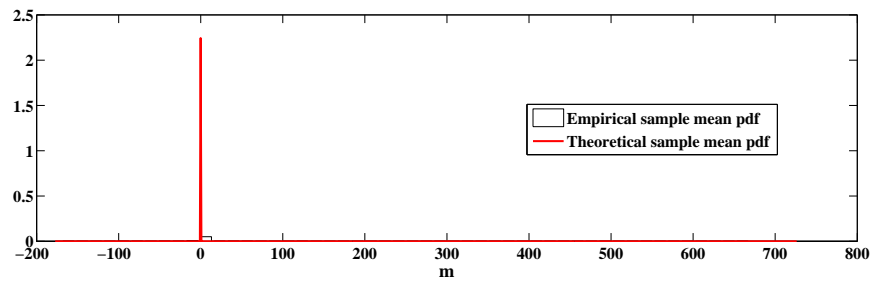


FIGURE 14.10: Empirical and theoretical pdfs of the sample mean.

29. (a) See plot below.

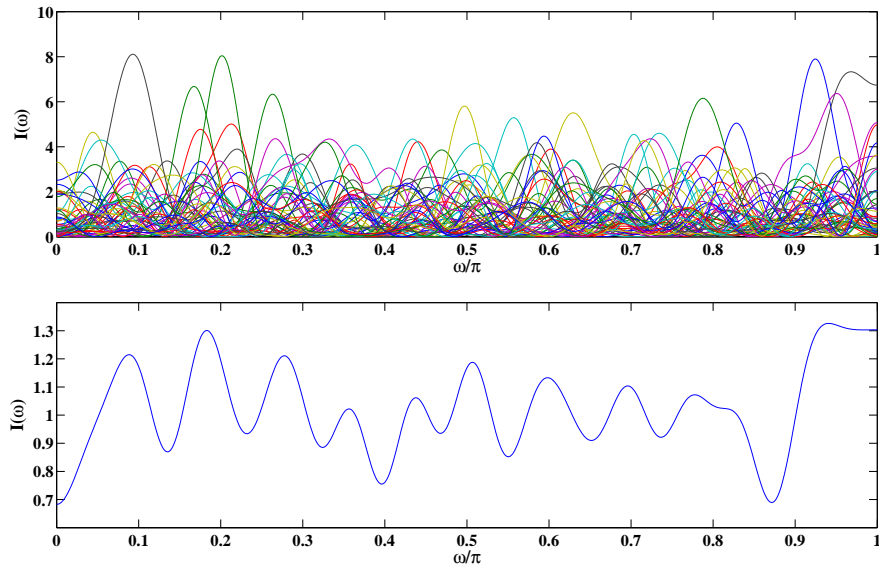


FIGURE 14.11: Plot of 50 periodogram estimates and the average of these overlays for $N = 32$.

(b) See plot below.

(c) See plot below.

(d) tba.

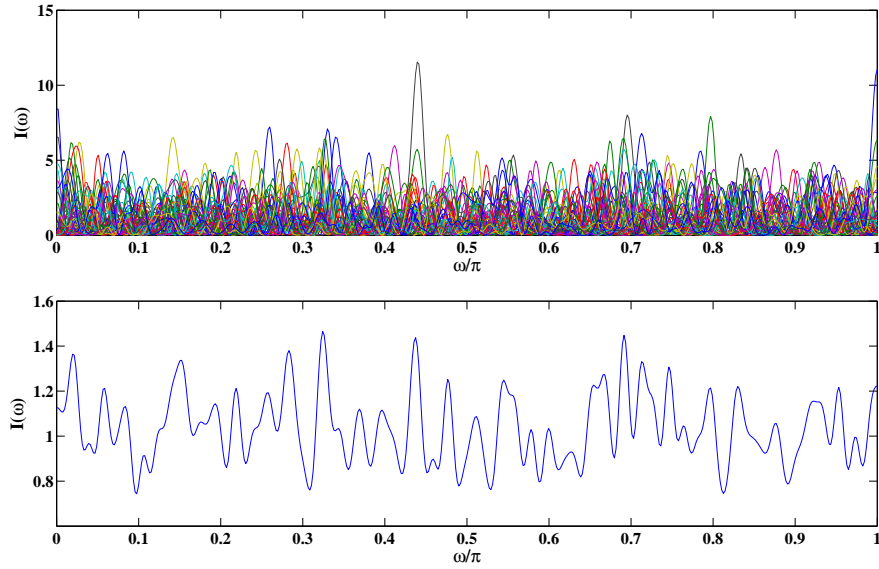


FIGURE 14.12: Plot of 50 periodogram estimates and the average of these overlays for $N = 128$.

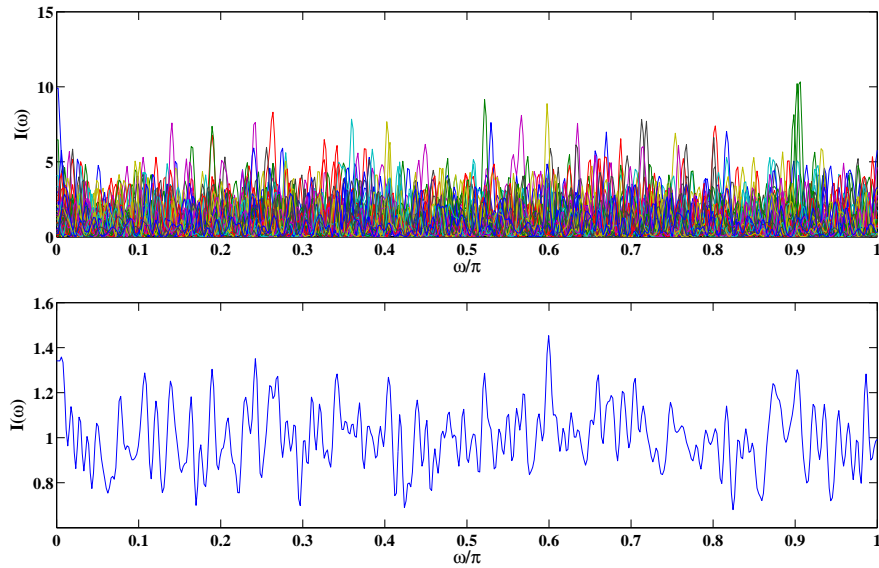


FIGURE 14.13: Plot of 50 periodogram estimates and the average of these overlays for $N = 256$.

30. (a)

(b) See plot below.

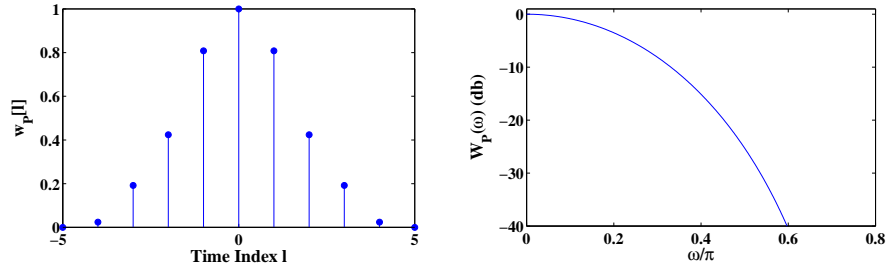


FIGURE 14.14: Plot of the data window $w_P[l]$ and its frequency-domain response $W_P(\omega)$ for $L = 5$.

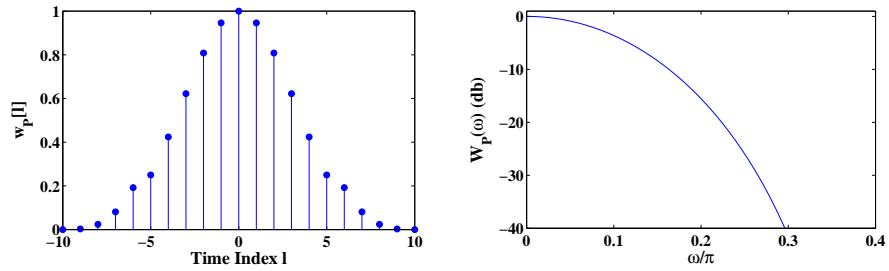


FIGURE 14.15: Plot of the data window $w_P[l]$ and its frequency-domain response $W_P(\omega)$ for $L = 10$.

(c)

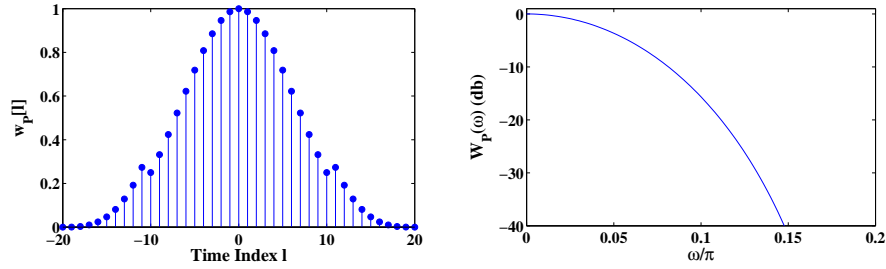


FIGURE 14.16: Plot of the data window $w_P[\ell]$ and its frequency-domain response $W_P(\omega)$ for $L = 20$.

31. Solution:

$$J = \begin{cases} \sigma_2^2, & \text{if } \sigma_1^2 > \sigma_2^2, & a_1 = 0, a_2 = 1 \\ \sigma_1^2, & \text{if } \sigma_1^2 < \sigma_2^2, & a_1 = 1, a_2 = 0 \\ \sigma_1^2, & \text{if } \sigma_1^2 = \sigma_2^2, & a_1 + a_2 = 1 \end{cases}$$

32. Solution:

The minimum variance is

$$J_{\min} = \frac{\sum_{k=1}^N \sigma_k^2}{N^2}$$

33. Solution:

$$a = \frac{\sigma_{xy}}{\sigma_y^2}, \quad b = \mu_x - a\mu_y$$

34. See plots below.

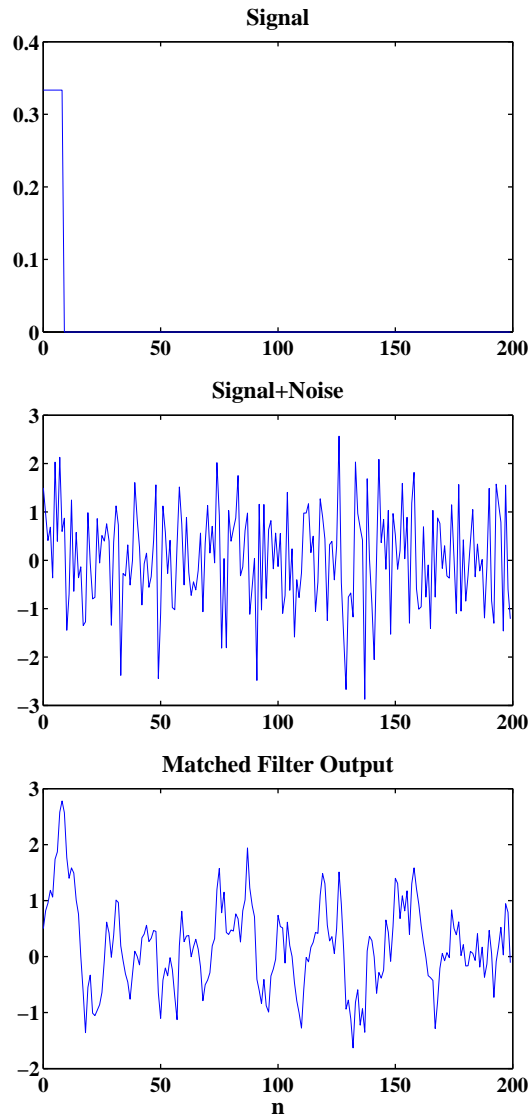


FIGURE 14.17: Plots of $s_i[n] = 1/3$, $p = 9$, noisy signal $x[n]$ and matched filter output.

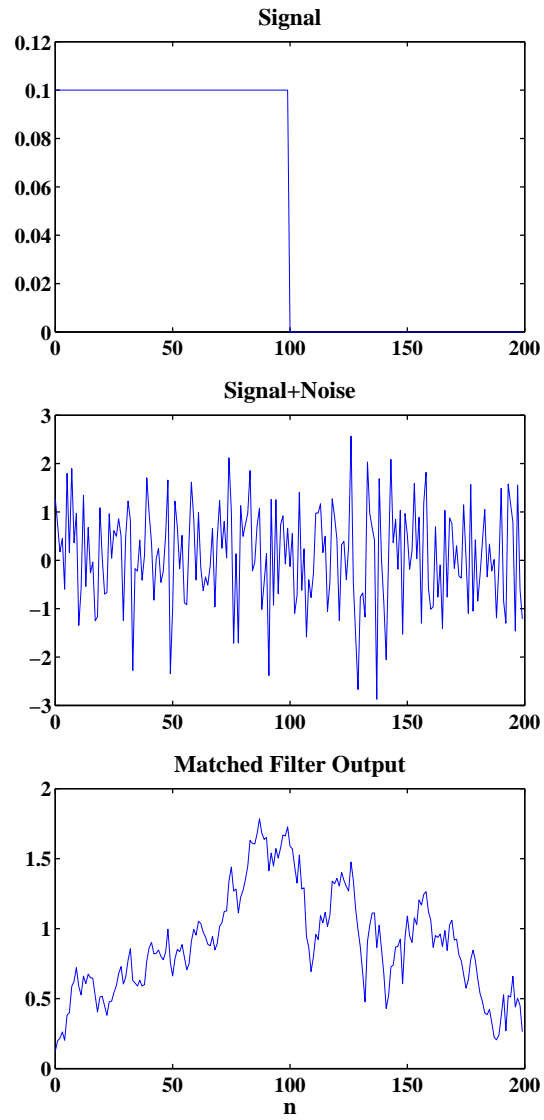


FIGURE 14.18: Plots of $s_i[n] = 1/3$, $p = 100$, noisy signal $x[n]$ and matched filter output.

35. (a) See plot below.

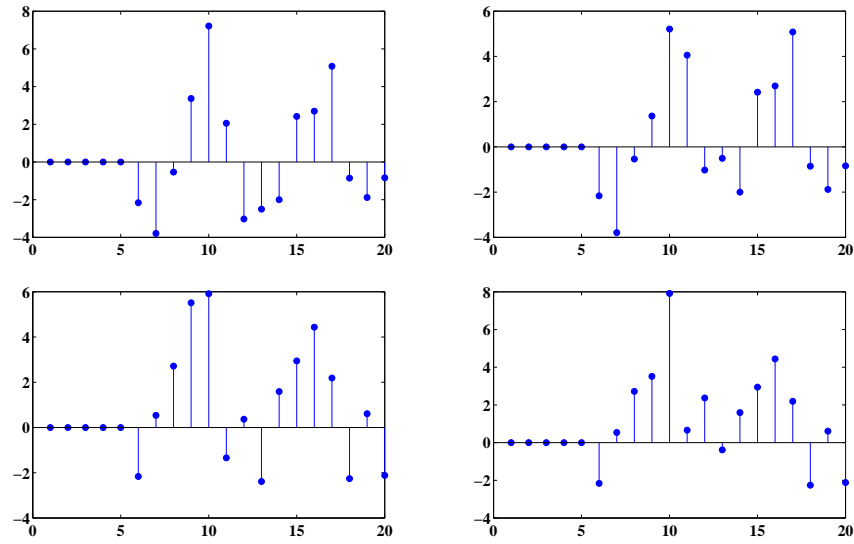


FIGURE 14.19: Plots of responses of $h_0[n]$ to $x_0[n]$ and $x_1[n]$ and $h_1[n]$ to $x_0[n]$ and $x_1[n]$.

(b) See plot below.

(c) Comments:

$$x_0[n] = \{-1, 0, 1, -1, -1, 0, 0, 0, 0, 0\}$$

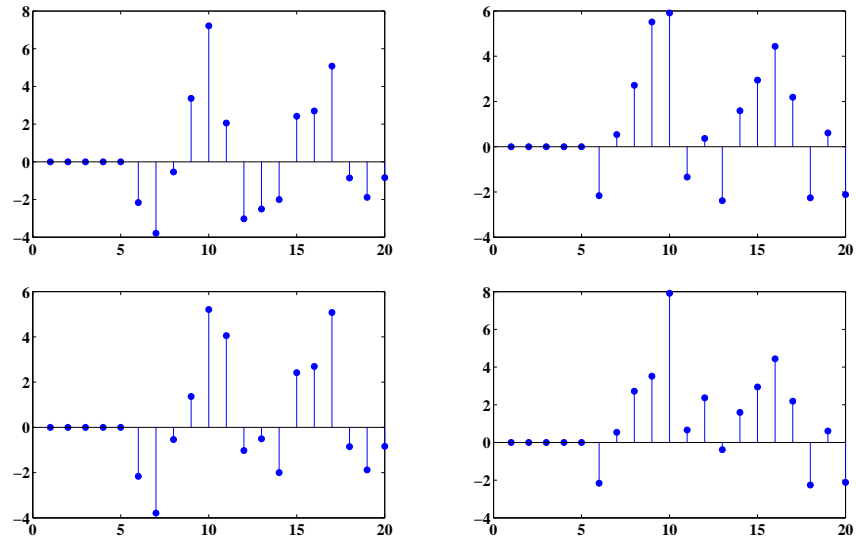


FIGURE 14.20: Plots of correlation sequences of impulse $h_0[n]$ to inputs $x_0[n]$ and $x_1[n]$ and impulse $h_1[n]$ to inputs $x_0[n]$ and $x_1[n]$.

36. (a) See plot below.

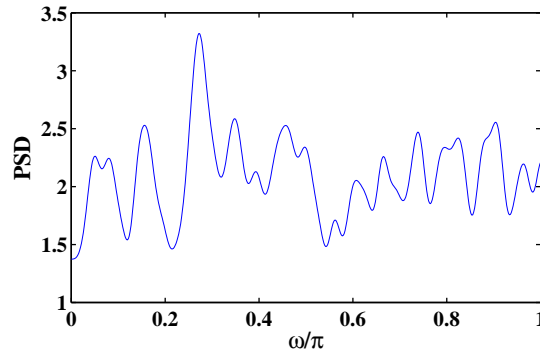


FIGURE 14.21: Plot of Welch PSD estimate of $v[n]$ at 512 frequency values over $[0, \pi]$.

(b) See plot below.

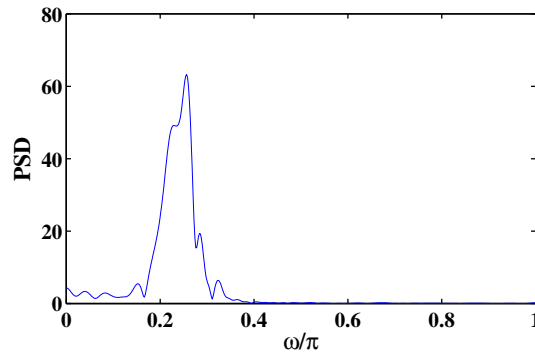


FIGURE 14.22: Plot of Welch cross-PSD estimate between $v[n]$ and $x[n]$ at 512 frequency values over $[0, \pi]$.

(c) See plot below.

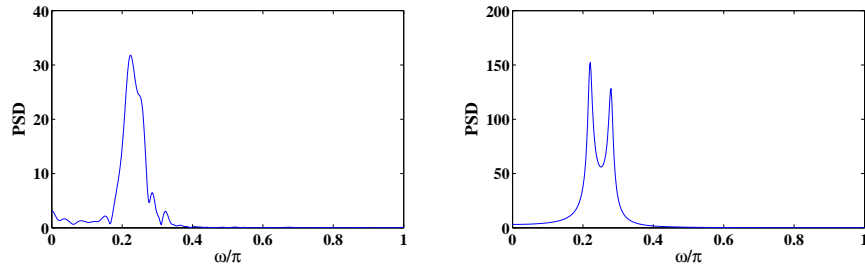


FIGURE 14.23: Plot of estimate and theoretical frequency response $H(e^{j\omega})$.

37. (a) See plot below.
- (b) See plot below.
- (c) tba.
- 38.
- 39.

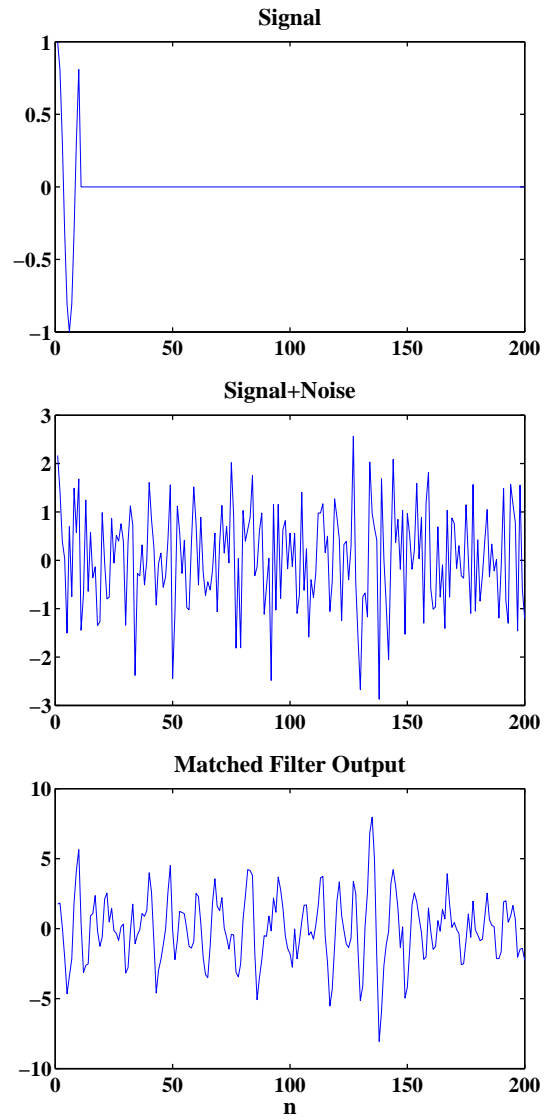


FIGURE 14.24: Plots of original signal $s_1[n]$, noisy signal $x_1[n]$ and matched filter output.

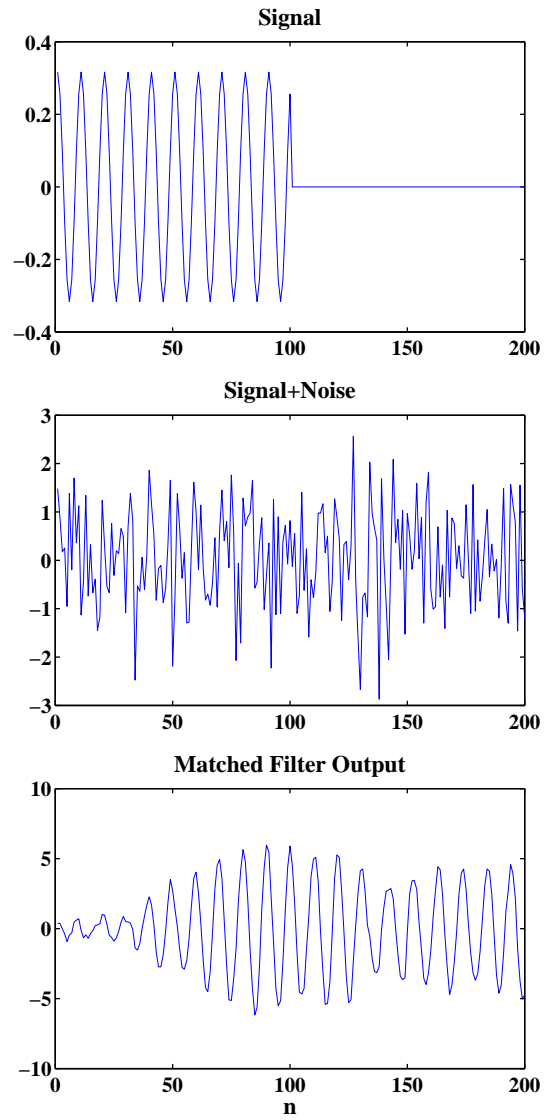


FIGURE 14.25: Plots of original signal $s_2[n]$, noisy signal $x_2[n]$ and matched filter output.