1) Lathi and Ding Chapter 8: 8.2.1, 8.2.7, 8.2.8.

2) Consider a ternary communication channel with input $X$ and output $Y$. Both inputs and outputs take on values 0, 1, or 2. The joint pmf of $X$ and $Y$ is

<table>
<thead>
<tr>
<th>X/Y</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>.24</td>
<td>.04</td>
<td>.08</td>
</tr>
<tr>
<td>1</td>
<td>.08</td>
<td>.20</td>
<td>.02</td>
</tr>
<tr>
<td>2</td>
<td>.04</td>
<td>.08</td>
<td>.22</td>
</tr>
</tbody>
</table>

a) Find the marginal pmfs of $X$ and $Y$.
b) Find the conditional pmf of $X$ given $Y = 1$.
c) Compute $E(X)$, $E(Y)$, and $\text{COV}(X,Y)$.

3) Assume that we want to quantize a signal drawn from a Gaussian random variable with mean 0 and variance 1. Design an optimal one bit, L=2 level quantizer that minimizes the mean squared quantization error (MSQE). Determine the decision boundary and the values where the two values where the signal is encoded to. Also compute the resulting MSQE.

4) Let $X_1$ and $X_2$ be iid Gaussian random variables with mean 0 and variance 1.

a) Let $Y_1 = X_1 - 2X_2 + 1$ and $Y_2 = 2X_1 + X_2 - 1$. Find the $E(Y_1)$, $E(Y_2)$, $\text{VAR}(Y_1)$, $\text{VAR}(Y_2)$, and the $\text{COV}(Y_1,Y_2)$.
b) Find the joint pdf of $Y_1$ and $Y_2$. What type of random vector is this?
c) Find a linear transformation of $Y_1$ and $Y_2$ to produce $Z_1$ and $Z_2$ that are iid Gaussian random variables with mean 0 and variance 1.
d) Implement the random variables in a) -c) on MATLAB. Find the sample means, variances, and covariances. Is the transformation unique?

5) Let $N(t)$ be a Gaussian white noise process with mean zero and power spectral density $S_N(f) = N_0/2$.

a) Let $N(t)$ be input to an LTI system with impulse response $h_1(t) = u(t) - u(t - T)$ to produce output $X_1(t)$. Find the power spectral density of $X_1(t)$, the power of $X_1(t)$, and the autocorrelation function, $R_{X_1}(\tau) = E(X_1(t + \tau)X_1(t))$.
b) Let $N(t)$ be input to an LTI system with impulse response $h_2(t) = \exp(-t)u(t)$ to produce output $X_2(t)$. Find the power spectral density of $X_2(t)$, the power of $X_2(t)$, and the autocorrelation function, $R_{X_2}(\tau) = E(X_2(t + \tau)X_2(t))$.
c) Implement $X_1(t)$ and $X_2(t)$ on MATLAB and confirm analytical results.