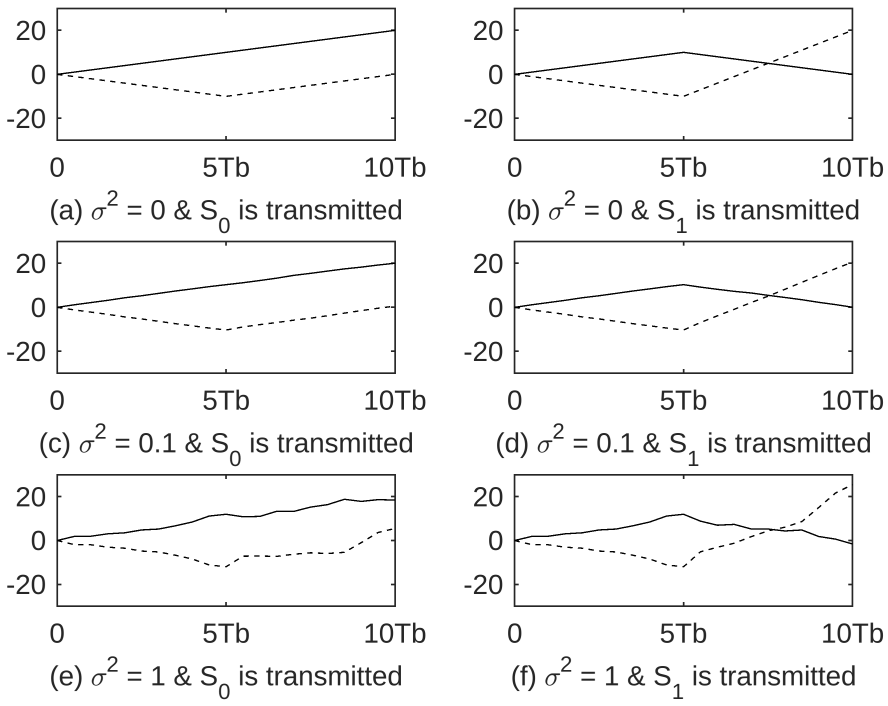
Question 1:

From [2], go through “Matched filter” from sections 5.2, solve illustrative problems 5.3 and 5.4. Then, reproduce the MATLAB script for illustrative problem 5.4. Thereafter, from theproblems at the end of the chapter, solve problem 5.4.

```
% MATLAB script for Illustrative Problem 5.4.
% Initialization:
K = 20; % Number of samples
A = 1;
% Signal amplitude
l = 0:K;
% Defining signal waveforms:
s_0 = A * ones(1, K);
s_1 = [A * ones(1, K/2) -A * ones(1, K/2)];
% Initializing output signals:
y_0 = zeros(1, K);
y_1 = zeros(1, K);

% Case 1: noise - N(0, 0)
noise = random('Normal', 0, 0, 1, K);
% Sub-case s = s_0:
s = s_0;
y = s + noise; % received signal
y_0 =conv(y, fliplr(s_0));
y_1 = conv(y, fliplr(s_1));
% Plotting the results:
subplot(3, 2, 1);
plot(l, [0 y_0(1:K)], '-k', l, [0 y_1(1:K)], '--k');
set(gca, 'XTickLabel', {'0', '5Tb', '10Tb', '15Tb', '20Tb'});axis([0 20 -30
30]);
xlabel('(a) \sigma^2 = 0 & S_0 is transmitted', 'fontsize', 10);
% Sub-case s = s_1:
s = s_1;
y = s + noise; % received signal
y_0 =conv(y, fliplr(s_0));
y_1 = conv(y, fliplr(s_1));
% Plotting the results:
subplot(3, 2, 2);
plot(l, [0 y_0(1:K)], '-k', l, [0 y_1(1:K)], '--k');
set(gca, 'XTickLabel', {'0', '5Tb', '10Tb', '15Tb', '20Tb'});axis([0 20 -30
30]);
xlabel('(b) \sigma^2 = 0 & S_1 is transmitted', 'fontsize', 10);
% Case 2: noise - N(0, 0.1)
noise = random('Normal', 0, 0.1, 1, K);
% Sub-case s = s_0:
s = s_0;
y = s + noise; % received signal
y_0 =conv(y, fliplr(s_0));
y_1 = conv(y, fliplr(s_1));
```

```
% Plotting the results:
subplot(3, 2, 3);
plot(l, [0 y_0(1:K)], '-k', l, [0 y_1(1:K)], '--k');
set(gca, 'XTickLabel', {'0', '5Tb', '10Tb', '15Tb', '20Tb'});axis([0 20 -30
30]);
xlabel('(c) \sigma^2 = 0.1 & S_0 is transmitted', 'fontsize', 10);
% Sub-case s = s_1:
s = s_1;
y = s + noise; % received signal
y_0 =conv(y, fliplr(s_0));
y_1 = conv(y, fliplr(s_1));
% Plotting the results:
subplot(3, 2, 4);
plot(l, [0 y_0(1:K)], '-k', l, [0 y_1(1:K)], '--k');
set(gca, 'XTickLabel', {'0', '5Tb', '10Tb', '15Tb', '20Tb'});axis([0 20 -30
30]);
xlabel('(d) \sigma^2 = 0.1 & S_1 is transmitted', 'fontsize', 10);
% Case 3: noise - N(0, 1)

noise = random('Normal', 0, 1, 1, K);
% Sub-case s = s_0:
s = s_0;
y = s + noise; % received signal
y_0 =conv(y, fliplr(s_0));
y_1 = conv(y, fliplr(s_1));
% Plotting the results:
subplot(3, 2, 5);
plot(l, [0 y_0(1:K)], '-k', l, [0 y_1(1:K)], '--k');
set(gca, 'XTickLabel', {'0', '5Tb', '10Tb', '15Tb', '20Tb'});axis([0 20 -30
30]);
xlabel('(e) \sigma^2 = 1 & S_0 is transmitted', 'fontsize', 10);
% Sub-case s = s_1:
s = s_1;
y = s + noise; % received signal
y_0 =conv(y, fliplr(s_0));
y_1 = conv(y, fliplr(s_1));
% Plotting the results:
subplot(3, 2, 6);
plot(l, [0 y_0(1:K)], '-k', l, [0 y_1(1:K)], '--k');
set(gca, 'XTickLabel', {'0', '5Tb', '10Tb', '15Tb', '20Tb'});axis([0 20 -30
30]);
xlabel('(f) \sigma^2 = 1 & S_1 is transmitted', 'fontsize', 10);
```



(a) $\sigma^2 = 0$ & S_0 is transmitted

(b) $\sigma^2 = 0$ & S_1 is transmitted

(c) $\sigma^2 = 0.1$ & S_0 is transmitted

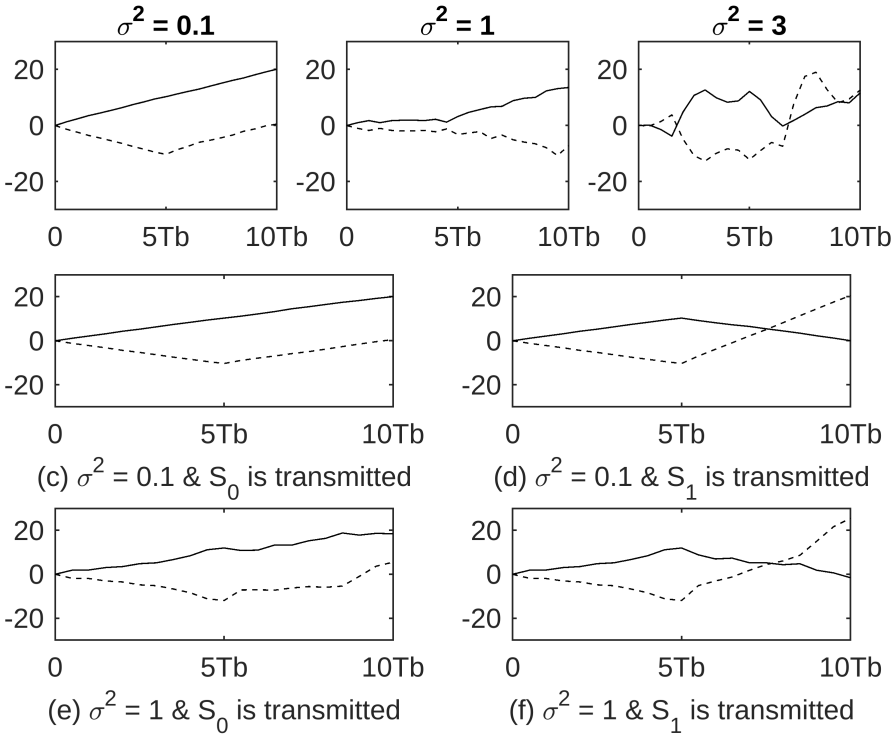
(d) $\sigma^2 = 0.1$ & S_1 is transmitted

(e) $\sigma^2 = 1$ & S_0 is transmitted

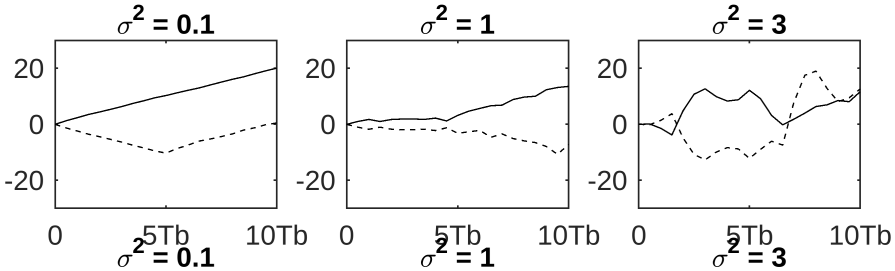
(f) $\sigma^2 = 1$ & S_1 is transmitted

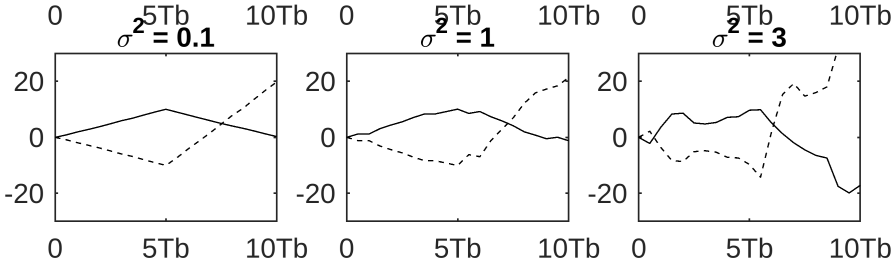
```
% MATLAB script for Illustrative Problem 5.4.
% Initialization:
K = 20; % Number of samples
A = 1;
% Signal amplitude
l = 0:K;
% Defining signal waveforms:
s_0 = A * ones(1, K);
s_1 = [A * ones(1, K/2) -A * ones(1, K/2)];
% Different noise variances:
variances = [0.1, 1, 3];
for var_idx = 1:length(variances)
% Initializing output signals:
y_0 = zeros(1, K);
y_1 =zeros(1, K);
% Noise for the current variance:
variance = variances(var_idx);
noise = random('Normal', 0, variance, 1, K);
% Sub-case s = s_0:
s = s_0;
y = s + noise; % received signal
y_0 = conv(y, fliplr(s_0));
y_1 = conv(y, fliplr(s_1));
% Plotting the results for the current variance:
subplot(3, length(variances), var_idx);
plot(l, [0 y_0(1:K)], '-k', l, [0 y_1(1:K)], '--k');
set(gca, 'XTickLabel', {'0', '5Tb', '10Tb', '15Tb', '20Tb'});axis([0 20 -30
30]);
```

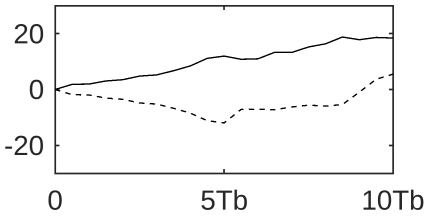
```
title(['\sigma^2 = ' num2str(variance)], 'fontsize', 10);
end
```



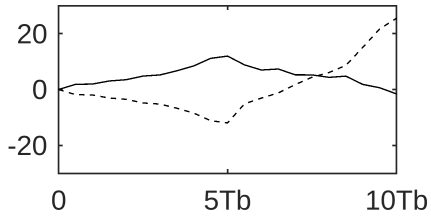

```
% Sub-case s = s_1:
s = s_1;
for var_idx = 1:length(variances)
% Initializing output signals:
y_0 = zeros(1, K);
y_1 = zeros(1, K);
% Noise for the current variance:
variance = variances(var_idx);
noise = random('Normal', 0, variance, 1, K);
y = s + noise; % received signal
y_0 = conv(y, fliplr(s_0));
y_1 = conv(y, fliplr(s_1));

% Plotting the results for the current variance:
subplot(3, length(variances), length(variances) + var_idx);plot(l, [0
y_0(1:K)], '-k',l, [0 y_1(1:K)], '--k');
set(gca, 'XTickLabel', {'0', '5Tb', '10Tb', '15Tb', '20Tb'});axis([0 20 -30
30]);
title(['\sigma^2 = ' num2str(variance)], 'fontsize', 10);

end
```







(e) σ^2 = 1 & S_0 is transmitted



(f) σ^2 = 1 & S_1 is transmitted