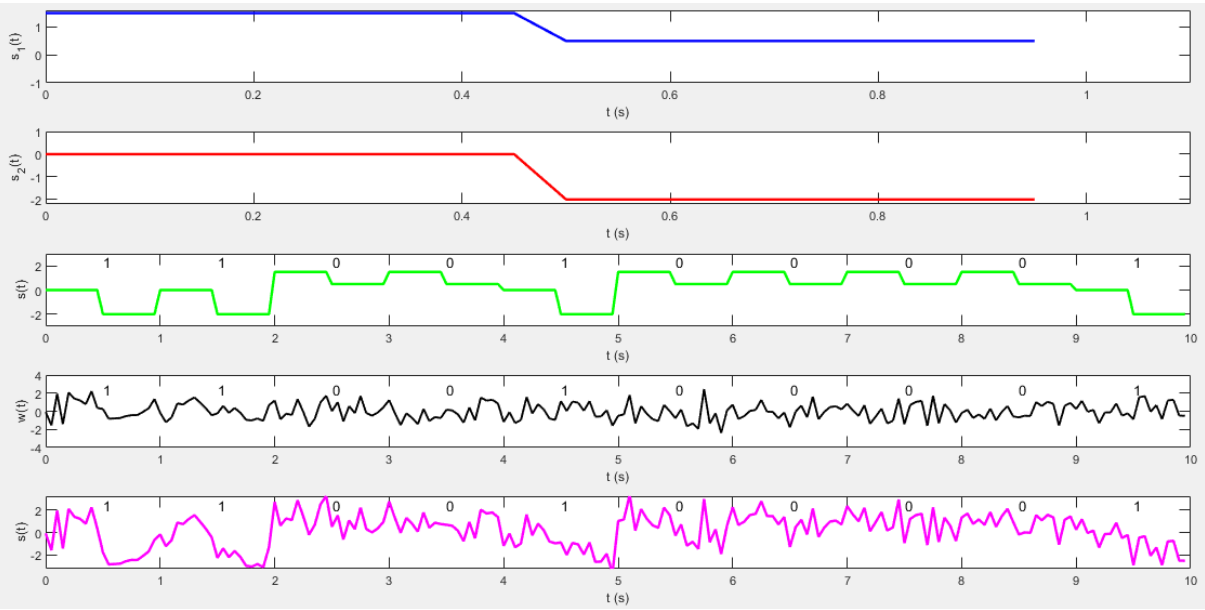
Chapter 3: Project

<u>Question 1</u>: Using the hyperthesis in Example 3, complete the following code to present 10 bits of the signal, which is transmitted with $P_1 = P_2 = 0.5$.

```
clc; clear; close all;

% ================ Represent s1(t) and s2(t)
ts = 0.05;  % The sample time
t1 = 0:   ts: 0.5 - 0.05;
t2 = 0.5: ts: 1 - 0.05;
t_1bit = [t1 t2];  % Time of 1 bit
L = length(t_1bit); % The number of samples of 1 bit

s1_t1 = ????;
s1_t2 = ????;
s1 = [????    ????];  % s1(t)

s2_t1 = ????;
s2_t2 = ????;
s2 = [????    ????];  % s2(t)


% ================ The transmitted signal
Ntry = 10^1; % The total transmitted bits
Bit = ???? ;% Transmission with P1 = P2 = 0.5

s = []; % The transmitted signal s(t)
t = []; % The time of s(t)
for i = 1:Ntry
    if Bit(i) == 0
        s = [s   ????];
    else
        s = [s   ????];
    end

    t_ibit = t_1bit + ????; % Time of i-bit
    t = [t  t_ibit];
end

% ================= The AWGN channel
N0_2 = 0.05; % The noise power spectrum desity (W/Hz) N0/2
B = 1/ts;    % Bandwidth of signals
Power_noise = ????; % The power of noise
w = ????;

% ================= The received signal
r = ????;
```

```
figure(1)
subplot(5,1,1)
plot(t_1bit,s1,'b-','linewidth',1.8); hold on;
xlabel('t (s)'); ylabel('s_1(t)');
axis([0 1.1 -1 1.6])

subplot(5,1,2)
plot(t_1bit,s2,'r-','linewidth',1.8);
xlabel('t (s)'); ylabel('s_2(t)')
axis([0 1.1 -2.2 1])

x_note = 0.5 :1 :Ntry - 0.5;
y_note = 2.4 *ones(1,Ntry);
Text = string(Bit);
subplot(5,1,3)
plot(t,s,'g-','linewidth',1.8);
text(x_note, y_note, Text);
xlabel('t (s)'); ylabel('s(t)')
axis([0 Ntry -3 3])

subplot(5,1,4)
plot(t,w,'k-','linewidth',1.4);
text(x_note, y_note, Text);
xlabel('t (s)'); ylabel('w(t)')
axis([0 Ntry -4 4])

subplot(5,1,5)
plot(t,r,'m-','linewidth',1.8);
text(x_note, y_note, Text);
xlabel('t (s)'); ylabel('s(t)')

axis([0 Ntry -3.2 3.2])
```



Question 2: Based on the receiver implementation in Example 4, complete the following code to evaluate the system performance via the bit error probability.

```
clc; clear; close all;

% ================= Represent s1(t) and s2(t)
ts = 0.1;  % The sample time
t1 = 0:   ts: 0.5 - 0.05;
t2 = 0.5: ts: 1 - 0.05;
t_1bit = [t1 t2];     % Time of 1 bit
L = length(t_1bit);   % The number of samples of 1 bit

s1_t1 = ????;
s1_t2 = ????;
s1 = [????   ????];   % s1(t)

s2_t1 = ????;
s2_t2 = ????;
s2 = [????   ????];   % s2(t)


% ================= The transmitted signal
Ntry = 10^4; % The total transmitted bits

N0_2 =0.2:0.2:1.2; % The noise power spectrum desity (W/Hz) N0/2

P_error_simul = zeros(1,length(N0_2));
P_error_theo = zeros(1,length(N0_2));

for j = 1: length(N0_2)
    Bit = ????; % Transmission with P1 = P2;

    s = []; % The transmitted signal s(t)
    t = []; % The time of s(t)
    for i = 1:Ntry
        if Bit(i) == 0
            s = [s ????];
        else
            s = [s ????];
        end

        t_ibit = t_1bit + ????; % Time of i-bit
        t = [t  t_ibit];
    end

    % ================= The AWGN channel
```

```
    B = 1/ts;    % Bandwidth of signals
    Power_noise = ????; % The power of noise
    w = ????;

    % ================== The received signal
    r = ????;

    % ================== The recovered signal
    h_t1 = ????;
    h_t2 = ????;
    h = [????  ????]; % The impulse response of the matched filter
    T = ????; % The decision threshold

    Bit_rec = zeros(1,Ntry);
    for i = 1:Ntry
        Frame = ????; % Construct 1 Frame with L samples
        y = ????; % The signals pass through the matched filter
        r2_mu = ????;

        % --------- Comparator for decision
        if ????
            Bit_rec(i) = ????;
        else
            Bit_rec(i) = ????;
        end

    end
    Bit_rec;

    % =================== The bit error probability
    % ------------- Simulation
    [Num, rate] = biterr(Bit, Bit_rec);
    P_error_simul(j) = rate;


    % ------------- Theory
    s12_mu = ????;
    s22_mu = ????;

    P_error_theo(j) = ????;

end

figure(1)
plot(N0_2,P_error_simul,'ko','linewidth',1.6,'markersize',6);
hold on;
plot(N0_2,P_error_theo,'r-','linewidth',1.8,'markersize',6);
```

```
xlabel('N_0/2'); ylabel('The bit error probability');
legend('Simulation','Theory');
```