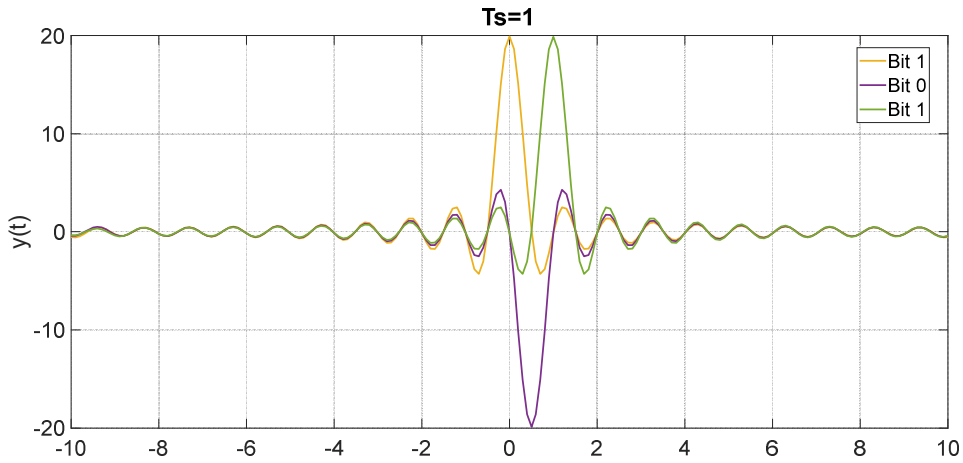
Birla Institute of Technology & Science, Pilani, Rajasthan

First Semester 2021-2022

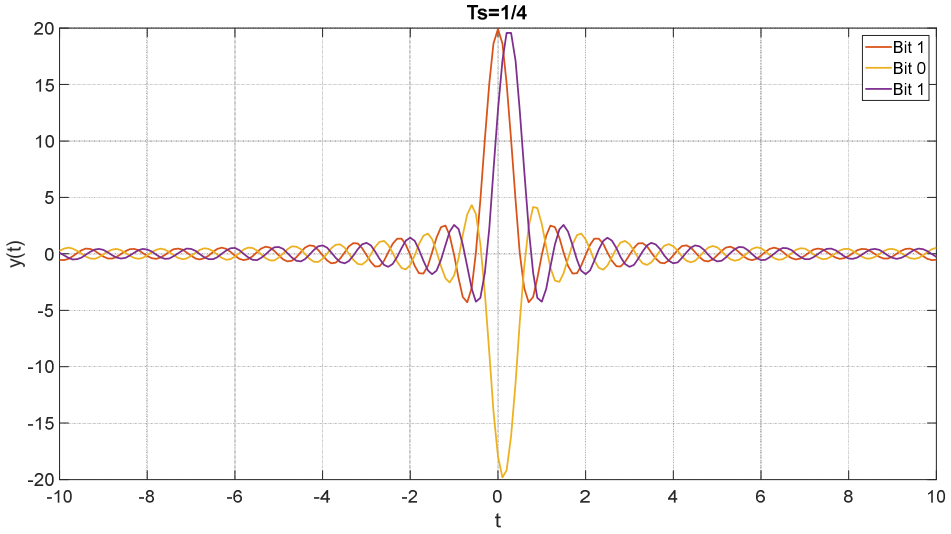
Comprehensive Exam: Lab Test (05-12-2021)

Solution

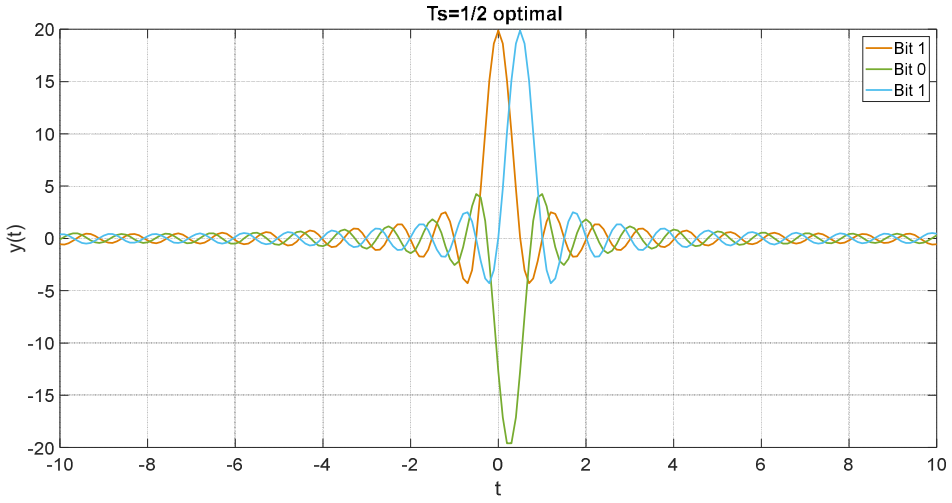
Q1 (a): Ts=1



Q1(b): Ts=1/4



Q1(c): Ts=1/2

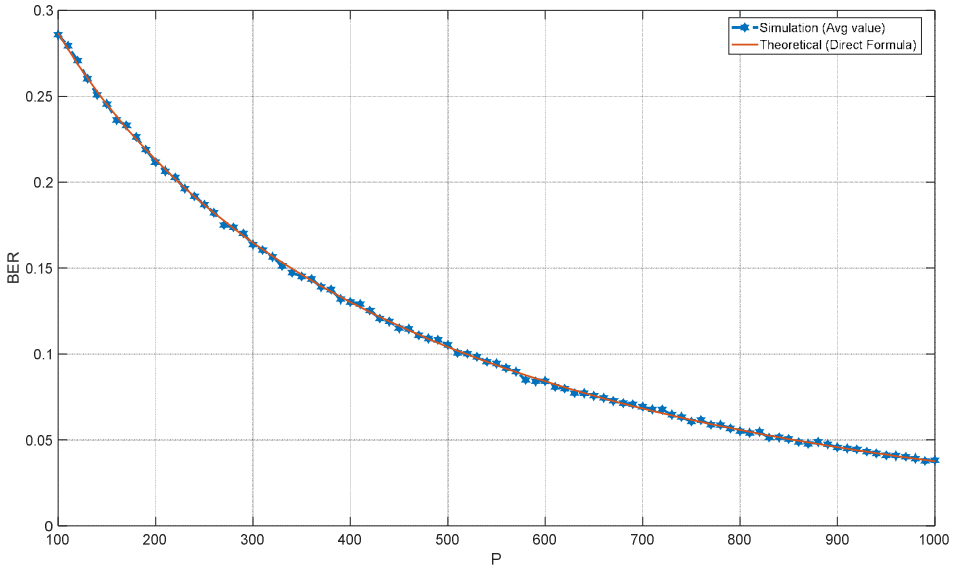


Q1(d): Q1 is based on Nyquist criteria. When Ts=1, we are transmitting at a lower rate; When Ts=1/4, we are transmitting at a faster rate and thus ISI; When Ts=1/2, optimal rate.

```
clear all
B=1;
Ts=1; %%%for (a) Ts=1; for (b) Ts=1/4; for (c) Ts=1/2 optimal
fs=10;
ts=1/fs;
t=-10:ts:10;
xt= 2*sinc(2*t);
ht=2*sinc(2*t);
yt=conv(xt,ht,'same');
figure(1)
hold all
plot(t, yt)

fs=10;
ts=1/fs;
t=-10:ts:10;
xt= -2*sinc(2*t-Ts);
ht=2*sinc(2*B*t);
yt=conv(xt,ht,'same');
figure(1)
hold all
plot(t, yt)
```

```
fs=10;
ts=1/fs;
t=-10:ts:10;
xt= 2*sinc(2*t-2*Ts);
ht=2*sinc(2*t);
yt=conv(xt,ht,'same');
figure(1)
hold all
plot(t, yt)
```

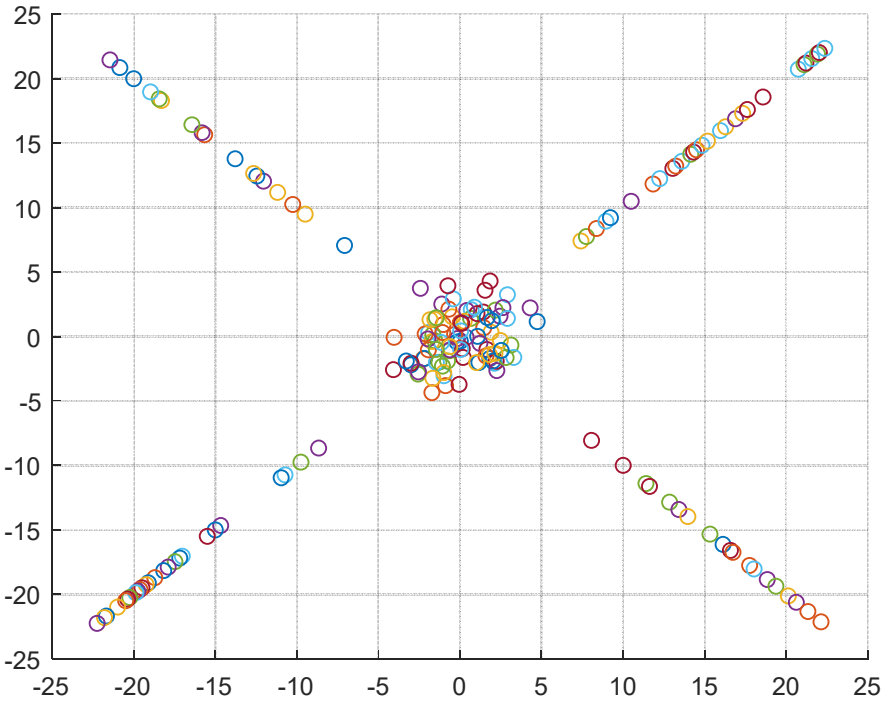
Q2 (a) Q2(b):




```
close all
clear all
%%%%%%%%%%S M Zafaruddin%%%%%%%
%%%%%%%%EEE F311 Communication Systems%%%%%%%%%%%%%%%%%


%%%%%System parameters %%%%%%%%%%%%%
noise_power_watt= 2;

transmit_power_p_min= 100;
transmit_power_p_max= 1000;

simulation_avg= [];
theoretical_direct_formula= [];
for p= transmit_power_p_min:10:transmit_power_p_max  %%% this
will increase the transmitted power of symbols.
```

```
   symbol_err=0;  %%%%%%%initialization
num_iter=10^5;
for iter=1:1:num_iter
    const=[1 -1];
    m= const(randi(2));
    x= sqrt(p)*m;
    n= sqrt(noise_power_watt)*randn(1);
    g=10^0.5;
    lambda=10;
    d=100;
   h=(g^2*lambda)/(4*pi*d); %%%channel coef.
    y= h*x+n;  %%%received signal
    x_est=y/(h*sqrt(p));
    threshold= (const(1)+const(2))/2;  %%%threshold or
decision boundary
    if (m==const(1)) && (x_est<threshold)  %%%%condition for
error
        symbol_err=symbol_err+1;
    end
            if (m==const(2)) && (x_est>threshold)
%%%condition for error
                symbol_err=symbol_err+1;
            end

end
simulation_avg= [simulation_avg symbol_err/num_iter];
received_snr=(abs(h)^2*p)/noise_power_watt;
theoretical_direct_formula= [theoretical_direct_formula
qfunc(sqrt(received_snr))];

end
p_axis= transmit_power_p_min:10:transmit_power_p_max ;

figure(1);
plot(p_axis, simulation_avg)
hold on
grid on
plot(p_axis, theoretical_direct_formula)
legend('Simulation (Avg value)', 'Theoretical (Direct
Formula)', 'location','Best')

grid on

xlabel('P')
ylabel('BER')
keyboard
```

Q2(c):




```
     close all
clear all
%%%%%%%%%%S M Zafaruddin%%%%%%%
%%%%%%%%EEE F311 Communication Systems%%%%%%%%%%%%%%%%%


%%%%%System parameters %%%%%%%%%%%%%
noise_power_watt= 2

transmit_power_p_min= 100;
transmit_power_p_max= 1000;

for p= transmit_power_p_min:10:transmit_power_p_max  %%% this
will increase the transmitted power of symbols.
  num_iter=10^2;
for iter=1:1:num_iter
    const=(1/sqrt(2)).*[1+1j, 1-1j, -1-1j, -1+1j ];
    m= const(randi(4));
    x= sqrt(p)*m;
```

```
    n=
sqrt(noise_power_watt)*randn(1)+1j*sqrt(noise_power_watt)*rand
n(1);
    g=10^0.5;
    lambda=10;
    d=100;
   h=(g^2*lambda)/(4*pi*d); %%%channel coef.
      y= h*x+n;  %%%received signal


end
figure(1)
hold all
scatter(real(x),imag(x))
hold on
scatter(real(y), imag(y))
grid on
end
```