Subject Name: Wireless Communication

Subject Code: CSP311M

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Practical Number: 5

Aim: Write Matlab code of AWGN (Additive white Gaussian noise) and Rayleigh fading for wired network and wireless networks to observe BER to SNR(dB) of each in QPSK.

Brief Theory:

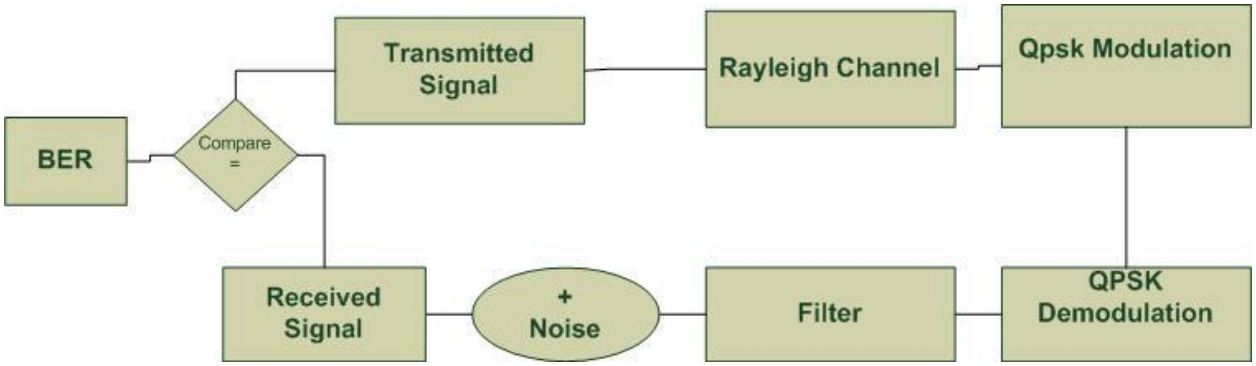
1. **AWGN (Additive white Gaussian noise) (Wired Communication):**

$$X_{qpsk} = \frac{1}{\sqrt{2}}\left(2 * x_{sym1} - 1\right) + j(2 * x_{sym2} - 1)$$
$$\sigma^2 = 10^{(-SNR/20)}$$
$$n = \frac{1}{\sqrt{2}}\left(randn(1,10^5) + j * randn(1,10^5)\right)$$
$$Y = hX_{qpsk} + n$$
$$BER = \frac{sum(error\ bit)}{total\ no.of\ bits} \quad (\because Practical)$$
$$P_E = \left(erfc\left(\sqrt{SNR_{linear} * 0.5}\right) - \frac{1}{4}\left(erfc\left(\sqrt{SNR_{linear}} * 0.5\right)\right)^2\right) (\because Theoretical)$$

Here,

X_{qpsk}: $Transmited\ signal\ QPSK$
x: $Transmited\ bits$
n: $Noise\ Component$
Y: $Recieved\ Signal$
h: $Complex\ Scaling\ factor (\because h = 1\ for\ wired\ Communication)$
$randn(1,10^5)$: $random\ number\ generater$
SNR_{linear}: $Signal\ to\ Noise\ Ratio\ (linear)$

2. **Rayleigh fading (Wireless Communication):**



Step 1. Transmit Signal

Step 2. Pass through Rayleigh Channel

Step 3. Modulate using Modem.pskmod (,,,,); where M=4

Step 4. Demodulate using Modem.pskdemod(,,,); where M=4

Step 5. Pass through Filter

Step 6. As it is wireless Network Add awgn noise to signal and finally we get received signal

Step 7. Compare Transmitted Signal and Received Signal and find Bit Error Rate.

Matlab Code:

1. AWGN (SNR(dB) -> BER) QPSK:

```
%AWGN
%making Array
n = zeros(1,10^5);
Ysym = zeros(1,10^5);
Y = zeros(1,10^5);
count=0;
%generating rando Symbols of X and Y and storing in Array
Xsym1 = (randi([0,1],1,10^5));
Xsym2 = (randi([0,1],1,10^5));
X = (2.*(Xsym1) - 1) + 1j*(2.*(Xsym2)-1);
X1=X/sqrt(2);

for SNR=1:10
    count =0;
    Var = 10.^(-SNR/20);
    n = (Var./sqrt(2)).*(randn(1,10^5)+ 1j.*randn(1,10^5));

    Y = X1 + n;%recieved Signal
    for i=1:1:10^5

         if real(Y(i))<0 && imag(Y(i))<0
            Ysym(i) = -1 - 1*j;
        elseif real(Y(i))>0 && imag(Y(i))<0
            Ysym(i) = 1 - 1*j;
        elseif real(Y(i))<0 && imag(Y(i))>0
            Ysym(i) = -1 + 1*j;
        elseif real(Y(i))>0 && imag(Y(i))>0
            Ysym(i) = 1 + 1*j;
        end

        if(X(i)~=Ysym(i))% detecting no. of error in recieved Signal
            count=count+1;
        end

    end

    ser(SNR)=count/10^5;% Prob. Error
end
%theoretical Computation
SNR=1:10;
SNR_linear=10.^(SNR./10);%converting dB to Linear
PE=erfc(sqrt(SNR_linear.*0.5))-
0.25.*erfc(sqrt(0.5.*SNR_linear)).^2;%Theoretical Equation

semilogy(SNR,ser,SNR,PE);
title('SER vs SNR(AWGN Channel)');
xlabel('SNR(dB)->');
```

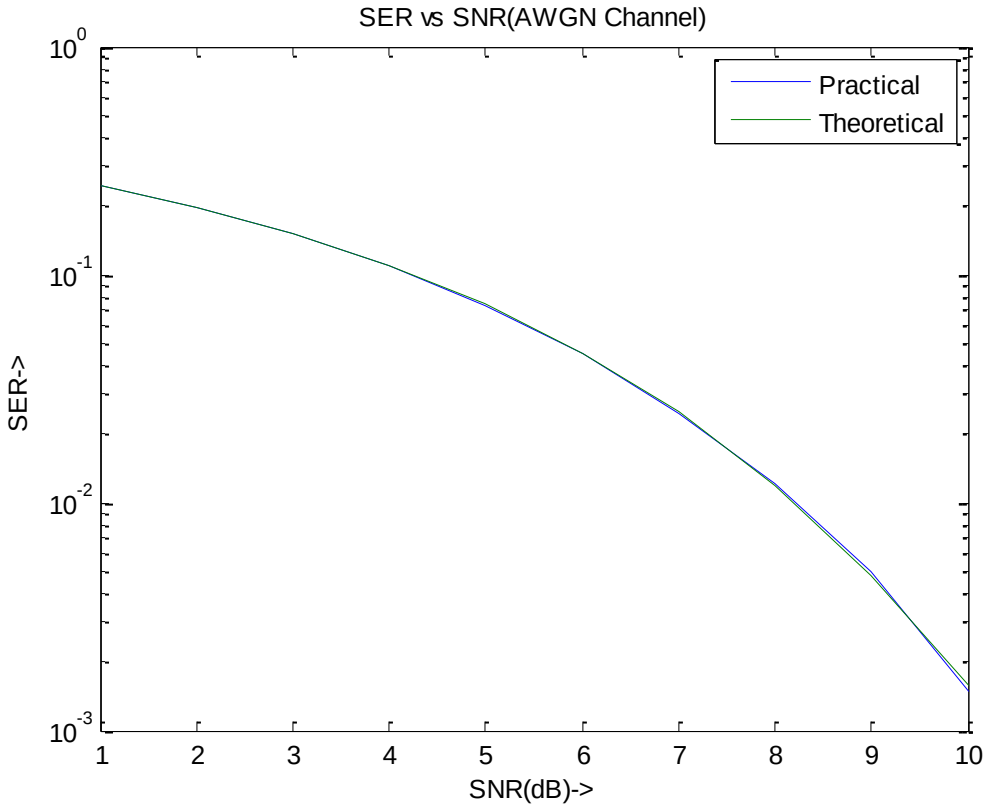
```
ylabel('SER->');
legend('Practical','Theoretical');
```

2. Rayleigh fading (SNR(dB) -> BER) QPSK:

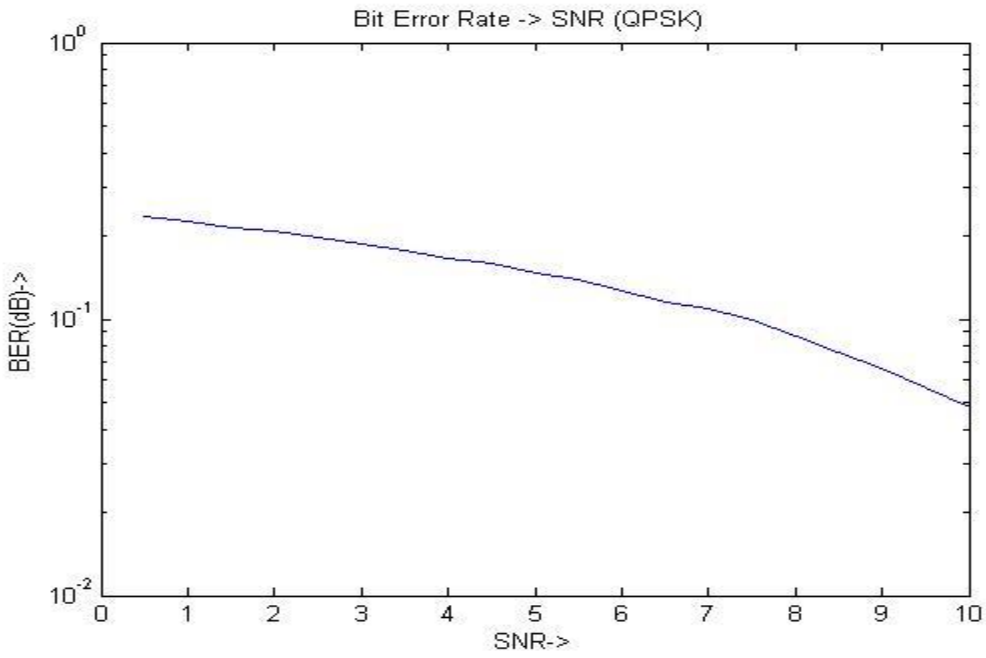
```
SNR = 0.5:0.5:10; % snr value

Tx=randsrc(10^5,1,[0,1]); % generate 10^5 number of bit

Ts=1/10^5; % time period

Ray_chan = rayleighchan(Ts,0); % generate rayleigh channel

mod_handler = modem.pskmod('M',4,'InputType','bit'); %M=4 becouse 4-
QPSK modulation

dem_handler =
modem.pskdemod('M',4,'OutputType','bit','DecisionType','hard
decision');%M=4 becouse 4-QPSK De-modulater

QPSK = modulate(mod_handler,Tx); % Modulate Signal

filter_signal = filter(Ray_chan,QPSK); % Geting Filter Signal

for i=SNR

    N = awgn(filter_signal,i); % Adding Noise to Filter
    Rx = demodulate(dem_handler,N); % De-modulate Received Signal
    SER(i*2) = biterr(Tx,Rx); %Find Bit Error
end
semilogy (SNR , SER/10^5);
title('Bit Error Rate -> SNR (QPSK) ');

xlabel('SNR->');
ylabel('BER(dB)->');
```

Output:

1. AWGN (QPSK):



2. Rayleigh fading (QPSK):



Result Interpretation:

BER in wireless communication (Rayleigh fading) is more than the Wired Communication (AWGN) because there is more noise disturbance in wireless communication than wired communication. In General Signal to Noise Ratio Increasing Bit Error Ratio (BER) decrease

As we can also observe that in wired communication bit error rate rapidly decrease as Signal strength increases as in wireless channel it is not so because of AWGN noise component in the wireless network.