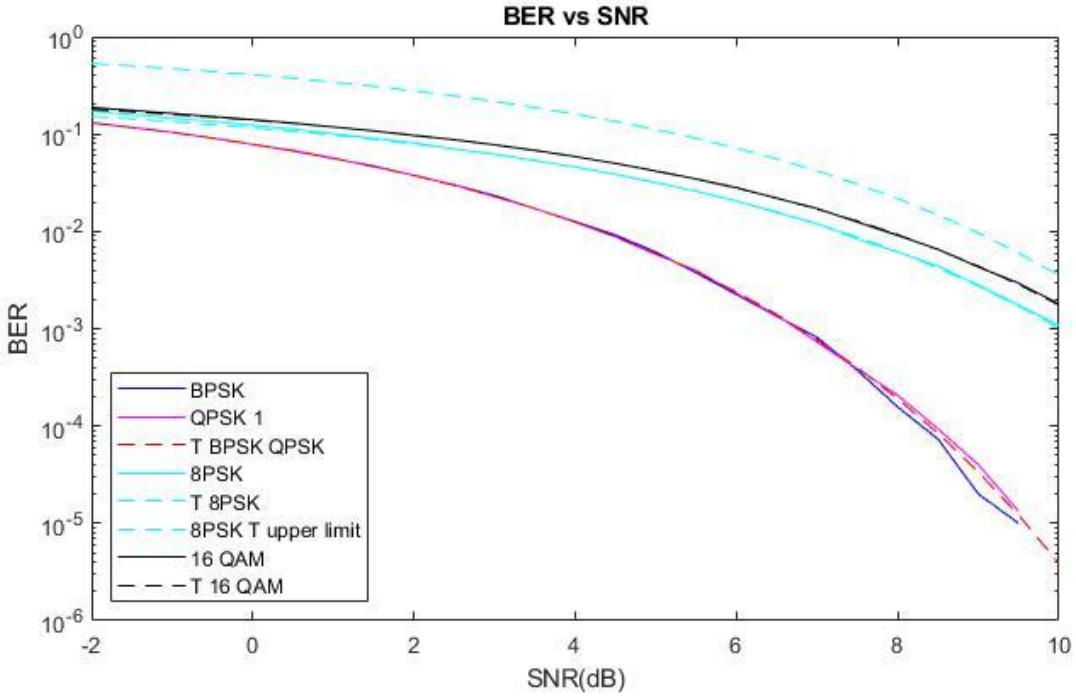
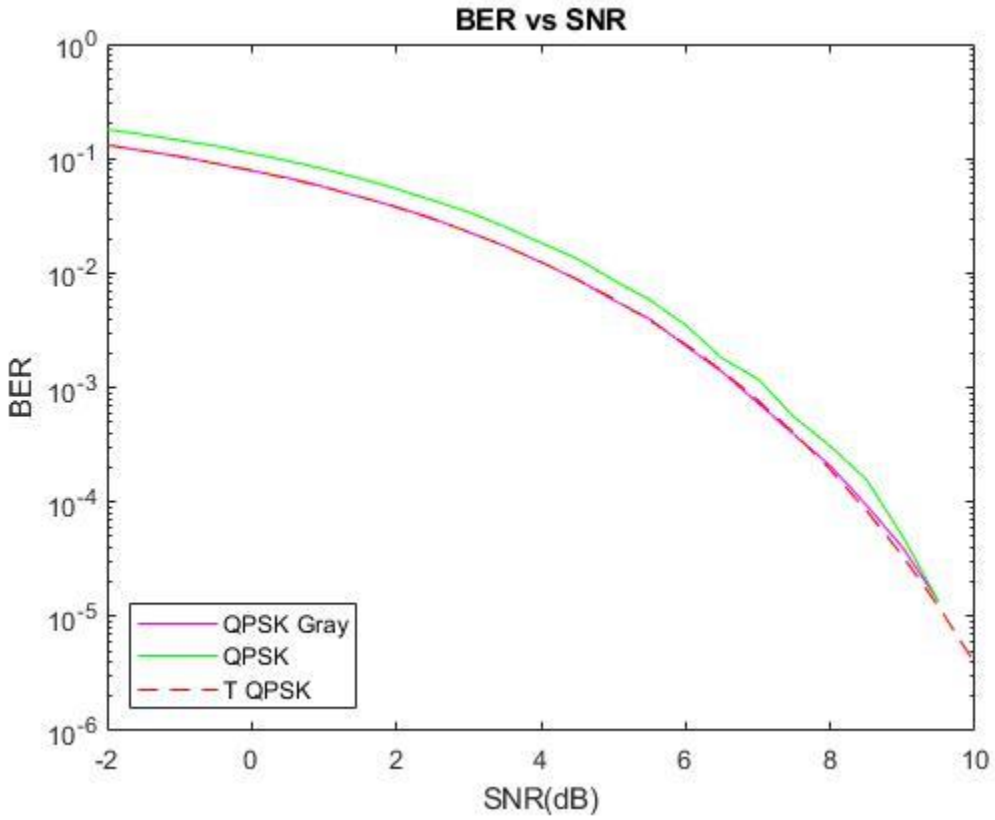
1 TASK 1

1.1 8PSK, BPSK, QPSK, AND 16-QAM CONSTELLATIONS



- BPSK, QPSK BER and there theoretical BER are the same.
- The actual 8PSK and the theoretical 8PSk
- The actual QAM and the theoretical QAM
- 8BSK's BER is higher than QBSK's BER
- QAM's BER is the worst BER

1.2 QPSK-GRAY, QPSK-NOT GRAY, QPSK-THEROETICAL

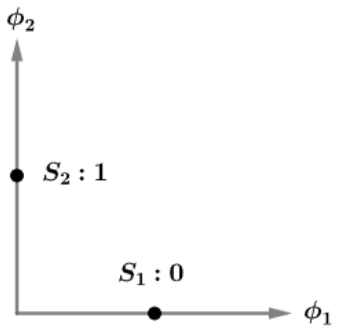


- The Gray code QPSK has lower BER than QPSK without Gray code

2 TASK 2: FSK

2.1 THE SIGNAL SET

$$\phi_i = \sqrt{\frac{2}{T_b}}\cos(2\pi f_i t)$$



$$s_1(t) = \sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c t)$$

$$s_2(t) = \sqrt{\frac{2E_b}{T_b}}cos(2\pi(f_c + \Delta f)t)$$

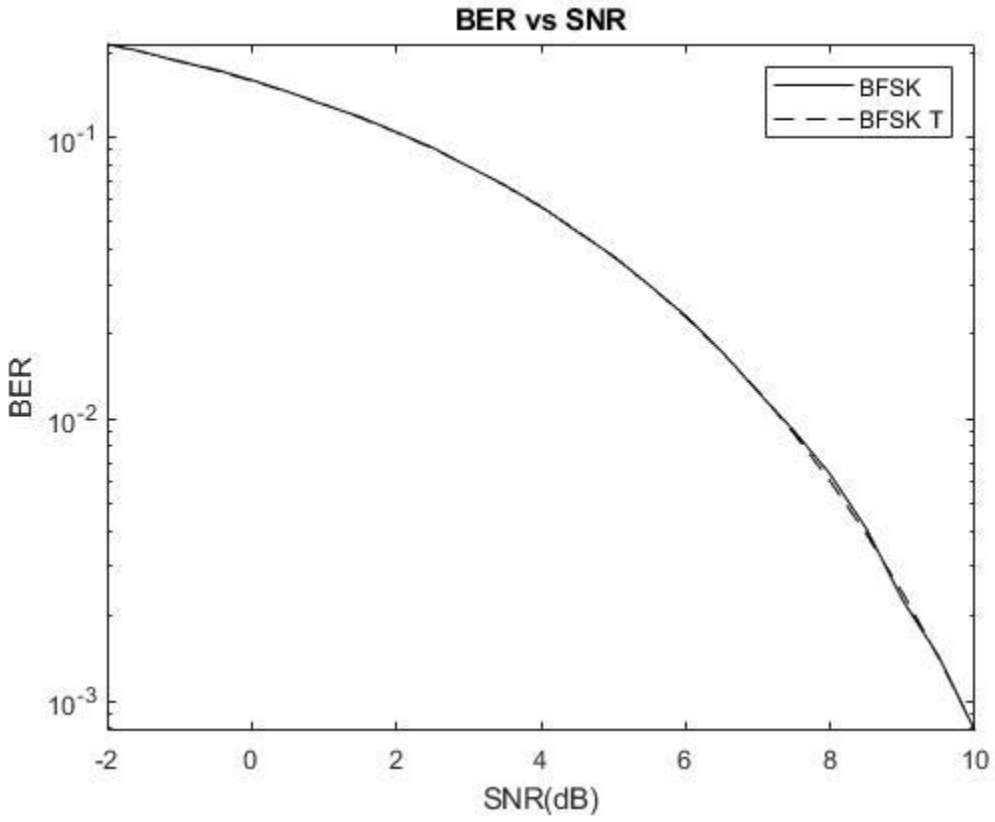
$$= \sqrt{\frac{2E_b}{T_b}}[\cos(2\pi f_c t) * \cos(2\pi\Delta f t) - \sin(2\pi f_c t) * \sin(2\pi\Delta f t)]$$

2.2 EXPRESSION FOR THE BASEBAND EQUIVALENT SIGNALS FOR THIS SET

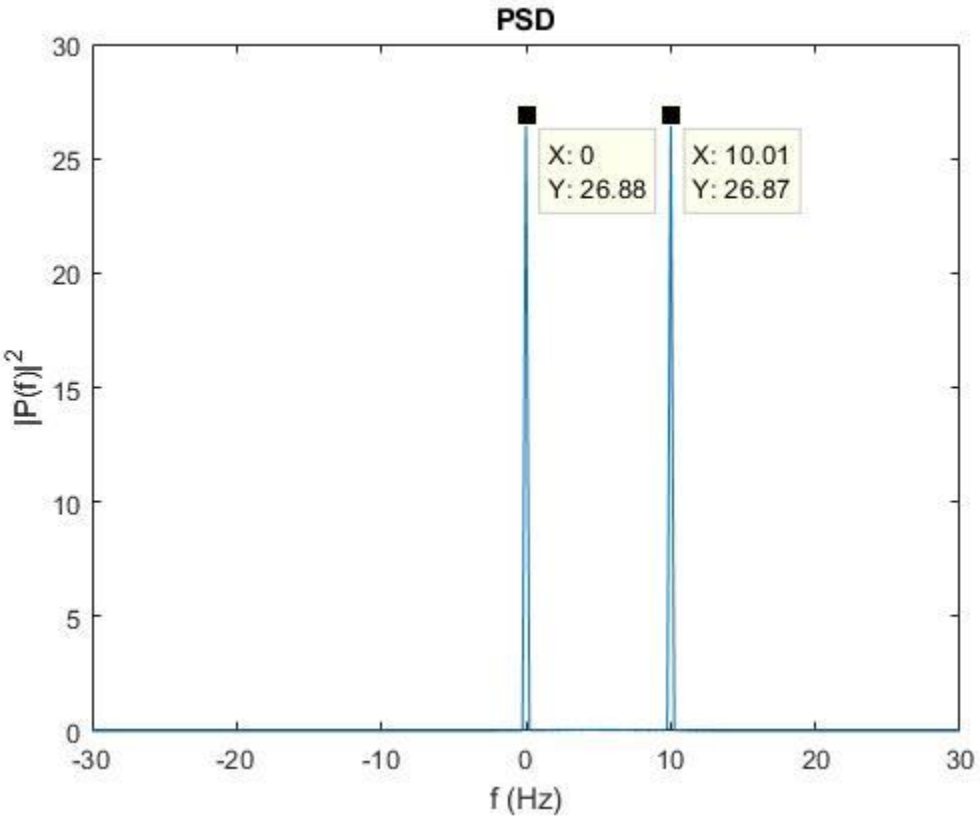
$$s_{1BB}(t) = \sqrt{\frac{2E_b}{T_b}}$$

$$s_{2BB}(t) = \sqrt{\frac{2E_b}{T_b}}[\cos(2\pi\Delta f t) + j\sin(2\pi\Delta f t)]$$

2.3 FSK BER



2.4 FSK PSD


PSD
X: 0
Y: 26.88
X: 10.01
Y: 26.87
30
25
20
15
10
5
0
-30
-20
-10
0
10
20
30
f (Hz)
|P(f)|^2

3 MATLAB CODE

```
%%
clc
clear
%% BIT generation
stream_length = 300000;
bit_stream = randi([0 1],1,stream_length);

SNR = -2:0.5:10;
Eb = 10.^(SNR/10);
num_of_iterations = size(Eb,2);
%%
BPSK_BER   = zeros(1,num_of_iterations);
QPSK_1_BER = zeros(1,num_of_iterations);
QPSK_2_BER = zeros(1,num_of_iterations);
PSK8_BER = zeros(1,num_of_iterations);
QAM16_BER = zeros(1,num_of_iterations);

for  i = 1:num_of_iterations

    BPSK_BER(i)   = BPSK(bit_stream,stream_length,Eb(i));
    QPSK_1_BER(i) = QPSK_1(bit_stream,stream_length,Eb(i));
    QPSK_2_BER(i) = QPSK_2(bit_stream,stream_length,Eb(i));
    PSK8_BER(i)   = PSK8(bit_stream,stream_length,Eb(i));
    QAM16_BER(i)  = QAM16(bit_stream,stream_length,Eb(i));
    fprintf(' %d Finished \n',i);

end
    QPSK_T=0.5*erfc(sqrt(Eb));
    PSK8_T=erfc(sqrt(3*Eb)*sin(pi/8))/3;
    PSK8_T_upper_limit=3.5*erfc(sqrt(3*Eb)*sin(pi/8))/3;
    QAM_T =1.5*erfc(sqrt(Eb/2.5))/4;
%%

semilogy(SNR,BPSK_BER,'b-')
hold on
semilogy(SNR,QPSK_1_BER,'m-')
hold on
semilogy(SNR,QPSK_T,'r--')
hold on

semilogy(SNR,PSK8_BER,'c-')
hold on
semilogy(SNR,PSK8_T,'c--')
hold on
semilogy(SNR,PSK8_T_upper_limit,'c--')
hold on

semilogy(SNR,QAM16_BER,'k-')
hold on
semilogy(SNR,QAM_T,'k--')
hold on



title('BER vs SNR');
xlabel('SNR(dB)');
ylabel('BER');
legend('BPSK','QPSK 1','T BPSK QPSK','8PSK','T 8PSK','8PSK T upper limit','16 QAM','T 16
QAM','Location','southwest');
%%
figure;
semilogy(SNR,QPSK_1_BER,'m-')
hold on
semilogy(SNR,QPSK_2_BER,'g-')
hold on
semilogy(SNR,QPSK_T,'r--')
hold on

title('BER vs SNR');
xlabel('SNR(dB)');
ylabel('BER');
legend('QPSK Gray','QPSK','T QPSK','Location','southwest');
```