Homework Set 4
EE 132A

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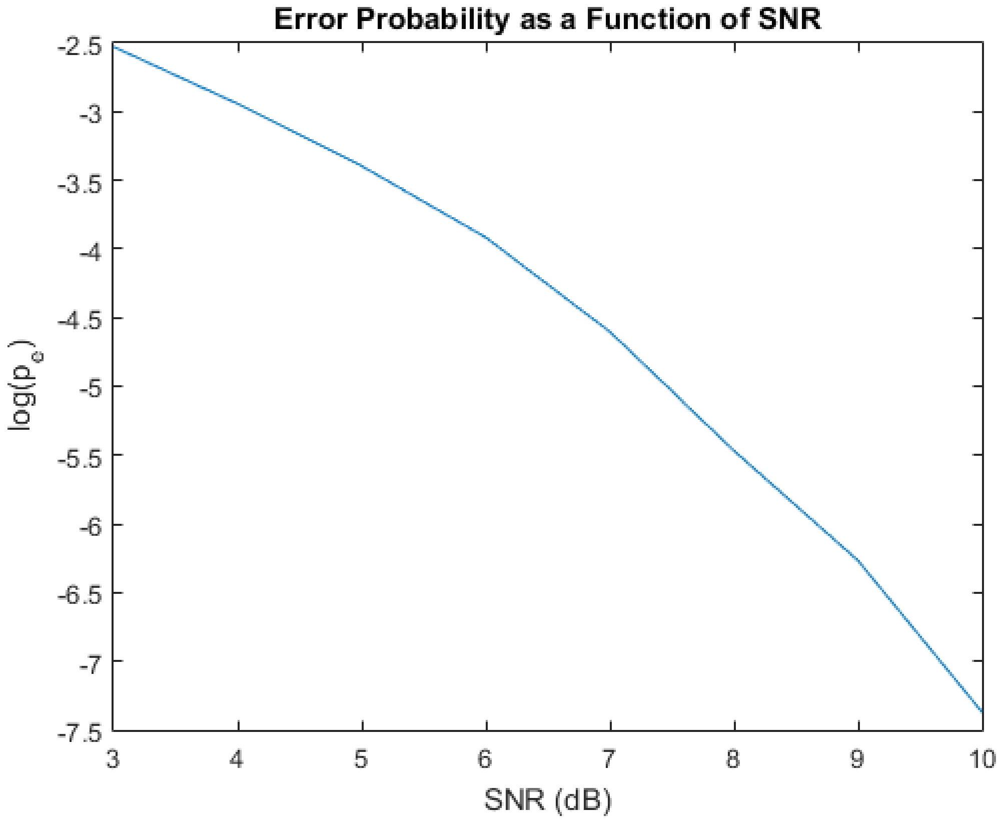
Problem 5:
For this project we just wanted to plot the effect of the SNR on the error probability, as an introduction to tradeoffs. The Matlab code is shown below and so is the plot. We see that on the log-log plot that we have plotted, the points are roughly linear.

```
N = 100000;
SNR_dB = [3 4 5 6 7 8 9 10];
SNR = 10.^(SNR_dB / 10);
E_av = 10;
sig = sqrt(E_av ./ SNR);
H = randi(8, 1, N);

X = zeros(N, 2);

constel = [-1 3; 3 3; -3 1; 1 1; -1 1; 3 -1; -3 -3; 1 -3];

for i=1:N
    X(i,:) = constel(H(i),:);
end

basis0 = [ones(1,10) zeros(1,10)];
basis1 = [zeros(1,10) ones(1,10)];

factor = norm(basis0);

basis0 = basis0 / factor;
basis1 = basis1 / factor;

S = zeros(N, 20);

for i=1:N
    S(i,:) = X(i,1) * basis0 + X(i,2) * basis1;
end

p_e = zeros(1,8);

for k=1:8
    noise = sig(k) * randn(N,20) / factor;
    R = S + noise;

    Y = zeros(N,2);

    for i=1:N
        C_0 = conv(R(i,:), basis1);
        C_1 = conv(R(i,:), basis0);
        Y(i,1) = C_0(20);
        Y(i,2) = C_1(20);
    end
    H_hat = zeros(1,10000);

    for i=1:N
        min = 1;
        dist = (Y(i,1)-constel(1,1))^2 + (Y(i,2)-constel(1,2))^2;
        for j=1:8
            if dist > (Y(i,1)-constel(j,1))^2 + (Y(i,2)-constel(j,2))^2
                min = j;
                dist = (Y(i,1)-constel(j,1))^2 + (Y(i,2)-constel(j,2))^2;
            end
        end
        H_hat(i) = min;
    end

    error = H ~= H_hat;
    p_e(k) = mean(error);
end

plot(SNR_dB, log(p_e));
title('Error Probability as a Function of SNR');
xlabel('SNR (dB)');
ylabel('log(p_e)');
```


Error Probability as a Function of SNR
log(p_e)
SNR (dB)