The Q Function and Baseband Data Communication

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Contents

1 Eye Diagram for a Digital Communication Channel

1.1 Eye diagram

1.2 `c5ce2.m`: explanation

Here follows a thoroughly commented version of the provided `c5ce2.m` MATLAB script. The code below generates and plots the eye diagrams of four band-limited signals composed of random sequences of bits.

```
% clean figure and load signal package (only for Octave)
clf
pkg load signal

% simulation parameters:
% - nr of symbols (must be divisible by 4)
% - nr of samples per symbol
% - filter cutoff values (normalized values)
nsym = 100;
nsamp = 50;
bw = [0.4 0.6 1 2];

% for each filter..
for k = 1:length(bw)
  % generate filter coefficients
  lambda = bw(k);
  [b,a] = butter(3,2*lambda/nsamp);

  l = nsym*nsamp;

  % Total sequence length
  y = zeros(1,l-nsamp+1);

  % Initalize random output vector with +1 and -1
  x = 2*round(rand(1,nsym))-1;

  % for each overlap..
  for i = 1:nsym
    % place symbols into vector y
    kk = (i-1)*nsamp+1;
```

```
    y(kk) = x(i);
  end
  % zero-order hold
  datavector = conv(y,ones(1,nsamp));

  % apply filter to complite sequence
  filtout = filter(b, a, datavector);

  % splice sequence into sub-sequences of 4 symbols
  datamatrix = reshape(filtout, 4*nsamp, nsym/4);

  % discart the first 6 sub-sequences
  datamatrix1 = datamatrix(:, 6:(nsym/4));

  % plot and format
  subplot(length(bw),1,k)
  plot(datamatrix1, 'k')
  ylabel('Amplitude')
  axis([0 200 -1.4 1.4])
  legend(['Bn = ', num2str(lambda)])
  if k == 4
    xlabel('t/Tsamp')
  end
end
```

1.3 Channel model

1.4 `c5ce2.m`: different bandwidths

1.5 `c5ce2.m`: plots

This section will elaborate on the results and implications of the plots generated by the two scripts.

2 The Q function

2.1 Normal probability density function 2.1

2.2 Explanation

2.2.1 Inverse Q function

2.2.2 Complementary error function

2.3 Plots

3 Source Code

Here we have the properly prepared MATLAB codes for the second part of the second project. It has been used for observations, calculations and comparing with specified commands that given in this project.

The code belows computes and graphs normal(Gaussian) probability density function (pdf) in an appropriate intervals

```
%graphing PDF function with random variables
mu=0; % This is a mean value. As we know that mean value will be zero
sigma=10; %This is a sensible standard deviation number
MAX = 50; % Maximunm x value that x vector will get
MIN = -50; % Minimum x value that x vector will get
STEP = (MAX - MIN) / 1000; %This will give us the step values that we
PDF = normpdf(MIN:STEP:MAX, mu, sigma); % This function will give us
plot(MIN:STEP:MAX, PDF) %This will plot the required PDF graph.
```

4 The Matched Filter Base Band Receiver

4.1 Additive white gaussian noise model

4.2 `c8ce1a.m`: explanation

4.3