# 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

## 2.2 Explanation

### 2.2.1 Inverse Q function

### 2.2.2 Complementary error function

## 2.3 Plots

# 3 The Matched Filter Base Band Receiver

## 3.1 Additive white gaussian noise model

## 3.2 `c8ce1a.m`: explanation

## 3.3