BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI- HYDERABAD CAMPUS

LAB REPORT ON

"Coding Theory and Practice - Lab Project"

Submitted By

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Coding Theory and Practice - Lab

Project

For the given text file, implement a source and channel encoder-decoder pair (of your choice) and transmit the text in the file through a binary symmetric channel with error probability p = 0.25. Describe the performance of your implemented system.

CODE:

```
clc;
clear;
close all;

str='sdflm oimdvsoiiwe kmdsflkjew nnijpojewnmk msdfkjweti
kjoidfug ewruhweorhn kvdsfij kjweroijvdsn kjnjo ewhjndsf
eowirndfs ejwroiwjefng ewrwet kndsfue nsdpowen mcmnslgj oewir
anndshft lsoehnf asken nsdppewrpi asdjnr ssad ksdiruweknr
asnbasiurqer  asflkndgp mo jsnbhdsteber kksiaehr ksdhvbqpkamqjas
qgqqweh as jasdkfhtepwo vnasbafgtewpkn jaslkfjet qooxzqwenqwrnfc
asdlkwet mmajquwe jsdgotplakqwjw nnnsdgjwtr mnnnfdglproer
jbqiqweio nvskjnsd prksdjdsbvur jqwpqet  sfnsg nerterhh
nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg
jqwywetnsbashsg kjf kljwghh erop nasnfbe lknqwoit
sdgygpweoqwmasmnsdvknvrt lkjast wet khdsfoijt kjerjnsgd
lkjhwetiuwt asknvbahasoqrw qqqqqqq ggggggg oapasdf
aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk sqwerujjjasdurpqer
nnvkjhw iqoqof mmsdkfsdkpweo sdfnqpqjennf dfvav d prksdjdsbvur
jqwpqet  s nfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet
sfnsg nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx
jwqretnao nsdlgdkjrtg jqwywetnsbashsg fhtephft lsoehnf a asdjnr
ssad ksdirt lkjjaslkfjet qooxzqwenqhh nknerkkjrtg
jqwywetnsbashsg kjf kljwghh erop nasnfbe lknqwoit
sdgygpweoqwmasmnsdvknvrt lkjast wet khdsfoijt kjerjnsgd
lkjhwetiuwt asknvbahasoqrw qqqqqqq ggggggg oapasdf
aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk sqwerujjjasdurpqer
nnvkjhw iqoqof mmsdkfsdkpweo sdfnqpqjennf dfvav d prksdjdsbvpwo
vnasbafgtewpkn jaslkfjet qooxzqwenqwrnfc asdlkwet mmajquwe
jsdgotplakqwjw nnnsdgjwtr mnnnfdglproer jbqi jaslkfjet
qooxzqwenqwrnfc asdlkwet mmajquwe jsdgotplakqwjw nnnsdgjwtr
mnnnfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet  sfnsg
nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao
nsdlgdkjrtg jqwywetnsbashsg qqqqq ggggggg oapasdf aaaaaaaaaaaaaa
ewl mvlkjwportj qwkjreqtnvsdk sqwerujjjasdurpqer nnvkjhw iqoqof
mmsdkfsdkpweo sdfnqpqjennf dfvav d prksdjdsbvur jqwpqet  s
nfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet  sfnsg
nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao
nsdlgdkjrtg jqwywetnsbashsg fhtephft lsoehnf a asdjnr ssad
ksdirt lkjjaslkfjet qooxzqwenqhh nknerkkjrtg jqwywetnsbashsg kjf
kljwghh erop nasnfbe lknqwoit sdgygpweoqwmasmnsdvknvrt lkjast
wet khdsfoijt kjerjnsgd lkjhwetiuwt asknvbahasoqrw qqqqqqq
ggggggg oapasdf aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreq nerterhh
nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg
jqwywetnsbashsg kjf et qooxzqwenqwrnfc asdlkwet mmajquwe
jsdgotplakqwjw nnnsdgjwtr mnnnfdglproer jbqiqweio nvskjnsd
```

```
prksdjdsbvur jqwpqet  sfnsg nerterhh nknerkjwet njnhdsgy kjhq
ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg kjf
kljwghh erop nasnfbe lknqwoit sdgygpweoqwmasmnsdvknvrt lkjast
wet khdsfoijt kjerjnsgd lkjhwetiuwt asknvbahasoqrw qqqqqqq
ggggggg oapasdf aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk
sqwerujjjasdurpqer nnvkjhw iqoqof mmsdkfsdkpweo sdfnqpqjennf
dfvav d prksdjdsbvur jqwpqet  s nfdglproer jbqiqweio nvskjnsd
prksdjdsbvur jqwpqet  sfnsg nerterhh nknerkjwet njnhdsgy kjhq
ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg fhtephft
lsoehnf a asdjnr ssad ksdirt lkjjaslkfjet qooxzqwenqhh
nknerkkjrtg jaaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk
sqwerujjjasdurpqer nnvkjhw iqoqof mmsdkfsdkpweo sdfnqpqjennf
dfvav d prksdjdsbvur jqwpqet  s nfdglproer jbqiqweio nvskjnsd
prksdjdsbvur jqwpqet  sfnsg nerterhh nknerkjwet njnhdsgy kjhq
ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywg kjf kljwghh erop
nasnfbe lfhtephft lsoehnf a asdjnr ssdirt lkjjaslkfjet
qooxzqwenqhh nknerkkjrtg jqwdsfoijt kjerjnsgd lkjhwetiuwt
asknvbahasoqrw qqqqqqq ggggggg oapasdaaaa ewl mvlkjwpokjreq
nerterhh nknjnhdsgy kjhq ajasprksdjdsbvur jqwpqet  s nfdglproer
jbqiqweio nvskjnsd prksdjdsbvur jqwpqet  sfnsg nerterhh
nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg
jqwywetnsbashsg fhtephft lsoehnf a asdjnr ssad ksdirt
lkjjaslkfjet qooxzqwenqhh nknerkkjrtg jqwywetnsbashsg kjf
kljwghh erop nasnfbe lknqwoit sdgygpweoqwmasmnsdvknvrt lkjast
wet khdsfoijt kjerjnsgd lkjhwetiuwt asknvbahasoqrw qqqqqqq
ggggggg oapasdf aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk
sqwerujjjasdurpqer nnvkjhw iqoqof sdfnqqjennf dfvav d
prksdjdsbvpwo vnasbafgtekn jaslkfjet qooxzqwenqwrnfc asdlkwet
mmajquwe jsdgotplakqwjw nnnsdgjwtr mnnnfdgroer jbqi jaslkfjet
qooxzqwenqwrnfc asdlkwet mmajquwe jsdgotpla'

c=1;

%% for (k,1) repetition code (i.e., each digit is
repeated/transmitted 'k' times)
for i=1:2:5

    fprintf('For k = %d',i);
    encoded_sequence=encode(str);
    channel_encoded_sequence=channel_encode(encoded_sequence,i);

bsc_output_binary_sequence=bsc_channel(channel_encoded_sequence)
;

channel_decoded_sequence=channel_decode(bsc_output_binary_sequen
ce,i);
    decoded_output=decode(channel_decoded_sequence)
```

```matlab
    %% error after bsc
    compare1 = bsc_output_binary_sequence-
channel_encoded_sequence;
    count=0;
    for k=1:length(bsc_output_binary_sequence)
        if compare1(k)==1 || compare1(k)==-1
            count = count+1;
        end
    end
    error1 = count; % counting no. of error digits received
    prob_error_bsc = error1/length(bsc_output_binary_sequence)

    %% comparing the input sequence with received sequence
    compare = encoded_sequence-channel_decoded_sequence;
    count=0;
    for k=1:length(encoded_sequence)
        if compare(k)==1 || compare(k)==-1
            count = count+1;
        end
    end
    error = count; % counting no. of error digits received
    probability_error = error/length(encoded_sequence)
    prob_error(c) = probability_error;
    value_k(c)=i;
    string_pe=str_cmp(str,decoded_output)
    str_pe(c)=string_pe;
    c=c+1;
end
stem(value_k, prob_error);
xlabel('Value of
K','Fontweight','bold','FontSize',16,'Color','r');
ylabel('Probability of Decoding
Error','Fontweight','bold','FontSize',16,'Color','r');
title('Probability of Decoding Error at the Receiver for k=1,3,
and 5','Fontweight','bold','FontSize',16,'Color','r');
axis([0 6 0.05 0.30]);

figure;
stem(value_k, str_pe);
xlabel('Value of
K','Fontweight','bold','FontSize',16,'Color','r');
ylabel('Probability error in
string','Fontweight','bold','FontSize',16,'Color','r');
title('Probability error in string at the Receiver for k=1,3,
and 5','Fontweight','bold','FontSize',16,'Color','r');
axis([0 6 0.30 0.90]);
```

```matlab
%% Function for Encoder
function encoded_sequence=encode(str1)
    bin_enc=[];
    for i=1:strlength(str1)
        str=str1(i);
        if str==' '
            bin_enc=[bin_enc 0 0 0 0 0];
        elseif str=='a'
            bin_enc=[bin_enc 0 0 0 0 1];
        elseif str=='b'
            bin_enc=[bin_enc 0 0 0 1 0];
        elseif str=='c'
            bin_enc=[bin_enc 0 0 0 1 1];
        elseif str=='d'
            bin_enc=[bin_enc 0 0 1 0 0];
        elseif str=='e'
            bin_enc=[bin_enc 0 0 1 0 1];
        elseif str=='f'
            bin_enc=[bin_enc 0 0 1 1 0];
        elseif str=='g'
            bin_enc=[bin_enc 0 0 1 1 1];
        elseif str=='h'
            bin_enc=[bin_enc 0 1 0 0 0];
        elseif str=='i'
            bin_enc=[bin_enc 0 1 0 0 1];
        elseif str=='j'
            bin_enc=[bin_enc 0 1 0 1 0];
        elseif str=='k'
            bin_enc=[bin_enc 0 1 0 1 1];
        elseif str=='l'
            bin_enc=[bin_enc 0 1 1 0 0];
        elseif str=='m'
            bin_enc=[bin_enc 0 1 1 0 1];
        elseif str=='n'
            bin_enc=[bin_enc 0 1 1 1 0];
        elseif str=='o'
            bin_enc=[bin_enc 0 1 1 1 1];
        elseif str=='p'
            bin_enc=[bin_enc 1 0 0 0 0];
        elseif str=='q'
            bin_enc=[bin_enc 1 0 0 0 1];
        elseif str=='r'
            bin_enc=[bin_enc 1 0 0 1 0];
        elseif str=='s'
            bin_enc=[bin_enc 1 0 0 1 1];
        elseif str=='t'
```

```matlab
            bin_enc=[bin_enc 1 0 1 0 0];
        elseif str=='u'
            bin_enc=[bin_enc 1 0 1 0 1];
        elseif str=='v'
            bin_enc=[bin_enc 1 0 1 1 0];
        elseif str=='w'
            bin_enc=[bin_enc 1 0 1 1 1];
        elseif str=='x'
            bin_enc=[bin_enc 1 1 0 0 0];
        elseif str=='y'
            bin_enc=[bin_enc 1 1 0 0 1];
        elseif str=='z'
            bin_enc=[bin_enc 1 1 0 1 0];
        end
    end
    encoded_sequence=bin_enc;
end

%% Function for Channel Encoder
function
channel_encoded_sequence=channel_encode(encoded_sequence,k)
    channel_encoded_sequence=[];
    for i=1:length(encoded_sequence)
        E=encoded_sequence(i);
        if E==0
            channel_encoded_sequence=[channel_encoded_sequence
zeros(1,k-1) E];
        elseif E==1
            channel_encoded_sequence=[channel_encoded_sequence
ones(1,k-1) E];
        end
    end
    channel_encoded_sequence;
end

%% Function for BSC Channel
function
bsc_output_binary_sequence=bsc_channel(channel_encoded_sequence)
    bsc_output_binary_sequence=[];
    for j=1:length(channel_encoded_sequence)
        prob = 0 + (1-0) .* rand(1,1);
        if (prob>=0) && (prob<0.75)
            bsc_output_binary_sequence(j) =
channel_encoded_sequence(j);
        else
            if channel_encoded_sequence(j) == 0
                bsc_output_binary_sequence(j) = 1;
```

```matlab
            else
                bsc_output_binary_sequence(j) = 0;
            end
        end
    end
    bsc_output_binary_sequence;
end

%% Function for Channel Decoder
function
channel_decoded_sequence=channel_decode(bsc_output_binary_sequen
ce,k)
    % Let no. of ones denoted by 'o'
    % Let no. of zeros denoted by 'z'
    count=0;
    var=1;
    count1=1;
    for i=1:length(bsc_output_binary_sequence)
        dummy(var) = bsc_output_binary_sequence(i);
        if var==k
            clear var;
            var = 1;
            for j=1:k
                if dummy(j)==0
                    count=count+1;
                end
            end
            z=count;
            o=k-z;
            if z>o
                channel_decoded_sequence(count1)=0;
                count1=count1+1;
            else
                channel_decoded_sequence(count1)=1;
                count1=count1+1;
            end
            count=0;
        else
            var=var+1;
        end
    end
    channel_decoded_sequence;
end

%% Function for Decoder
function decoded_output=decode(channel_decoded_sequence)
    decoded_output=[];
```

```matlab
count=1;
for i=1:length(channel_decoded_sequence)
    D(count)=channel_decoded_sequence(i);
    if count==5
        if D==[0 0 0 0 0]
            decoded_output=[decoded_output ' '];
        elseif D==[0 0 0 0 1]
            decoded_output=[decoded_output 'a'];
        elseif D==[0 0 0 1 0]
            decoded_output=[decoded_output 'b'];
        elseif D==[0 0 0 1 1]
            decoded_output=[decoded_output 'c'];
        elseif D==[0 0 1 0 0]
            decoded_output=[decoded_output 'd'];
        elseif D==[0 0 1 0 1]
            decoded_output=[decoded_output 'e'];
        elseif D==[0 0 1 1 0]
            decoded_output=[decoded_output 'f'];
        elseif D==[0 0 1 1 1]
            decoded_output=[decoded_output 'g'];
        elseif D==[0 1 0 0 0]
            decoded_output=[decoded_output 'h'];
        elseif D==[0 1 0 0 1]
            decoded_output=[decoded_output 'i'];
        elseif D==[0 1 0 1 0]
            decoded_output=[decoded_output 'j'];
        elseif D==[0 1 0 1 1]
            decoded_output=[decoded_output 'k'];
        elseif D==[0 1 1 0 0]
            decoded_output=[decoded_output 'l'];
        elseif D==[0 1 1 0 1]
            decoded_output=[decoded_output 'm'];
        elseif D==[0 1 1 1 0]
            decoded_output=[decoded_output 'n'];
        elseif D==[0 1 1 1 1]
            decoded_output=[decoded_output 'o'];
        elseif D==[1 0 0 0 0]
            decoded_output=[decoded_output 'p'];
        elseif D==[1 0 0 0 1]
            decoded_output=[decoded_output 'q'];
        elseif D==[1 0 0 1 0]
            decoded_output=[decoded_output 'r'];
        elseif D==[1 0 0 1 1]
            decoded_output=[decoded_output 's'];
        elseif D==[1 0 1 0 0]
            decoded_output=[decoded_output 't'];
        elseif D==[1 0 1 0 1]
```

```matlab
            decoded_output=[decoded_output 'u'];
        elseif D==[1 0 1 1 0]
            decoded_output=[decoded_output 'v'];
        elseif D==[1 0 1 1 1]
            decoded_output=[decoded_output 'w'];
        elseif D==[1 1 0 0 0]
            decoded_output=[decoded_output 'x'];
        elseif D==[1 1 0 0 1]
            decoded_output=[decoded_output 'y'];
        elseif D==[1 1 0 1 0]
            decoded_output=[decoded_output 'z'];
        else
            decoded_output=[decoded_output '#'];
        end
        clear count;
        count=1;
    else
        count=count+1;
    end
    end
    decoded_output;
end

%% String Comparision

function string_pe=str_cmp(str,decoded_output)
    N = 0;
    M = 0;
    for i = 1:length(decoded_output)
        if str(i) == decoded_output(i)
            N = N+1;
        else
            M = M+1;
        end
    end
    string_pe = M/length(str);
end
```

OUTPUT:

str =

'sdflm oimdvsoiiwe kmdsflkjew nnijpojewnmk msdfkjweti kjoidfug ewruhweorhn kvdsfij kjweroijvdsn kjnjo ewhjndsf eowirndfs ejwroiwjefng ewrwet kndsfue nsdpowen mcmnslgj oewir anndshft lsoehnf asken nsdppewrpi asdjnr ssad ksdiruweknr asnbasiurqer asflkndgp mo jsnbhdsteber kksiaehr ksdhvbqpkamqjas qgqqweh as jasdkfhtepwo vnasbafgtewpkn jaslkfjet qooxzqwenqwrnfc asdlkwet mmajquwe jsdgotplakqwjw nnnsdgjwtr mnnnfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet sfnsg nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg kjf kljwghh erop nasnfbe lknqwoit sdgygpweoqwmasmnsdvknvrt lkjast wet khdsfoijt kjerjnsgd lkjhwetiuwt asknvbahasoqrw qqqqqqq ggggggg oapasdf aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk sqwerujjjasdurpqer nnvkjhw iqoqof mmsdkfsdkpweo sdfnqpqjennf dfvav d prksdjdsbvur jqwpqet s nfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet sfnsg nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg fhtephft lsoehnf a asdjnr ssad ksdirt lkjjaslkfjet qooxzqwenqhh nknerkkjrtg jqwywetnsbashsg kjf kljwghh erop nasnfbe lknqwoit sdgygpweoqwmasmnsdvknvrt lkjast wet khdsfoijt kjerjnsgd lkjhwetiuwt asknvbahasoqrw qqqqqqq ggggggg oapasdf aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk sqwerujjjasdurpqer nnvkjhw iqoqof mmsdkfsdkpweo sdfnqpqjennf dfvav d prksdjdsbvpwo vnasbafgtewpkn jaslkfjet qooxzqwenqwrnfc asdlkwet mmajquwe jsdgotplakqwjw nnnsdgjwtr mnnnfdglproer jbqi jaslkfjet qooxzqwenqwrnfc asdlkwet mmajquwe jsdgotplakqwjw nnnsdgjwtr mnnnfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet sfnsg nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg qqqqq ggggggg oapasdf aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk sqwerujjjasdurpqer nnvkjhw iqoqof mmsdkfsdkpweo sdfnqpqjennf dfvav d prksdjdsbvur jqwpqet s nfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet sfnsg nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg fhtephft lsoehnf a asdjnr ssad ksdirt lkjjaslkfjet qooxzqwenqhh nknerkkjrtg jqwywetnsbashsg kjf kljwghh erop nasnfbe lknqwoit sdgygpweoqwmasmnsdvknvrt lkjast wet khdsfoijt kjerjnsgd lkjhwetiuwt asknvbahasoqrw qqqqqqq ggggggg oapasdf aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreq nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg kjf et qooxzqwenqwrnfc asdlkwet mmajquwe jsdgotplakqwjw nnnsdgjwtr mnnnfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet sfnsg nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg kjf kljwghh erop nasnfbe lknqwoit sdgygpweoqwmasmnsdvknvrt lkjast wet khdsfoijt kjerjnsgd lkjhwetiuwt asknvbahasoqrw qqqqqqq ggggggg oapasdf aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk sqwerujjjasdurpqer nnvkjhw iqoqof mmsdkfsdkpweo sdfnqpqjennf dfvav d prksdjdsbvur jqwpqet s nfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet sfnsg nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg fhtephft lsoehnf a asdjnr ssad ksdirt lkjjaslkfjet qooxzqwenqhh nknerkkjrtg jaaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk sqwerujjjasdurpqer nnvkjhw iqoqof mmsdkfsdkpweo sdfnqpqjennf dfvav d prksdjdsbvur jqwpqet s nfdglproer jbqiqweio nvskjnsd

prksdjdsbvur jqwpqet sfnsg nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywg kjf kljwghh erop nasnfbe lfhtephft lsoehnf a asdjnr ssdirt lkjjaslkfjet qooxzqwenqhh nknerkkjrtg jqwdsfoijt kjerjnsgd lkjhwetiuwt asknvbahasoqrw qqqqqqq ggggggg oapasdaaaa ewl mvlkjwpokjreq nerterhh nknjnhdsgy kjhq ajasprksdjdsbvur jqwpqet   s nfdglproer jbqiqweio nvskjnsd prksdjdsbvur jqwpqet sfnsg nerterhh nknerkjwet njnhdsgy kjhq ajasfatenvbpalamx jwqretnao nsdlgdkjrtg jqwywetnsbashsg fhtephft lsoehnf a asdjnr ssad ksdirt lkjjaslkfjet qooxzqwenqhh nknerkkjrtg jqwywetnsbashsg kjf kljwghh erop nasnfbe lknqwoit sdgygpweoqwmasmnsdvknvrt lkjast wet khdsfoijt kjerjnsgd lkjhwetiuwt asknvbahasoqrw qqqqqqq ggggggg oapasdf aaaaaaaaaaaaaa ewl mvlkjwportj qwkjreqtnvsdk sqwerujjjasdurpqer nnvkjhw iqoqof sdfnqqjennf dfvav d prksdjdsbvpwo vnasbafgtekn jaslkfjet qooxzqwenqwrnfc asdlkwet mmajquwe jsdgotplakqwjw nnnsdgjwtr mnnnfdgroer jbqi jaslkfjet qooxzqwenqwrnfc asdlkwet mmajquwe jsdgotpla'

For k = 1

decoded_output =

  'fdnl#umcmfpqniiuetbeds#nhjds   olhp#j#sjoormz   jebtev#bj   yjtc#f   fgbmhee##xj j#s#rknluxwergik#dslkm#jio   kohhjdbfpomwazn   pchezsrk#wnif#sfdltw#h kbdwr#gwnbttupenzmaenslgj#nmcioacfnbsxdtanslbbngu   qce# bsarxeuzxahqsaj#jjvsm#xjspivuvuzj#decdcace#pudsdeuwvdyotbxboglnzbcpx##dbg#qc#qiaehr ocebgkytnaoe#facyoqurdzgxsdjisvvdhtexfkit#abcade##wrinpfablio#erfunlp#ysdosvslthlesddkwt tuk#icrwwlmlsfebtpyecewcaem#osd#jdd pmgn#w fl bmazhdzqiqwkjo luwyaosd lrmadbarrw#r kua   ya#dvifnckafdftetdml#mf#rnj#u#hl##hpkccsk#tabcjfsy#zy#vhx   hal#cewpzd#ghkrnrtng hmq#e bqaygdd#sjvp #g ojvam##wwq#hhvmtagqr#dbeddjoxvje#xsegifptaoqwmaa#o#ldkjprd #mxdcd   veumchfsnomxfdkoersfrgdxflplwuthquqbeulgtgdpcsferg vypsqyyxjv#wcfghhmzqpnfq#aqhiaaapaiaalb#slfmplonwdesljlqgczcdf f##lkdum#auwjj#a#ge#rygr   dlt#jd#jjabqjnbegvwiv##ke#dofzdvodxsjd#jvrdlwuv #ikfcqfhbsbwdrbniwmshl#ysjng   gyxx#ezizbfaswqag lr#skfrebrsosdnl#igckjzslpxcthcyb#sca#epverlxfnfwewanweqojhjxdfe#d#jhy   ##zf   # vzbxijpi#dsup#enmooejc#mcvyzptg jywiwputp aamr#bfiu s#b# #sldhoddbdiappmr #wh xisbkxlmfso#eshkfbevdq#f   psmals   p##tcebj#   drgabsgstmvnqfaphsvq#hf ihkgglikezb#cnfg#hbdhdzfqw#iu   wbw#wts   gp#oirmkclv#nf##iloj #td#evf#k#sd#ibpdkjfrnfacaplmkfwapa###hay#jbr mavm#jsdypuxuwqxgovgvgmfjuhisefjcgaqqeucabbapapewl   #gli#w#lt#j   #ajxg#dnrc gtceum#qzzo   #pqsrses   o#vjjhebm#op#abi#cpod   xjpw#gbr   #jq#zbaojfe   dl   utudavkr

jlkr#pw#j#nabbavcsawpco naelonje#taywt#pwa#atbndvd#shhk#cf #miheqqcrr#eegrplbnyqfw
vnfcjbj#bmw#r##duc#bqourik   skujfsiigrapt#gg##pocdqwpf#raqqfmioatbmlujqesujzzcfot
t#kkgzrandng   ghwtphmdfj##glj##gr   jbqawy#ie   nvr#ovstpr#jwexmgbvqrvxxchsgv
pscosunnerygtippnogtrajwdtvhhfhtcoyu   biqaiheavaoqzwhucma#hqesyzepbu#   #ybdglmn
podbpu#ced#trarkiwd   bykwtgmoocnghn   p   cegcc   qc   kudtce
emwlhlrmkn#qo#ujrygcqvus#otcloddqwfxej#nev   p#tptx#z#vmxh#bkse##wlnesmcbsty##enjk
ufppazwlvojievathd   pr#sdn   sbpdbbh   u#pqtpjcphdleetcnkbbjzweqweyg   zvyqnksb
krcrbjh#jvhrbbcsacuxdp#nnq#d#f   duvmgpnvoeaczwetavnnidtkibonhaha#cs#atcnvqpk
oo#ejep#etjqj   p   dighkdrxoeotsptevxsbcriwc   ji#geln#   wcznm#vde   as   jnqdwsi
#bhiu#im#sipshymjevqco##zqxsoqchbnkxdgsnhrpc lpaqsaq #bezlqctgjfpoo#sjl#dizbvb##cob##
lmnwwnspa ou#ghoembsd vdnc nzkvst nbkazpq#etdk dsetijtjijer#xqsurlsjlwew uwlpaccn#
hlyowpvrthtpqwqqbewnecgfage#ubrd   ciaqeiueqkseag   ewm   o   n#   eaoruk
awkjjcatnozv#vhlpokndpczveehlkpdtsfvkknhujqbaavitg#fhfqdim#aj#qvoznaoancthghoinew
bq##nctncbisrsabqntdmxhrn#xzuwex wrgfa ar hkropcmikj#vrg ##qgkpplpj##fg m#gxldr#tm
mxjfv   gfptmfg#jbyqpvi#iagggaljrdvrskseokbrcublise#qetfasdjvedkg#rgsh
ojxzgpohu#ujdznqtgfiq#zzq
kcdwfadan#bzaiamzqjwsrhvoeypn#r#ffhj#hkhn#wk#etnbbqah#mibblddlnggjhjez#hdfaxnfrxdlkl
uwgi#p#hgmup#mhqc#   sjjsdpzzbdx   lfzlsdhqelikpdcf#m#thdhgvmjsf#peoj#umul#sfj
s#fvcaklbnqp#   ipwqsp ccdseeg #aaqc#tbialwkcqcsajaailm#mbdtlbkb##rtj qg#j#dtt#w###
qqvecqnjhgsdwvpsgrvontkbpeeysjuofpm#rghfqfk#wuckibwhpxshmzfmdfore#dlbpfzc#jpwjzwz
basqye#   urp#elumxrgdnpbbuxqveioq#tqkzj#fh#   #q   i   cbuq   jqduqeu
acdd#spfsrugrhxnnjoeclh#upagy#ld#gidirjshazipvwdjxbbxalswejzqqwetjiob##atmlknh#chhtg#w
z##s xqhkocihpetifo h#s#lofakhlwlzobdpfod ccumt#iekzjkwl#finul#####eeenq#hdj#nehkcj af
hqcaccwaemb#aqaawgnpmfhkbvtobxomqw#creuql#spqx#qu   s#bjnipawbpuip
ndu#fhvhkqosoghmfstbfsdkpgmg   zenxqdp#anlc   #   rag   latzjsjvakcwdtuoa##s   t
pwljwddhbnsezbpb#kq#gikfnvs ldrf pbfzljdubtadljbwuhpqdyrb#dehneb#efli mmndraj#gtakjlt
s#up#jxppc isvauif#   qs#omy zoernt#bk jsdlddpbr#wdzqsyfgtkkcqaljsfdhbmzojqj   tanbu
lgjddpzfqamr#d##mci   cjdjzgblsemxv#myoeggeinjepaemgxysvefqhkf####skkzbddehqsg#voijt
jlfpjn#btjlkjewghi#wtdxko#vpkiacwucvbsttuywqbgmfvdak # z sdaccchoqe mtikjszikp uy
fm#lgbbya#hnhnbtvoiefojqex#ds##cpcn#yafedtzzwzswu
pqcnbmthtxmgcticyys#wiojjvcijosfyu###acdq   xzr   cs#wuq#c   #vn#eqneromfhh
bkne#ufcmthmoghdse# ihxaf # rlafelvkyqlq#k rux#upla#pojdebejnvpdhzss#sqdrsf chscdc#tc hf
v#cmeh#nugdqqln#wbsq abb   yzv ozhzjpv#fditktollk#smkpyzbm##erkgivxrizy#xwu#lbrcgnsw
nb#pajjggicfgrwprjlxz#ueakerptkjtbsao#gcdwlrveowdfrtekofrfd#kchv#xvev
#xiuwmaneq#jnrbd#sgumsjnwdqqwtv as##ebafes#qdc #y#qyuqaowmbb#sbcyvqxgl tafccaaea
qacebeslv#fko#vqnrdzdzqwajriyzmfydih#q#e   elzkssu#ph   efbmngi#jw   lpgxtnayefkayjeonb
batqdbddpqkgdcd#mriw#kf#gsbacvrgprrjpgllfba   podzp   ve#   #ajtp   qa   lfvldb#laja#qt

pr#nmv#lahs#i#hsnoqlgp#tdhy##ffa#rogr   #bpkhjkqkkvjmtxpki   bypuomxtn#cscopm#sq#
a#abm#geynydd##t#k'

prob_error_bsc =

   0.2475

probability_error =

   0.2475

string_pe =

   0.7604

For k = 3

decoded_output =

   'slfm# ommtvs#iiwe ci qflkvewblvibpmjuuv#ed#sedjjggtmx##gmdfeo esruhtegrhn kfdwfhj
kjwebnkhvmf#
khnn##wuhjntsfdeowikodbcjwjfzoqehef#gdfwr#utqk#vsfugl#sepkomnfmaonslfzhniuirqcxn phf#
l#mghff sccan o#dpqmwrpi sdkg#bszcdpksdizvugm#r prwbasiwrserx cyglk ug# mnhhsff dstm
csdkkwiaexz   ksehrrpqkkmsjaz   qfyywei   s#   beqfkfhtepwmhvliecifgte##kl   jesdygjat

quohj#wenc#rnfcdqwdlnw#w mmcjyuwq jsfdofplikq#kwvojnsdozwdb #nnnf#glxp#esbnbuqqvqic #vwikncd pbksd#lwbvwy lgutqevahsfopg vebt#rhhinhnerkk#et lznhpsgi kxaq keqfatg#t pqlhmx jwyretnamphsdngf#zrdgjjuwqwdtnscaehse shvlkl woxjblrmtrjisnfbg #jjqwoyu sdcmw ogoxwmaslnsdni#vrt lkjaz#vumu khfwgoijp jjespnmgdxlkj geuywvt fskjvrahqroursaqipqprq #ig#evf mmp qpgeqai atayahqihablglco# c#gjgrtiasgkjbaqtnvqfklwacuruhfzasvur#qerpjftjjjw iuaukfa#gsumvsdjwsu#hsddnqpxc#lnfbffvhw pm biud#asbv#v hswpqe cpshogtglxxmic o#qii#aaoinrsoznrlhrrcstzd#bruvrniy qdd cvnsea#artazjh jijeroj#eutnk##dsgidkjha alq#ja#egfb alem# bwuwe naohnyd#gdkortgukqgxwc#nggashcg fhveahft lflghjjhs qr# n hsqee #cliz# #cn#sslkdbetdqlmyzqgev h qnnnqrkjnspg jqey#utjsbqcne# jofbjmjskhjferez oewffbmixk#qxoivbstfywpweny#hicglwtwinvrtrj#jegt wet ihf#f#aja kketkns#lthkzlwm#iuut q#khvjazcs#ufwlya#uyqq gwggjggkeppacmfpaci ucra gpaq aew#dmrykjg osuj qwkbrmq#nt# #psewlsujhzqcdurpetrbnntij # kdkqolpeisvkvsditwegdrdnnqqqbvnngrvjvak sz#cdbdsbvyuo unasfafgtdw coajawxkbjup yooppq#enq#r#hceaqlliteb mmajqugu j#dggtpda#yunginnnslghwdspfnnntdgnyzcgr jbqmhb slcfkewpqogxztwm#u#f#mktjs logdtci#cjqegehbragoptdakygzwbnngwdcjutrdcnonwfgl vomrhnzymiwoaoln ck#jwdbtvkrejlqbuwrtb#wtpdt rb#swt##xtepklhnonirkbvgpanbhhfwgux#khcxejacfqtenbfq da# jwurepze#xj#lmfdfjjtf huwxkwqnbbkshwd qtqpq gggggog ocpepdr awaacba ekheei xsm #vnkhgx#rpbaqwkjbdspnvwtjaaqgt##lhjqrdurrrer nlvcr wbqamygtamlpekvaektvmo qufnu#qhdl#b lvtcv d xzowdnlrbvqvxotuise#vpw ngdr#proow jb#iaveiyan#gkjnqd pvkrl#dyhvurjjqwraethecflsepntrteshi nkngrkjvev nzoxhsgy jnxqpqbawfa#movbpahmmh ##qvodjao #ollgdljsvgdjpwyyutopbc#hsa lxdupj q esiehhzpa asvkfs ssad kcpisqphkjzeqmkfimd yno#zsqenqxpd#jjur#nbptg jsw#uatvsbezisw kjxekmhwglxbavnpxnqwogfejm##rwkhw sdgywqsefawmaamkwlvknvsthlkjastksetfkhlsnkunt khepjnrwe#nkjhuetawga cwhos#mnecoysg cupqquphecc#gg#fkqpasdv p#aad haaaaaaahew# mt#nf#vmrvjpqwkkrdudiertapiha#ilerijuotpnc# dbg#pcb s jaznade#vrp lelx ngqwepn gdnsejedyjrtgdjwwywe#xaj#udbohojn ppqkkxryuejqwbnfgfcselkuat imgju#wg h#ldmux#a#qw wdnnnwfgjsq#aenn#feg#vzievbhjdiutmxwjnfwjjlsenxvksfbe#bvwp nqcpaulbarl q# nortgthlqnoj rkj#lt okfhdqfq jj s jiscad lvfpalclz bw#rg#nyoxdsddodkjptt jqw#ge#nrbwrjp#bknt kilwghjhotktan snbcehmg#qsoh# sdgygxweo#vm ##nsdscovrdilcndrtdsedpehhwffmjt k#mrjkwg dlij#setiuyupasknvjahawoqrwriquqstt wewwbuwdoixbsdns qaaaeiaaapacahnu#alwdkjvdgrwhrvvkzreq#lvsok sqwevwjjh sddrpqdvynnkkh t iyoekfhm#rf#bwdkewag cdffapqjennfdfnrc#pahxpcsdxdsbvsp jpgh#gtdds lflglprmgpdnrhiqumiocn##kjn#l xrk#dk wbwur jswpwmt ssfnsoblkstesyl #kluqkjwutanfnlmgwk jbhwapnasfi ejvaxadgm#azsqretfj# #wddftkzp#d zuqiwotlvrikhvc aipm#hfztnroex#vdb eqdzfrprccmdksfirt z#j#as#afnetaponzj wen#hiahkner# kvtgpraa aa caeaagadew#tmrlijsroxtjcugijsqq#nvsd# segtc#bjjectozpympaln#kjpuaiumpgfzmmwd#fse#poun #dgfc qjfn#fqlgver dlproqlj sjv#rhzqsppeta fbdgnnlpfgex hcqhquuiobodskjfwdc risnjusrfe

jmwqiedh   svnaw   dgzvurli   f#ndrkjumuxcnfhesg#pkhxqianqsfaqenbcpi#eny jwazetfemanwdloacjruwxjawyvodijfaklh#ohhzgpopqnaro   d   lfhtc   hntdlskehol   apiwfjnp rsfir#xdzjja#lkfjee   s#kzzu#enubp   nbzwwcjjzqg   jqwdrf#kjtakkezjmzkdtdobxgltiewtt wknbba#asoppwtpyqqyprdefggfgf   o   pasdqcqaaewnl#ulkjstokzrg# jvddcrhhdnknjnhewc#dbklqlmfaspbisdhd#p#urp   qwpagd   z   ntfflproaqhjbqqyqehnxnn jb#sdypbkrtsdcf#srakswpuouhprfgscpndrvfvahbl#gewkjvetcbznhdzkycjzhy   jjewf fem#bpefa#xbkwq et#anbhs lgd#krtetjawyuutnrbiricw ohteqhftqlqomllfbe ajdzn#b#qe a#qdird dkhjuqlifjdu   qomx#qum#ehhg#knevkkbqtfbzquqmdtggbicizn   ckn   kljww jldrgpanacmvcvhlooqw#ivbsdgygp#   gavmaslncdtanvzp   lkkastrwgdbjllcno   jt kkerj#vuthdkbhvethuw#hawwzvca#asoprw   qqqqsumagmggcggaoiteslfpabae ecaaaaieipewlcugljb# orunrtvskrmya#nsdk spvgzdb zasluzvwarrrntjhhwpaqjcmfbcdgnsqjufnn lftazqpbproudjdscwqw#hvocsbavgtik#   jschcfzud   qmoxzqceouvrnna   agllkv   t omckau#dtjzegfpuhaipwjsh#l#slajwtzb   fnbftfr#nr   jh#hbjqslkrjet   a#fxjp#wnqvrjfg esdhksethilsjqvwipzslg#vpl '

prob_error_bsc =

   0.2479

probability_error =

   0.1546

string_pe =

   0.5687

For k = 5

decoded_output =

's flm mkm #soiiwekkmdsb#kbew nlijpkzewnokamsdfkjweqkbicfadfuodewrqhsgoshj #vdsfinbijuer#yjfdknhkznno ewyzndqr e#wyvn cs ehgroawjffnu ekzwe# knd#fuu jrdpowe#pmamocmgjdoe# ra ondssfu mrgehnfhaskgndnueppew#rafsbdjjs s#clrksdyzuwecnst sjbcuiuvger a#flkjdop mo j#nrhl#tgfmr cksieeipaisdjvbqqkalrjet pgqqwebaar jaslkfhtgrwn vha#farwtuwhinhjiclkvjet sgozzqgenqwbnfc asddicgt imajqegm jsdg#tplak #j# flnvdcjqdr monmdd#lprker jbqiqwean ntskjnsd drkstjesbvwr rwwpqft sffwc ner#erhhbnkmer#kged #jnhuwf#bk hq qn svatenvrpa#qmxbjwpvetnqo jsllgd#jr#g jpvuwetfwbeslwk kjf kljuwhh drn narjfbe lhnqwlkbastgygrwdoq#mismnsdvknvpt lkjycp set khfsffijt ijdfnnsg lknxslt uwt asnnvbilasoqvv yqqqqqy ggsgccw oapawlf qaaaa aaaseica egl mvl#jwpgrthzacojse #nrsljpsywmvujhjksburpqgrhi#vknhw iq#soehmnwdknwvkpnmg sdfoqtqjeofobafwawbdarrkstjdvbv#vpkqwpqdv s ngtct boerbjnqiqwem#bn#smjnsd pnksdldvbvuz jq#pqetgaznnqgpneqtejhh j##erijwutdnjn fseydibhc anasbivenvbpalaix zwqrav#am nsdmgdjjrug favywetlqcevhsgbfitgxhf#dl#oehnfba fsdn#rhscad irdirtblkjjaxlkfh#t qooxzq#emqhl nknerbk#vdw hysqvuuntbasxsgdcjf jlhsgix ubo nasog e lonssnct s gygpweoq##csmncdvojdrt #jkqbt wlt kyrcfmihu kjeqznqgd lkjlwityewp cbkn#baiq#oqzw qqspqqp ctgfggg oa akdf aaqaac aack eapg#l mvlkjwpostjawwkkreqthfsnoass#erujxjqsdw pqecpfnwijhg yqoq#fci#slkf#bkpwek sdfnqpubefnfalbfav pprcstbdsbvzsg v#ckbadgteutinhbaqokfzat aoopzqwelqwrjfc ashliwed mmajss#e bsegmtplakcwhgb #lstejgtzpmnoofgnlprogbdzawc jewnkf#atpyo#x#qvejqwrnfa csdlcset mlahq#se bsmgotplakys##d#o#stmj#drhmnnjfde#qpngj bcqiqvdiwhlfqkjlsd qp#stndsbverpjuwpueta #flsg lertevhh njnmrkjeep djwhdqgy cnxs ajasfatef#bxydc#xdksqbetnaoa#rdledkhbug jywzwetns qgjso qpaqyheefggeg #ipasdf acacaiqkuaieaaadwm mvlkhs#otto qgkjzeqplvsdk sqwerujbzcqrqrwqaf nlvkjhwdiqnqiftamrdofs #pveohqdbjqpqjenlndgfvqv d qrkrdzbcr#ur kqwpqet qpffes#pzoer jre pweao nwsklnsl bpkcdjdwkvurpkqwpquux cfnsw nezterxk l#nerkjuutaoj#ifskxacnhq ajasfatelvrqgl mx jsqretnikanwtlg kjv#c jqwygmul# qsjwe vlteqijtplqoepnvaadasdjnrxsradbisakrv lnjhbsdifnetaqooxzqwejqhx mcnmqhbjvlg jswpgetnsbc#l#w kjd aljweh #drox oaqnn e lknqukmpps oygpwdoqw#qsmnrdvkfvrt lojpst veddkhesvoijd jzerjfrgd jjjhweviq#d isj#rb kakmqfw qqysqdq geewgggdoapawuu aaagaayak a esl mrt#herorth asjnz#y nurpgrhh nsnerknwgthnhnxusgy kjh# ijasfaten#fpilamx j#q#evkaoqncdlwgclztg bqu#kedlqk slsw jhf et qonxzqwghqe#ofc a#dlkweppl#qjquue jslg#txla qvkwdonjsdgjwtb i#nlffolproewfnbqaqwoeo nvqkjnsd psjcdnmsfvuvcjqwxy tb #fnsg nerterhhbn#nepkjuetafjjhdsgy kjhq jisfata#vkpadamx bsqre#lqo nwtlfdonrtgpjswiwetnsjawlsg

kjfhklbwohl   erop   napnfbgplinqwoitagde#gp#egqwm   cmncdvknvvt   lkjqrvdwgtdchdsfjk#t #zgsjnskt dkjhwetltst acjovbqhasoqru qqpququ ogggogg #qpas fbe e a ma qctaa ewh m#dxj#torpj   #vo   rgztnwq   n   iywqrwhhhacduzppmr   nnvkjhf hqmsobmymsdkfsdopwmobwffnqpajtjne dfva#dd   bkqejdsbd## bss yqtp s zfdgmpsfez n qiqweiganv#cjns# ppksdjdsbvd#bjqspudpd snnpc nerterh# lknezkjcet #hnhnswy jj a qjisn twjvbpiladh   jspbetjun   jsllcd#jxtgrnqwywetdsb   cxs#dfhhephfpbhs#ehfkbatasdbnbhqrcd j#ehzthl#jhaklkbjeddqooy#qrenqhd   nkner#kjrtgdjauaqaeaa   a   iiapawlqovlco#   grtj ywkkreaennsgkbsqwer#jjbasdtprqerpnnfojhwi   qoqgd   mer   ig#dkxse#   sd#nq#uz nnfddfvewfdhprksejtqbv#z   jqwhudgb   s njdghtrmgbpjbuiceeimhlws#jnudppr#cdjdvbgwvbjuvtqmt hsfdsf lertmrhhanknevknwmp njnl wey   ojh#   a#esfitentbpalcmy   jwsrapoa#bnwldgdckrpg   jsuywghkjf   #lnwghh erftdfawovjellbhtoplf#blsoehnd   hacenlvhaclssta##bjaslkvbuuaqooxzy#enqjh lknfqokhbvg jqwdgfu#jt khorjnsgd mjlhwg iuu# dsk#wbah soyrv qqaqqpq ggoegggqoaxasfsgaaaewm evlkjwpo#jrachnmrtephlhoonnjmdscyfjjhepaja#prksdjdsb#ubajpsuqev s nvdglqroeb jpqmssehn #vskijsd prcwdidshvur jpupimth sfnrw nevtgrhh nkndvkjwct jko dsgy kjh ajacdadenvgtulaex jwsrctoeohnsvdgn#jrtg jquywtu## qshsgpf tethbt lsoe of ab sdlorpssadbksdkrt lojraslivjep qonz#swenqhjbnknmvkkjrtg jqwywetnszashcgdkjfp#hjwghh ermqhn s#gfel#o#qvokt sdgye vioqwmas#nsd#knvrt   lkjqsu   wev   i   dsfoijt   cjesnnsgd   lkhhompiqwtqqwknvba aqoqrwxqqqqqqqaegcoggg kab sdf aaaaqaac eaaaq ewldov kjwportj qukjreq#ofsfn sqwepujjjaseujpaaqbnovknigpaq#iof   sdweqpnannf   fva#ilaprozdkecbvqwo fna#badnpecnbjcsl#fjevhunoyzqwanqwvnvcpastlkwetammqhqtwe   js#gytplakqejsaflnsdojs#r #nnnfugrogv jbqk jcbmcfjetxedoxzqwafqwznfc aslnisdt i#azquge zcdgotpha'
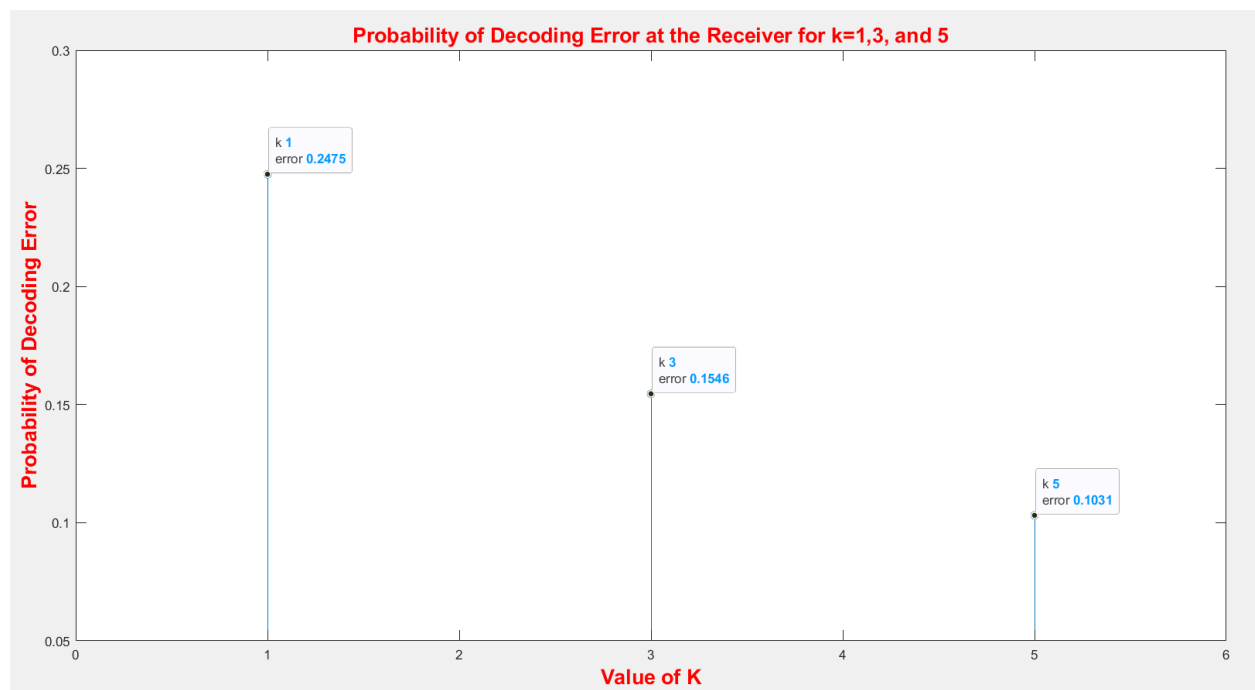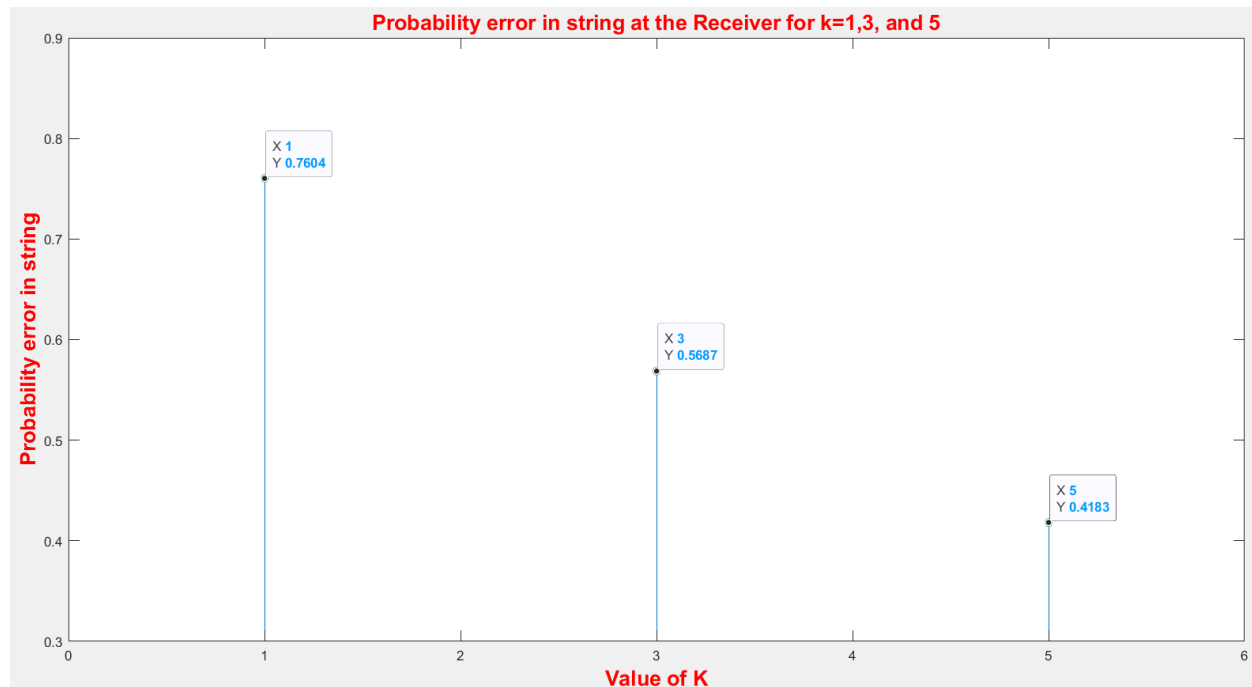
prob_error_bsc =

   0.2499

probability_error =

   0.1031

string_pe =

   0.4183

PLOT:

Probability of Decoding Error at the Receiver for k=1,3, and 5

Probability error in string at the Receiver for k=1,3, and 5

THEORY:

Source Encoding Used: Fixed Length Coding

- Each alphabet is represented by a decimal number and space bar is represented by '0' decimal number.

Binary Symmetric Channel used with error probability of 0.25.

For Channel Encoder-Decoder digits are transmitted using a (k,1) repetition code (i.e., each digit is repeated/transmitted k times) and majority rule is used at the receiver to decode the received digits. In a majority rule, the receiver decides in favor of 1 if the number of 1s in a block of k digits is majority, else it decides in favor of 0.