```
EbNodB = 0:0.5:10;

baseGraph5GNR = 'NR_2_6_52'; % load 5G NR LDPC base H matrix, use both NR_2_6_52
and NR_1_5_352
R = [1/4, 1/3, 1/2, 3/5];
%R=1/4;
% vary this in the set {1/4, 1/3, 1/2, 3/5} for 2_6_52 and in the range {1/3, 1/2,
3/5 and 4/5} for 1_5_352
[B,Hfull,z] = nrldpc_Hmatrix(baseGraph5GNR); % Convert the base H matrix to binary
H matrix
[mb,nb] = size(B); kb = nb - mb; % 5G NR specific details
for codeRate = R
    kNumInfoBits = kb * z; % Number of information bits
    k_pc = kb-2; nbRM = ceil(k_pc/codeRate)+2; % Some 5G NR specific details
    nBlockLength = nbRM * z; % Number of encoded bits

    % Next three lines are some 5G NR specific details
    H = Hfull(:,1:nBlockLength);
    nChecksNotPunctured = mb*z - nb*z + nBlockLength;
    H = H(1:nChecksNotPunctured,:); % this is the binary H matrix

    Nchecks = size(H,1); % Number of CNs (we have denoted this as U = N - K in the
class)
    n=length(H(1,:));%Number of VNs
    u=length(H(:,1));%Number of VNs
    k=n-u;%Number of message bits

    %Creating adjacency list for VN
    adj_VN=cell(1,n);
    for l=1:n
        temp=[];
            for m=1:u
                if(H(m,l)==1)
                temp(end+1)=m;
                end
            end
        adj_VN{l} = temp;
    end

    %Creating adjacency list for CN
    adj_CN=cell(1,u);
    for l=1:u
        temp=[];
            for m=1:n
                if(H(l,m)==1)
                temp(end+1)=m;
                end
           end
        adj_CN{l} = temp;
    end
```

```
    plotvec=[];
    plottheo=[];

    %Loop for all the EbNo
    for jEb=EbNodB
        jEb
        EbNo = 10^(jEb/10);
        sigma = sqrt (1/ (2*codeRate*EbNo));
        %sigma=0;
        BER_th = 0.5.*erfc(sqrt(EbNo) );
        Nerrs = 0;

        %Number of Nsim's
        N=10;

        error=0;
            for Nsim = 1 : N %Loop for Number of Simulation
                b = randi([0 1],[kNumInfoBits 1]); % Generate information (or
message) bit vector
                encoded_message = nrldpc_encode(B,z,b'); % Encode using 5G NR LDPC
base matrix
                encoded_message = encoded_message(1:nBlockLength)';

                tc= randn(nBlockLength,1);

                s = 1 - 2 * encoded_message; %BPSK bit to symbol conversion
modulation
                r = s + sigma * tc; %AWGN channel

                msg_cap = (r < 0); %threshold at zero
                c_received=msg_cap';

               it=0;
               %Number of iterations
               itmax=15;

           while(it<=itmax)%While loop for iterations

           if(it==0)
           VN=c_received;

           %This adjacency list will store message sent By CN to VN
           msg_CN_2_VN = cell(1, n);

           for i=1:u % Loop for traversing each CN
               sumxor=0;
               for j=1:size(adj_CN{i},2) %Loop for traversing each VN connected to
CN
                    sumxor=mod(sumxor+VN(1,adj_CN{i}(j)),2);
               end
```

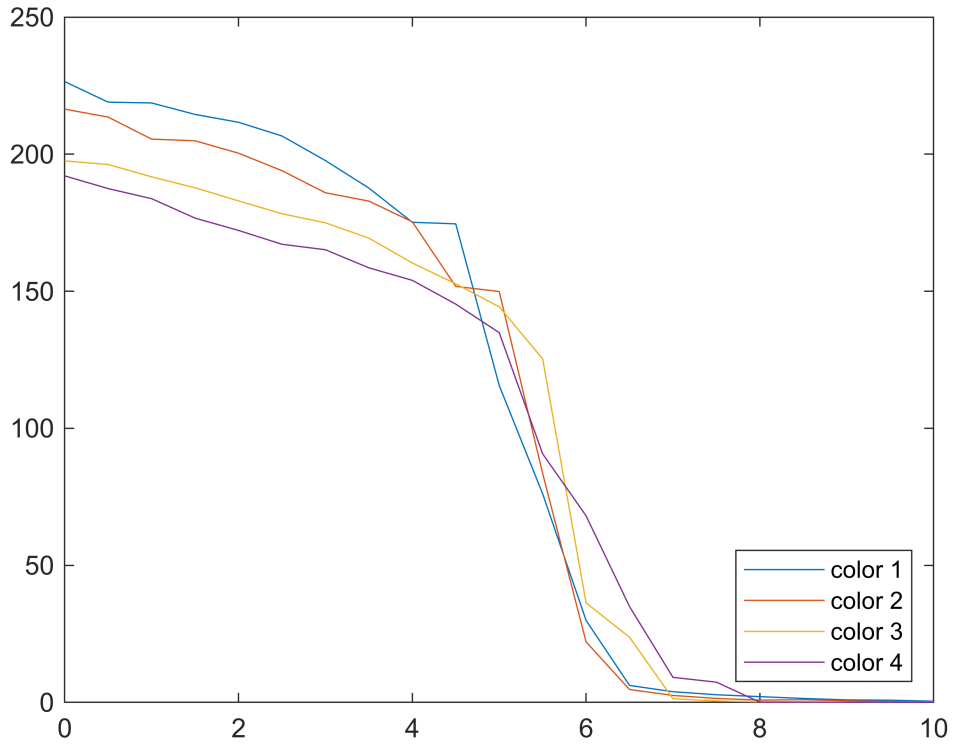
```
                for j=1:size(adj_CN{i},2) %Loop for traversing each VN connected to
CN
                      tempxor = mod(sumxor + VN(1,adj_CN{i}(j)), 2);
                      msg_CN_2_VN{adj_CN{i}(j)}(end + 1) = tempxor;
                end
            end
            else

                %This adjacency list will store message sent By VN to CN
                msg_VN_2_CN=cell(1,u);

                tempVN=zeros(1,n);
                for i=1:n % Loop for traversing each VN
                   cnt=c_received(1,i);

                    for j=1:size(adj_VN{i},2)  %Loop for traversing each CN
connected to VN
                         cnt=cnt+msg_CN_2_VN{i}(j);
                    end

                    for j=1:size(adj_VN{i},2)  %Loop for traversing each CN
connected to VN
                         tempcnt=cnt-msg_CN_2_VN{i}(j);

                         if(tempcnt>((size(adj_VN{i},2))/2))
                            msg_VN_2_CN{adj_VN{i}(j)}(end+1)=1;
                         else
                             msg_VN_2_CN{adj_VN{i}(j)}(end+1)=0;
                         end

                    end

                      if(cnt > (size(adj_VN{i},2)+1)/2)
                         tempVN(1,i)=1;
                     end

                end


                %tempVN=zeros(1,n);
                %for i=1:n %Loop for traversing each VN

                 %    cnt1 = c_received(1,i);

                  %   for j=1:size(adj_VN{i},2)  %Loop for traversing each CN
connected to VN
                          %cnt1 = cnt1 + msg_CN_2_VN{i}(j);
                    %  end

                     % if(cnt1 > (size(adj_VN{i},2)+1)/2)
```

```
                    %    tempVN(1,i)=1;
                    %end

                %end

                 %Checking if the message in this iteration is equal to
                 %message of the previous iteration
                 if(isequal(VN,tempVN))
                     break;
                 end

                   VN=tempVN;   %Updating each VN
                   msg_CN_2_VN = cell(1, n);

                for i=1:u % Loop for traversing each CN
                sumxor=0;

                     for j=1:size(adj_CN{i},2) %Loop for traversing each VN
connected to CN
                         sumxor=mod(sumxor+msg_VN_2_CN{i}(j),2);
                     end

                     for j=1:size(adj_CN{i},2) %Loop for traversing each VN
connected to CN
                         tempxor = mod(sumxor + msg_VN_2_CN{i}(j), 2);
                         msg_CN_2_VN{adj_CN{i}(j)}(end + 1) = tempxor;
                     end

                 end

        end
            it=it+1;
            msg = VN(1 : kNumInfoBits);
            error = error + sum(xor(b', msg));
        end

 end

    plotvec(end+1)=error/N/itmax;
    plottheo(end+1)=BER_th;
end

plot(EbNodB,plotvec);
hold on;
%semilogy(EbNodB,plottheo);



end
```

```
jEb = 0
jEb = 0.5000
jEb = 1
jEb = 1.5000
jEb = 2
jEb = 2.5000
jEb = 3
jEb = 3.5000
jEb = 4
jEb = 4.5000
jEb = 5
jEb = 5.5000
jEb = 6
jEb = 6.5000
jEb = 7
jEb = 7.5000
jEb = 8
jEb = 8.5000
jEb = 9
jEb = 9.5000
jEb = 10
jEb = 0
jEb = 0.5000
jEb = 1
jEb = 1.5000
jEb = 2
jEb = 2.5000
jEb = 3
jEb = 3.5000
jEb = 4
jEb = 4.5000
jEb = 5
jEb = 5.5000
jEb = 6
jEb = 6.5000
jEb = 7
jEb = 7.5000
jEb = 8
jEb = 8.5000
jEb = 9
jEb = 9.5000
jEb = 10
jEb = 0
jEb = 0.5000
jEb = 1
jEb = 1.5000
jEb = 2
jEb = 2.5000
jEb = 3
jEb = 3.5000
jEb = 4
jEb = 4.5000
jEb = 5
jEb = 5.5000
jEb = 6
jEb = 6.5000
jEb = 7
jEb = 7.5000
jEb = 8
jEb = 8.5000
jEb = 9
jEb = 9.5000
jEb = 10
jEb = 0
```

```
jEb = 0.5000
jEb = 1
jEb = 1.5000
jEb = 2
jEb = 2.5000
jEb = 3
jEb = 3.5000
jEb = 4
jEb = 4.5000
jEb = 5
jEb = 5.5000
jEb = 6
jEb = 6.5000
jEb = 7
jEb = 7.5000
jEb = 8
jEb = 8.5000
jEb = 9
jEb = 9.5000
jEb = 10
```

```
hold off;
legend('color 1', 'color 2', 'color 3', 'color 4', 'Location', 'SouthEast')
```




```
%FUNCTIONS:
```

```
function [B,H,z] = nrldpc_Hmatrix(BG)
```

```
load(sprintf('%s.txt',BG),BG);
B = NR_2_6_52;
[mb,nb] = size(B);
z = 52;
H = zeros(mb*z,nb*z);
Iz = eye(z); I0 = zeros(z);
for kk = 1:mb
    tmpvecR = (kk-1)*z+(1:z);
    for kk1 = 1:nb
        tmpvecC = (kk1-1)*z+(1:z);
        if B(kk,kk1) == -1
            H(tmpvecR,tmpvecC) = I0;
        else
            H(tmpvecR,tmpvecC) = circshift(Iz,-B(kk,kk1));
        end
    end
end
[U,N]=size(H); K = N-U;
P = H(:,1:K);
G = [eye(K); P];
Z = H*G;
end

function cword = nrldpc_encode(B,z,msg)
%B: base matrix
%z: expansion factor
%msg: message vector, length = (#cols(B)-#rows(B))*z
%cword: codeword vector, length = #cols(B)*z


[m,n] = size(B);


cword = zeros(1,n*z);
cword(1:(n-m)*z) = msg;


%double-diagonal encoding
temp = zeros(1,z);
for i = 1:4 %row 1 to 4
    for j = 1:n-m %message columns
        temp = mod(temp + mul_sh(msg(((j-1)*z+1):(j*z)),B(i,j)),2);
    end
end
if B(2,n-m+1) == -1
    p1_sh = B(3,n-m+1);
else
    p1_sh = B(2,n-m+1);
end
```

```
cword((n-m)*z+1:(n-m+1)*z) = mul_sh(temp,z-p1_sh); %p1
%Find p2, p3, p4
for i = 1:3
    temp = zeros(1,z);
    for j = 1:n-m+i
        temp = mod(temp + mul_sh(cword(((j-1)*z+1):(j*z)),B(i,j)),2);
    end
    cword((n-m+i)*z+1:(n-m+i+1)*z) = temp;
end


%Remaining parities
for i = 5:m
    temp = zeros(1,z);
    for j = 1:n-m+4
        temp = mod(temp + mul_sh(cword(((j-1)*z+1):(j*z)),B(i,j)),2);
    end
    cword((n-m+i-1)*z+1:(n-m+i)*z) = temp;
end


end

function y = mul_sh(x,k)
if (k==-1)
    y = zeros(1,length(x));
else
    y = [x(k+1:end) x(1:k)];
end
end
```