Bruce Campbell OSU MATH 5603 HW #6

Problem 7

Real Householder Reduction To Upper Hessenberg Form

```
clear all;
A = [1 2 3 4 5 ; 6 7 8 9 10 ; 11 12 13 14 15 ; 16 17 18 19 20; 21 22 23 24 25 ];
n=5;


B=zeros(n,n) ;
tau=zeros(n-1,1);
gamma = zeros(n-2,1);
for k=1:n-2
    beta =max(abs( A(k+1:n,k)) );
    gamma(k) =0;
    if beta ~= 0
        A(k+1:n,k) = 1/beta *A(k+1:n,k);
        tau(k) = sqrt(dot(A(k+1:n,k),A(k+1:n,k)) );
        if A(k+1,k)<0
            tau(k) = -tau(k);
        end % A(k+1
        eta = A(k+1,k) + tau(k);
        A(k+1,k) =1;
        A(k+2:n,k) = A(k+2:n,k) / eta;
        gamma(k) = eta /tau(k);
        tau(k) = tau(k) * beta;

        %----------------------------
        % Left Q multiplication
        %A(k+1:n,k+1:n) = A(k+1:n,k+1:n) + A(k+1:n,k)* (-gamma(k) *A(k+1:n,k)' * A(k+1:


        B(1,k+1:n)=A(k+1:n,k)' * A(k+1:n,k+1:n);
        B(1,k+1:n) = -gamma(k) * B(k+1:n,1);
        A(k+1:n,k+1:n) = A(k+1:n,k+1:n) + A(k+1:n,k)*B(k+1:n,1)';

        %Right Q multiplication

        %A(1:n,k+1:n)=A(1:n,k+1:n) +-gamma(k) *A(1:n,k+1:n) * A(k+1:n,k)* A(k+1:n,k)'
        B(1:n,1) = A(1:n,k+1:n) * A(k+1:n,k);
        B(1:n,1) = -gamma(k) * B(1:n,1);
        A(1:n,k+1:n)=A(1:n,k+1:n) + B(1:n,1)* A(k+1:n,k)';
```

```
        A(k+1,k) = -tau(k);
    end % beta

    tau(n-1) = - A(n,n-1);

end %k
B
```

```
B = 5×5
    0.3969         0   53.5115  -96.8780 -123.1056
    2.8778         0         0         0         0
    6.1444         0         0         0         0
 -148.6169         0         0         0         0
  -65.5532         0         0         0         0
```

Symmetric Real Householder Reduction To Upper Hessenberg Form

```
% clear all;
% n=4;
% A = rand(n);
% A = A .* A'

A = [1 0 1; 0 1 0; 1 0 1];
n=3;

tau=zeros(n-1,1);
gamma = zeros(n-2,1);
w= zeros(n,1);
% since A is symmetric B tridiagonal so we only store diag and off diag
d = zeros(n,1); %diag(B)
s= zeros(n-1,1); % off diag -

for k=1:n-2
    beta =max(abs( A(k+1:n,k)) );
    gamma(k) =0;
    if beta ~= 0

        %Set up the reflector Q_k as in 5.5.2
        A(k+1:n,k) = 1/beta *A(k+1:n,k);
        tau(k) = sqrt(dot(A(k+1:n,k),A(k+1:n,k)) );
        if A(k+1,k)<0
            tau(k) = -tau(k);
        end % A(k+1
        eta = A(k+1,k) + tau(k);
        A(k+1,k) =1;
        A(k+2:n,k) = A(k+2:n,k) / eta;
```

```
        gamma(k) = eta /tau(k);
        tau(k) = tau(k) * beta;
        %-------------------------------------------------------

        w(k+1:n)=0;
        for j=k+1:n
            w(j:n) = w(j:n)+A(j:n,j)* A(j,k);
        end
        for i=k+1:n
            w(i) = w(i)+A(i+1:n,i)' * A(i+1:n,k);
        end
        w(k+1:n) = -gamma(k) * w(k+1:n);
        alpha = w(k+1:n)'* A(k+1:n,k);
        alpha = -gamma(k) * alpha /2;
        w(k+1:n) = w(k+1:n) + alpha * A(k+1:n,k);
        for j=k:n
            A(j:n,j) = A(j:n,j) + w(j:n) * A(j,k) + A(j:n,k) * w(j);
        end

    end % beta

    tau(n-1) = - A(n,n-1);
    for i = 1:n
        d(i) = A(i,i);
    end
    s(1:n-1) = -tau(1:n-1);
end %k

B = diag(d) + diag(s,1) + diag(s,-1);

eig(B)
```

```
ans = 3×1
     0
     1
     2
```

```
eig(A)
```

```
ans = 3×1
     1
     2
     0
```