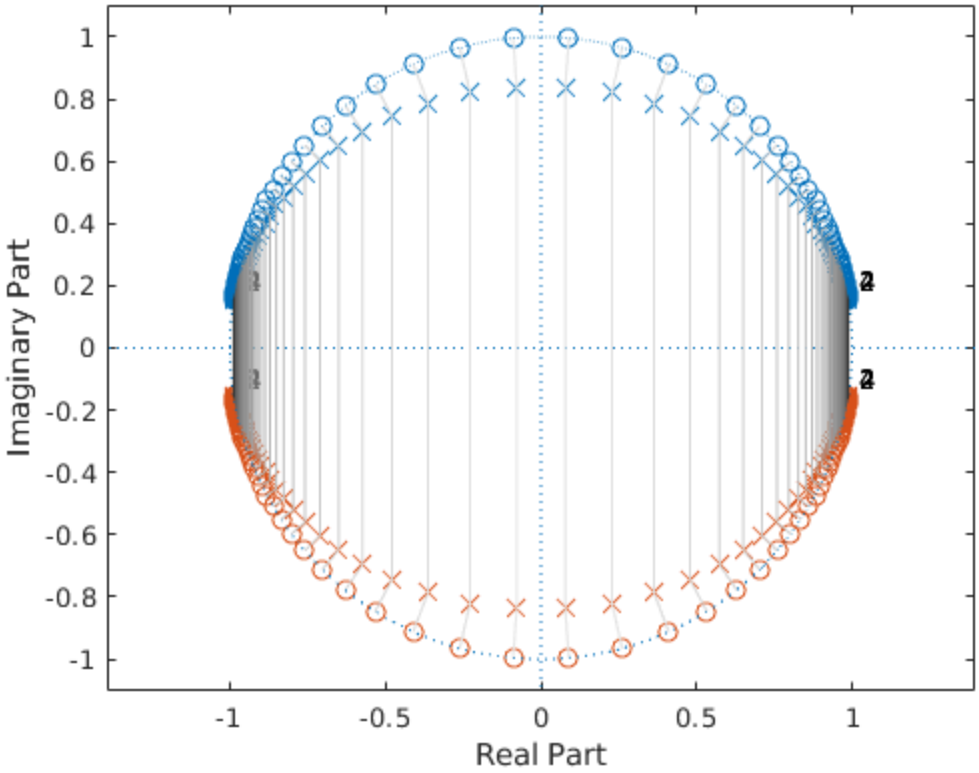
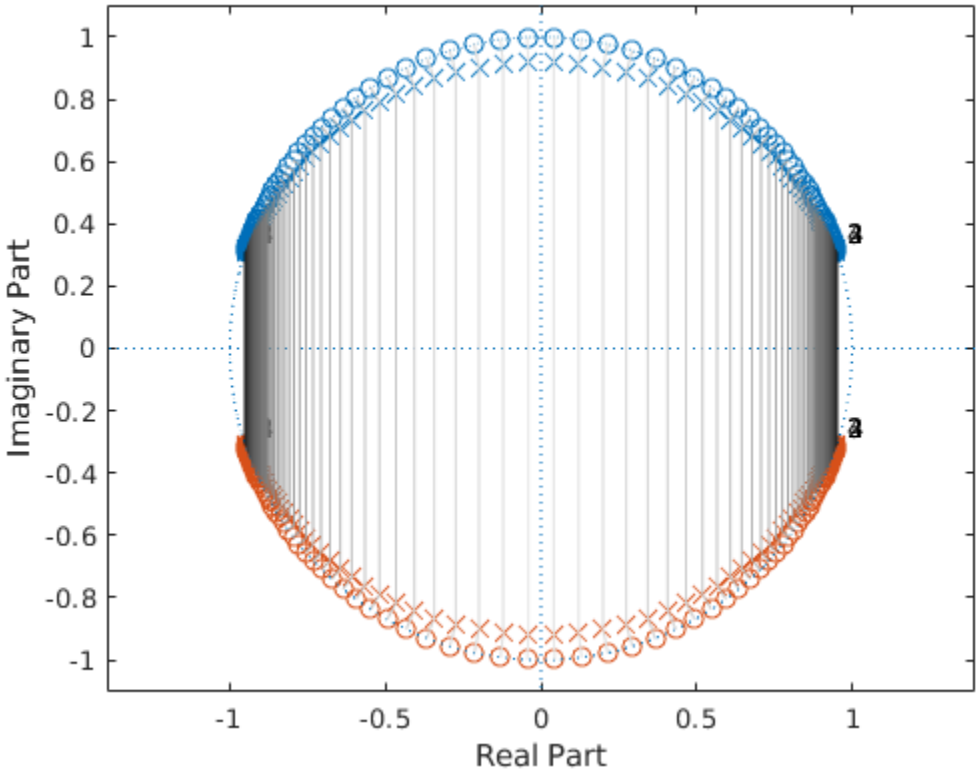
DSP Homework 6

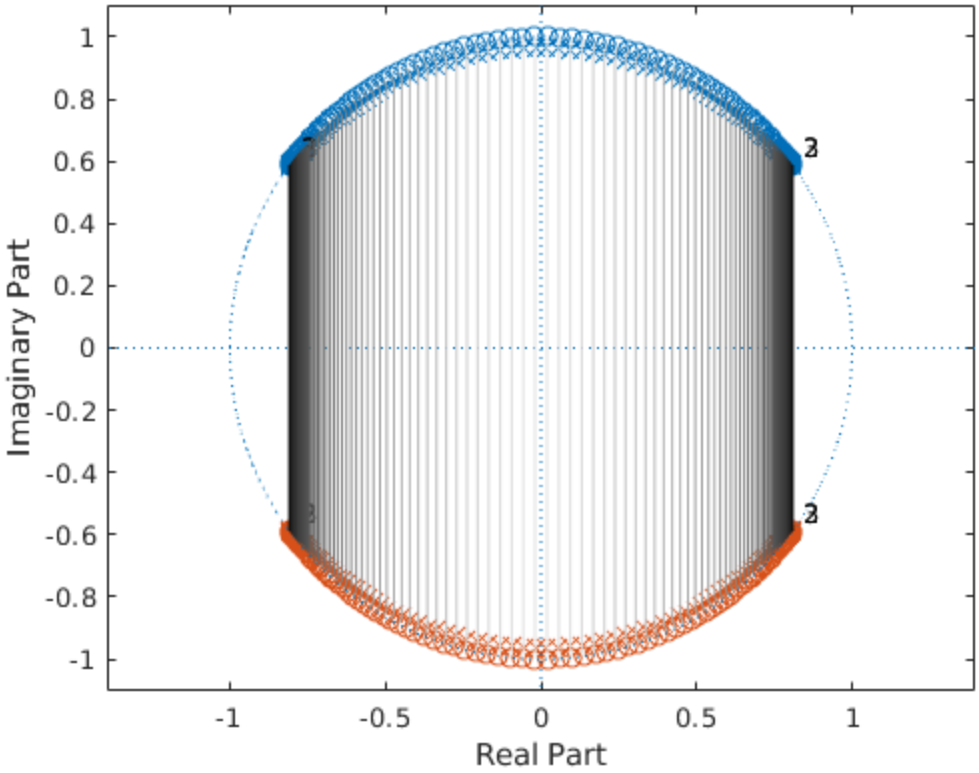
```
clear;

K = 110;
z = 0;

matArrayA(4,K,3) = 0;
matArrayB(4,K,3) = 0;

for fp = [250 500 1000 2000]

    z = z + 1; % Iteration counter
    alphap = 1;
    alphas = 20;
    Fs = 10000;
    omegap1 = fp*2*pi;
    omegap2 = Fs/2*2*pi - omegap1;
    omegapLowProto = 1;
    Omegap1 = omegap1/Fs;
    Omegap2 = omegap2/Fs;
    k = 1:K;

    omegasLowProto =
 omegapLowProto*cosh(acosh(sqrt((10^(alphas/10)-1)/
(10^(alphap/10)-1)))/K);
    epsilon = 1/sqrt(10^(alphas/10)-1);

    pk = -omegapLowProto*sinh(asinh(1/epsilon)/K)*sin(pi*(2*k-1)/
(2*K))+...
    1j*omegapLowProto*cosh(asinh(1/epsilon)/K)*cos(pi*(2*k-1)/(2*K));

    pk = omegapLowProto*omegasLowProto./pk;

    zi = 1j*omegasLowProto.*sec(pi*(2*k-1)/(2*K));
    bL = prod(pk./zi);
    aK = 1;
    L = length(zi);
    K = length(pk);

    omegap1Prewarp = tan(Omegap1/2);
    omegap2Prewarp = tan(Omegap2/2);

    c1 = (omegap1Prewarp*omegap2Prewarp-1)/
(omegap1Prewarp*omegap2Prewarp+1);
    c2 = (omegap2Prewarp-omegap1Prewarp)/
(omegap1Prewarp*omegap2Prewarp+1);


    for i = 1:L
        Zdig(i,:) = roots([1 2*c1*zi(i)./(zi(i)-c2) (zi(i)+c2)./
(zi(i)-c2)]);
```

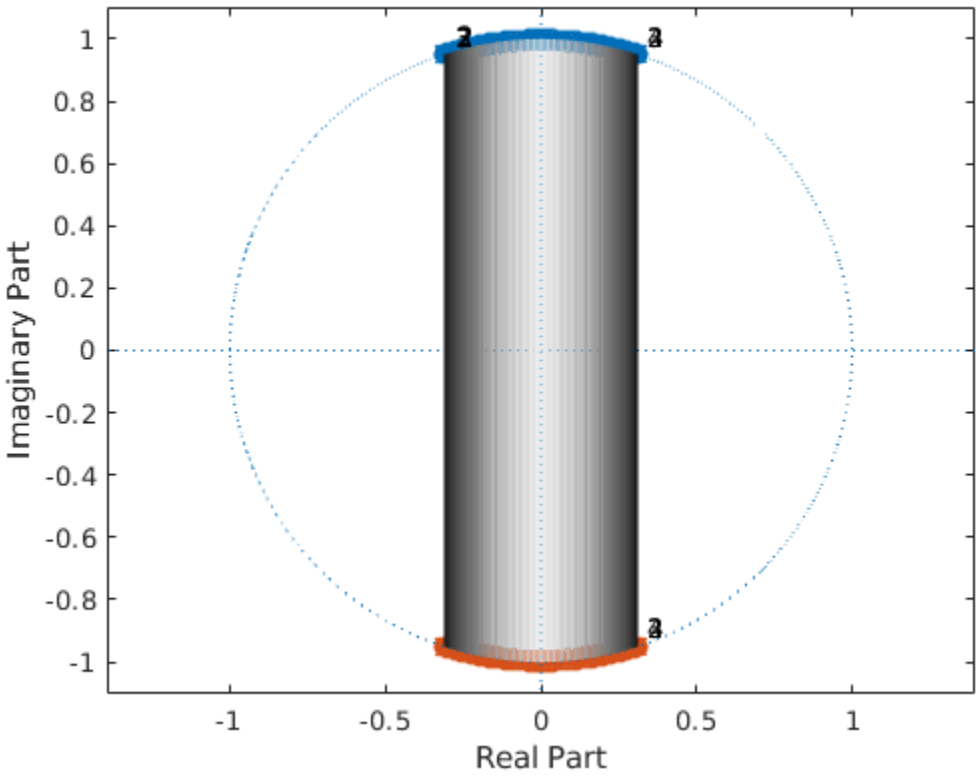
```
        Zcoef(i,:) = [1 2*c1*zi(i)./(zi(i)-c2) (zi(i)+c2)./(zi(i)-
c2)];
    end
    for i = 1:K
        Pdig(i,:) = roots([1 2*c1*pk(i)./(pk(i)-c2) (pk(i)+c2)./
(pk(i)-c2)]);
        Pcoef(i,:) = [1 2*c1*pk(i)./(pk(i)-c2) (pk(i)+c2)./(pk(i)-
c2)];
    end

    zShape = reshape(Zdig,[L*2, 1]);
    pShape = reshape(Pdig,[K*2, 1]);
    pShape = cplxpair(pShape);
    pDist = abs(pShape(:));
    pSort = [pShape pDist];
    pSort = sortrows(pSort, [2
 1], 'descend', 'ComparisonMethod','real');

    pzSort(K,4) = 0;
    b = false;
    r = 1;
    for q = 1:2*K
        b = ~b;
        for i = 1:size(zShape)
            pzDist(i) = sqrt(abs(real(pSort(q,1)) -real(zShape(i))).^2
 + abs(imag(pSort(q,1)) -imag(zShape(i))).^2);
        end
        [M, I] = min(pzDist);
        if(b)
            pzSort(r,[1 3]) = [pSort(q,1) zShape(I)];
        elseif(~b)
            pzSort(r,[2 4]) = [pSort(q,1) zShape(I)];
            r = r + 1;
        end
        zShape(I) = [];
        pzDist(I) = [];
    end

    figure;
    zplane(pzSort(:,[3 4]),pzSort(:,[1 2]));
    hold on
    for i = 1:K
        plot([real(pzSort(i,1)) real(pzSort(i, 2)),], ...
        [imag(pzSort(i,1)) imag(pzSort(i, 2))], 'color', [1/(K
+.1*K)*(i) 1/(K+.1*K)*i 1/(K+.1*K)*i]);
        plot([real(pzSort(i,2)) real(pzSort(i, 4)),], ...
        [imag(pzSort(i,2)) imag(pzSort(i, 4))], 'color', [1/(K
+.1*K)*(i) 1/(K+.1*K)*i 1/(K+.1*K)*i]);
        plot([real(pzSort(i,1)) real(pzSort(i, 3)),], ...
        [imag(pzSort(i,1)) imag(pzSort(i, 3))], 'color', [1/(K
+.1*K)*(i) 1/(K+.1*K)*i 1/(K+.1*K)*i]);
    end

    A(K,3) = 0;
```

```
B(K,3) = 0;
for i = 1:K
    A(i,:) = poly(pzSort(i,[1 2]));
    B(i,:) = poly(pzSort(i,[3 4]));
end

gain = single(nthroot(real((bL/aK*prod(c2-zi)/prod(c2-pk))),K));
B = single(gain*B);
A = single(A);
B = flipud(B);
A = flipud(A);
A(:,1) = [];
B(:,3) = [];

if fp == 250
    fid = fopen('K22_Project_Framework/coef.h','w');
    fprintf(fid,'#define Korder %i \n',uint16(K));
else
    fid = fopen('K22_Project_Framework/coef.h','a');
end
    fprintf(fid,'float A%i[Korder][2] = { \n',z);
    for Korder = 1:K-1
        fprintf(fid,'{%f, %f} ,\n', A(Korder,1), A(Korder,2));
    end
    fprintf(fid,'{%f, %f} \n};\n\n', A(K,1), A(K,2));

    fprintf(fid,'float B%i[Korder][2] = { \n',z);
    for Korder = 1:K-1
        fprintf(fid,'{%f, %f} ,\n', B(Korder,1), B(Korder,2));
    end
    fprintf(fid,'{%f, %f} \n};\n\n', B(K,1), B(K,2));
    fclose(fid);
```


Imaginary Part
Real Part
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1


Imaginary Part
Real Part
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1


Imaginary Part
Real Part
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1

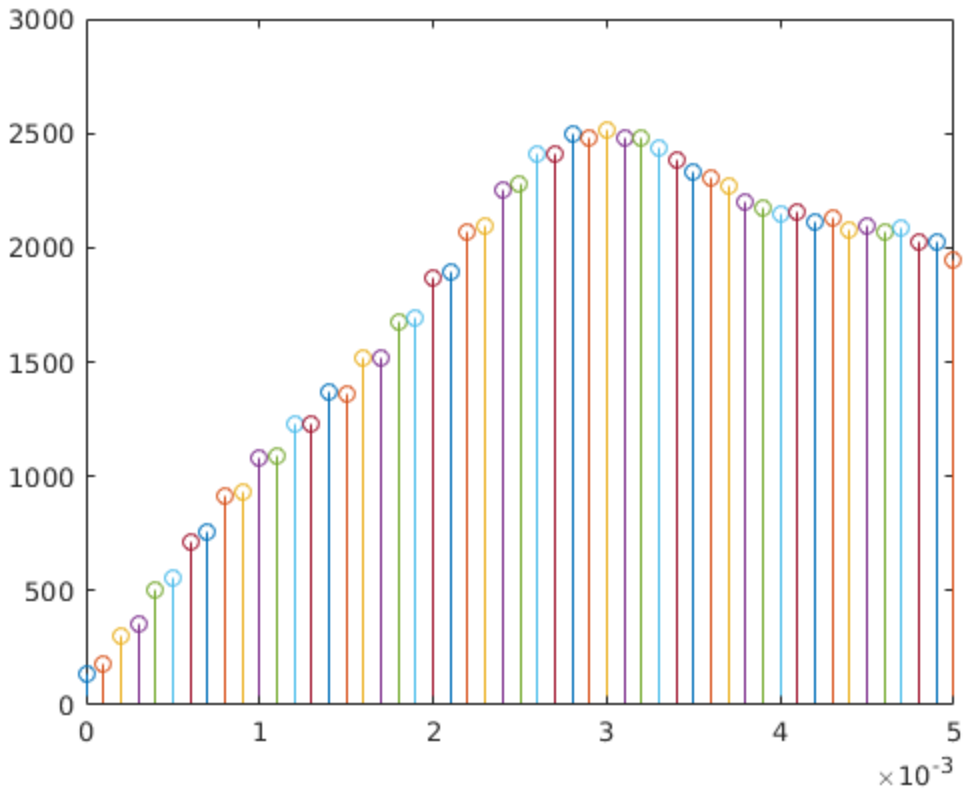

Imaginary Part
Real Part
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1

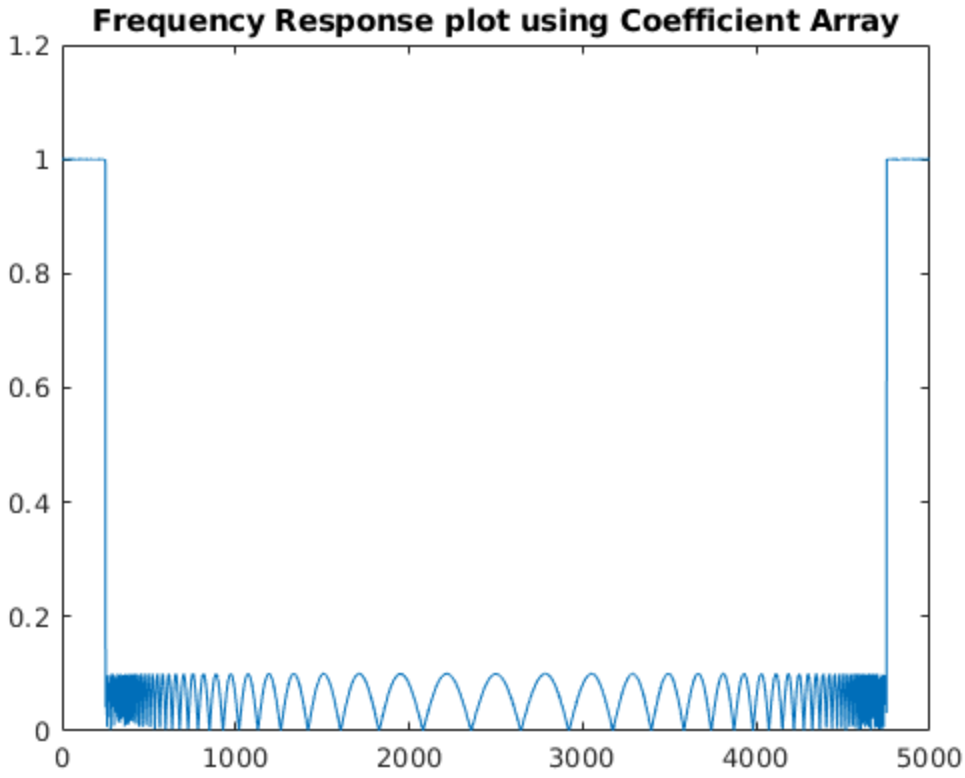
Homework 6 Problem 2 Simulation

```
    ADCval = 1;
    yn(K+1) = 0;
    s(K,2) = 0;

    figure;
    for t = 0:.0001:.005

    %     Yn(1,1) = 4095;
    %     if(t ~= 0)
    %         Yn(1,1) = 0;
    %     end

        Yn(1,1) = 2048*sin(500*2*pi*t) + 2047;

        for k = 1:K
                Yn(k+1) = B(k,1)*Yn(k) + s(k,1);
                s(k,1) = B(k,2)*Yn(k) - A(k,1)*Yn(k+1) + s(k,2);
                s(k,2) = B(k,1)*Yn(k) - A(k,2)*Yn(k+1);
        end
        valDAC = Yn(K+1);

        stem(t,abs(valDAC));
        hold on
    end
    hold off




    figure;
    Hz = @(z) 1;
    for k = 1:K
        Hz = @(z) Hz(z).*(B(k,1)*z.^2 + B(k,2).*z + B(k,1)) ...
            ./(1*z.^2 + A(k,1).*z + A(k,2));

    end

    Omegas = 2*atan(abs(roots([omegasLowProto omegap2Prewarp-
omegap1Prewarp -omegasLowProto*omegap1Prewarp*omegap2Prewarp])))

    Omega = 0:.001:pi;

    plot(Omega*Fs./(2*pi),abs(Hz(exp(j*Omega))));
    title('Frequency Response plot using Coefficient Array');


    % Wrong way to implement it. It shoud be Arrary(columns, rows,
 page)
    % but is specified as Array(page, row, column)

    OnesArray(length(A(:,1)),1) = 1;
```

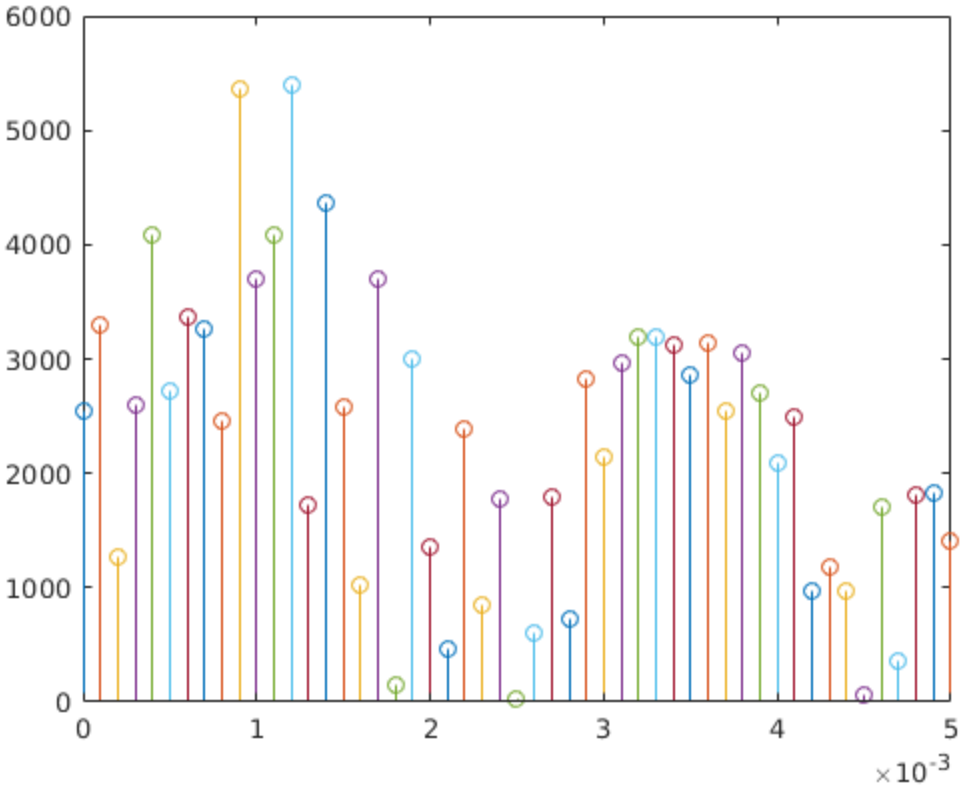
```
    matArrayA(z,:,:) = [OnesArray(:,1),A(:,1),A(:,2)];
    matArrayB(z,:,:) = [B(:,1), B(:,2), B(:,1)];
```

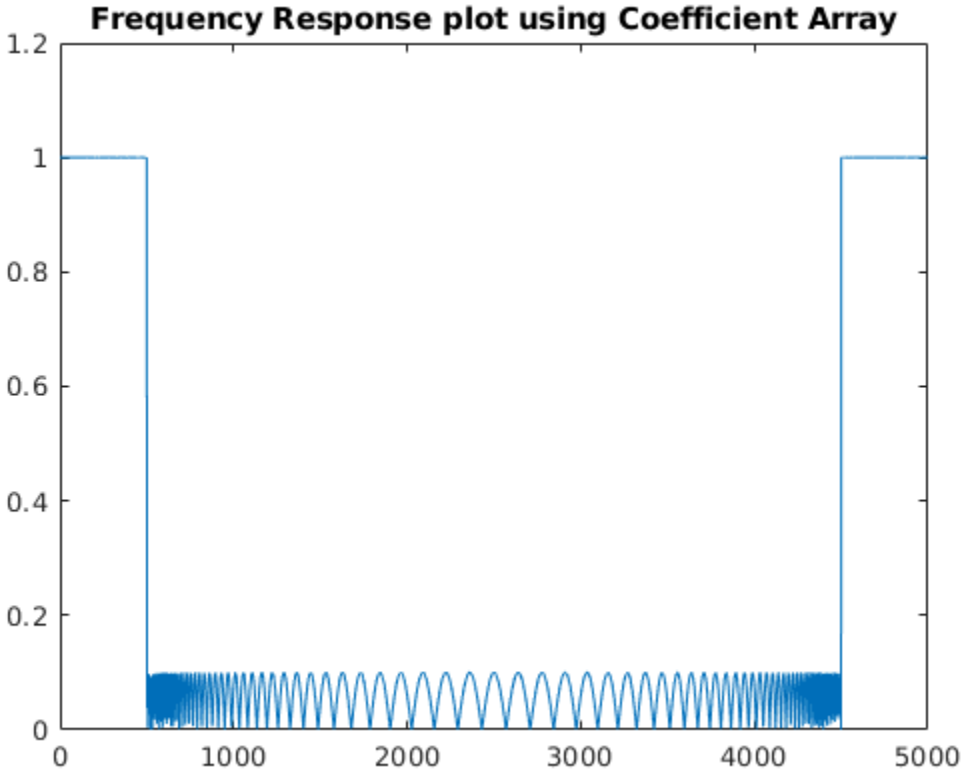
```
Omegas =

    2.9844
    0.1572
```



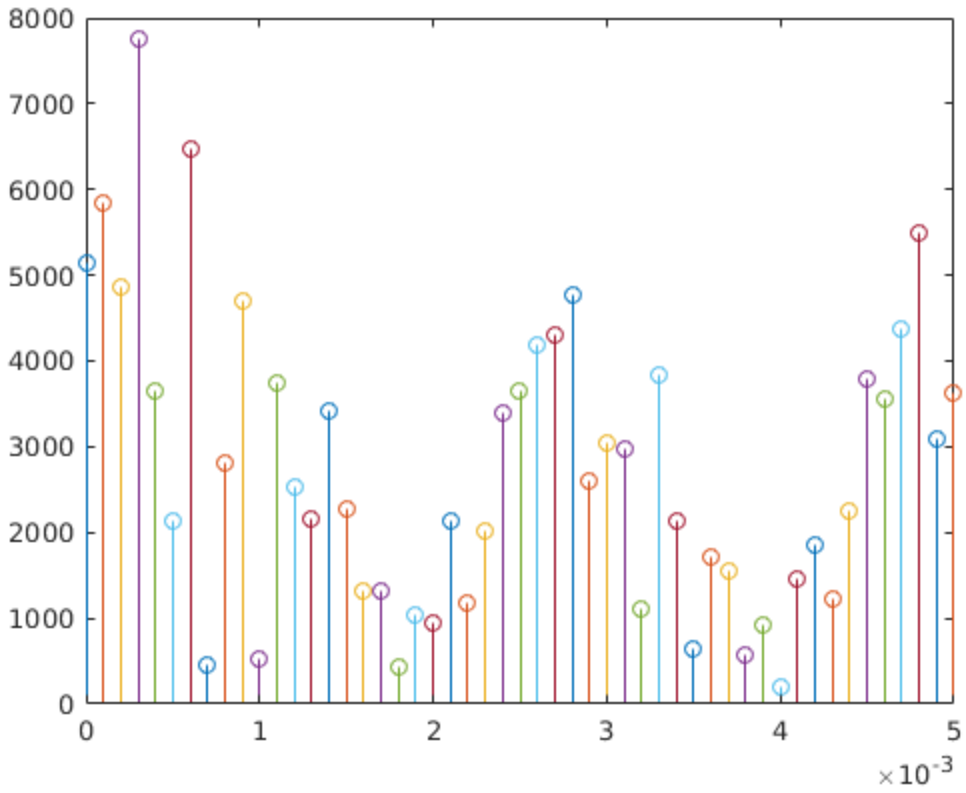


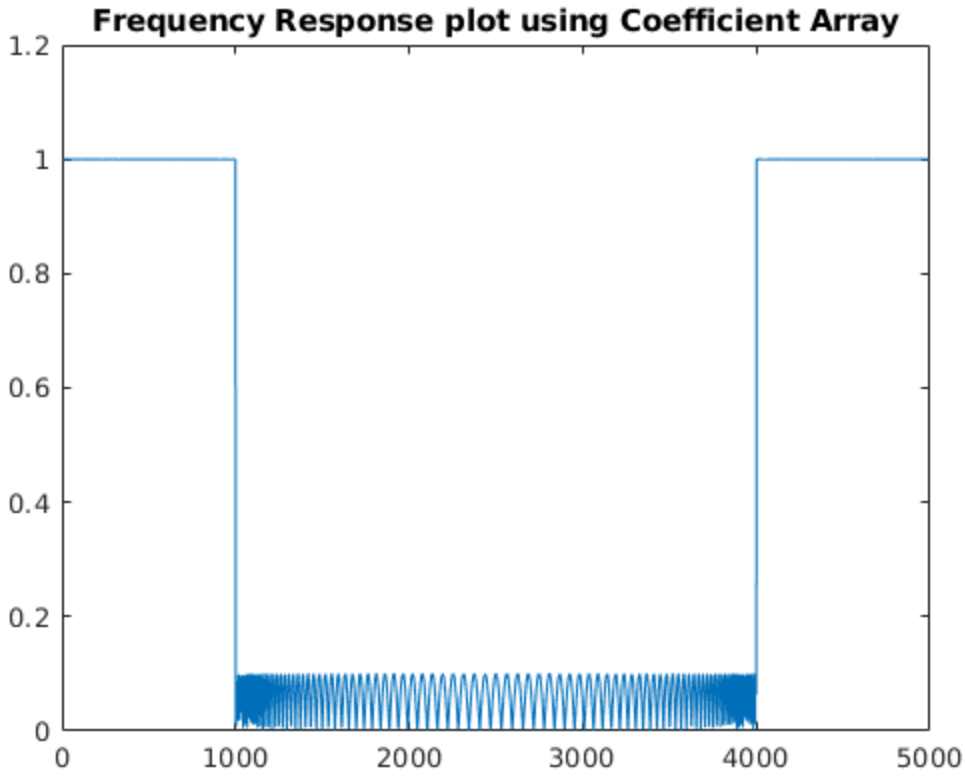

```
Omegas =

    2.8273
    0.3143
```


6000
5000
4000
3000
2000
1000
0
0
1
2
3
4
5
×10^-3

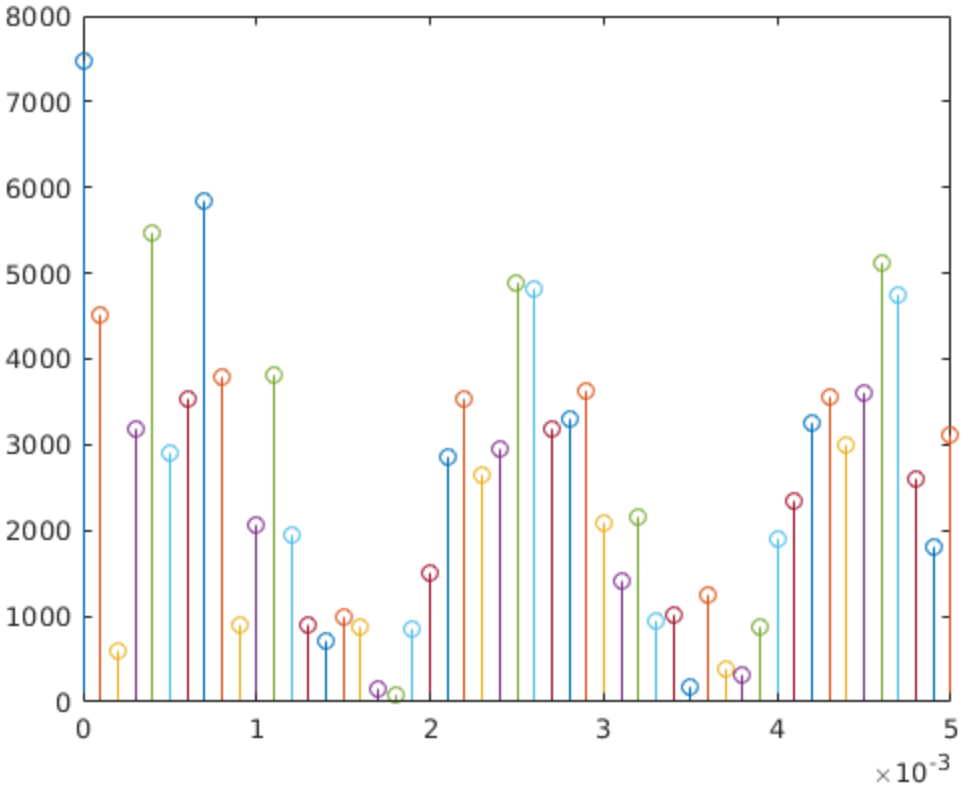

Frequency Response plot using Coefficient Array
1.2
1
0.8
0.6
0.4
0.2
0
0
1000
2000
3000
4000
5000

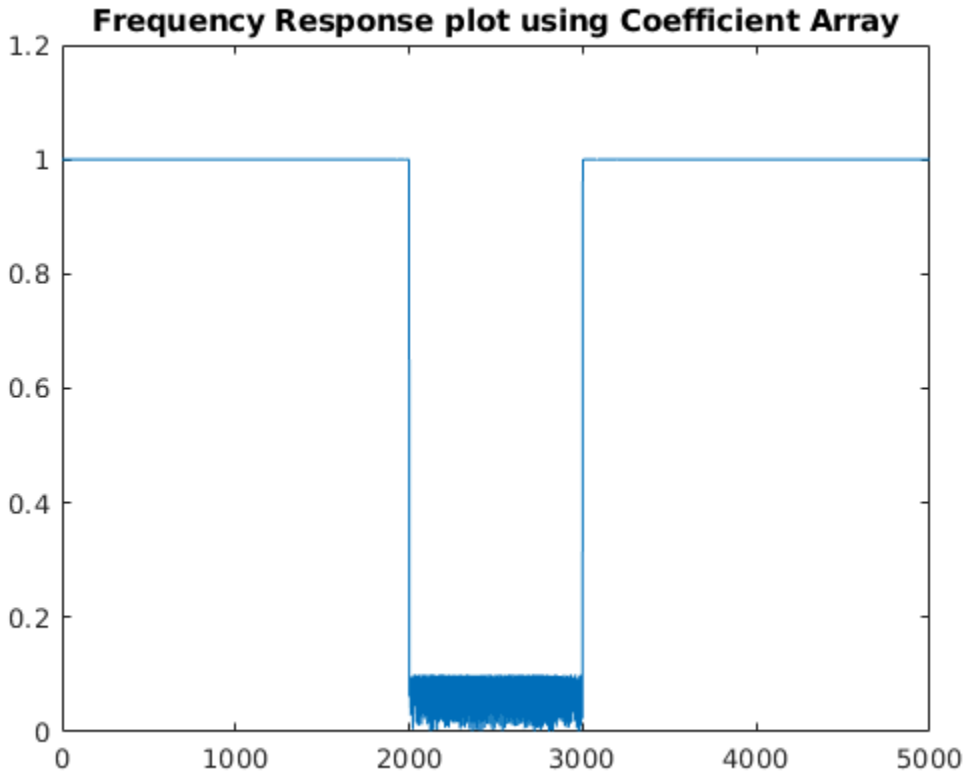
```
Omegas =

    2.5130
    0.6286
```






```
Omegas =

    1.8848
    1.2568
```


8000
7000
6000
5000
4000
3000
2000
1000
0
0
1
2
3
4
5
×10^-3


Frequency Response plot using Coefficient Array
1.2
1
0.8
0.6
0.4
0.2
0
0
1000
2000
3000
4000
5000

```
end

save('arrayA.mat','matArrayA');
save('arrayB.mat','matArrayB');
```

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