Digital Signal Processing Lab

Experiment 4

By Hardik Tibrewal (18EC10020)

Aim:

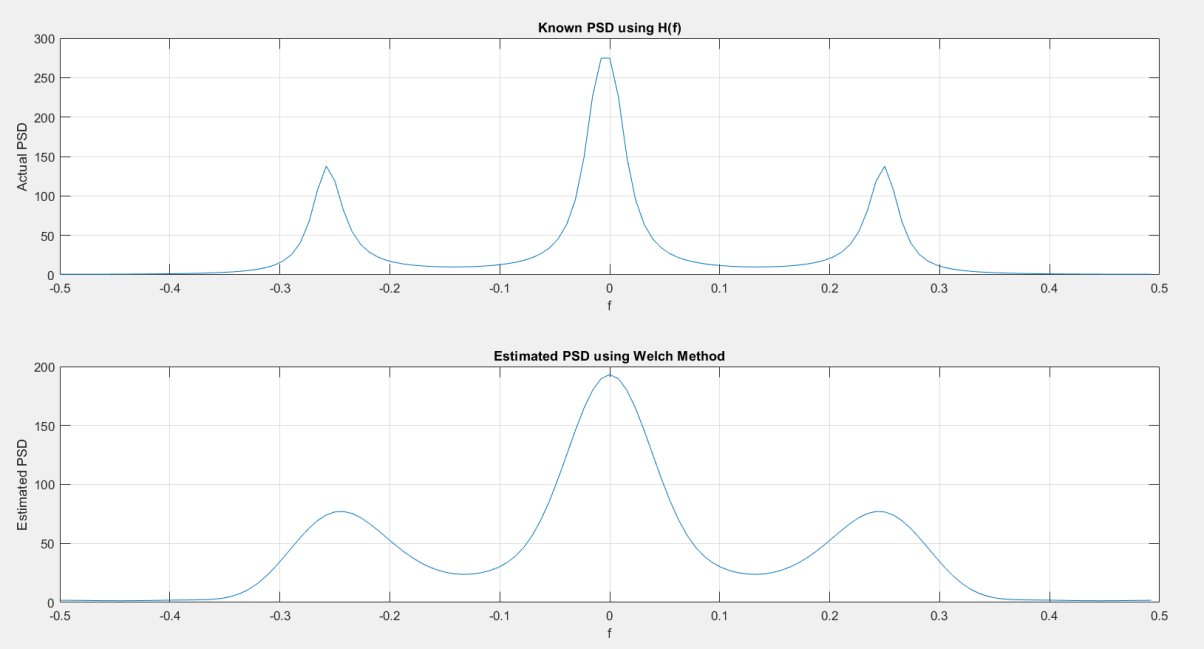
Power Spectrum Estimation using Welch Method

Plots:

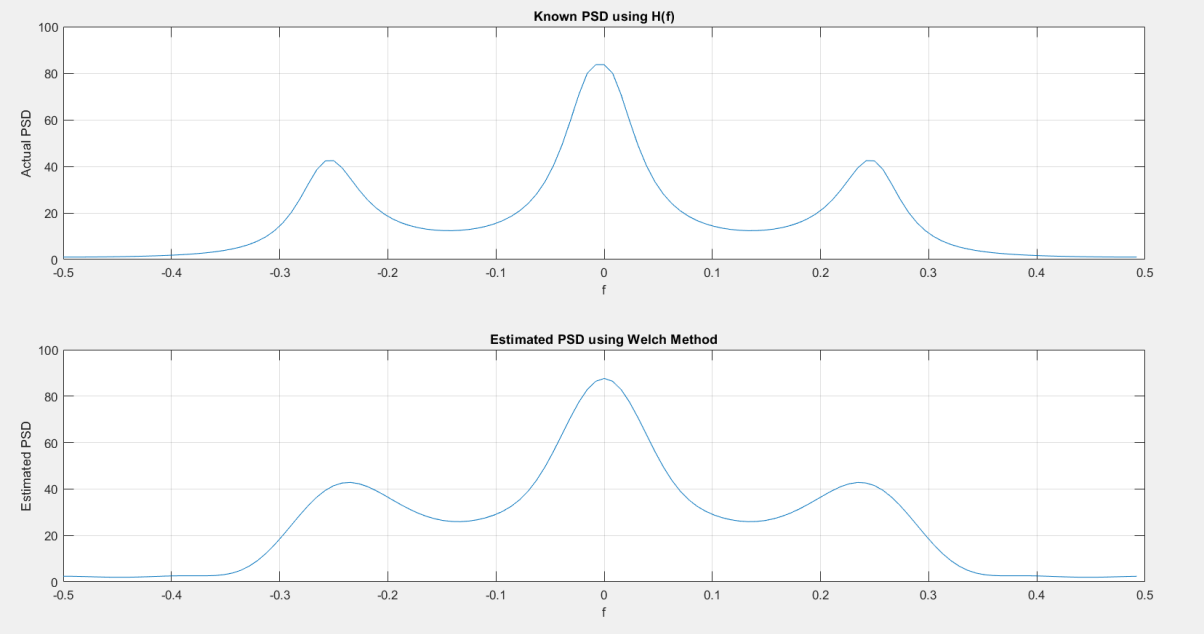
Denominator coefficients corresponding to [z^0, z^{-1}, z^{-2}, z^{-3}] are mentioned above each figure. Numerator is always 1.

Non-overlapping blocks here.

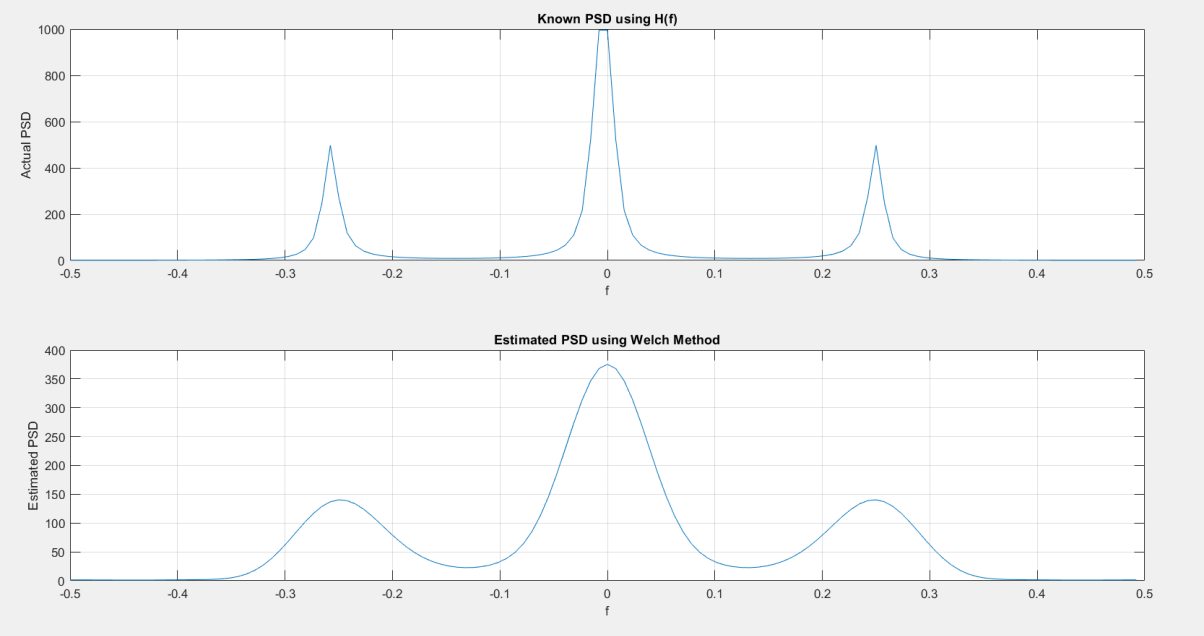
```
A = [1, -0.9, 0.81, -0.729]
```



A = [1, -0.8, 0.64, -0.512]



A = [1, -0.95, 0.9025, -0.8574]



(Due to network issues, overlapping part could not be done today.)

Code:

```
clc
clear all
close all

mean = 0;
std_dev = 3;
N = 128;
rng('default');
noise = std_dev.*randn(N,1) + mean;
denom = 0.9;
A = [1, -denom, denom^2, -denom^3];

X = filter(1, A, noise);
L = 8;
M = 16;
D = 0;
X_divs = zeros(L, M);

for ii = 1:L
   X_divs(ii,:) = X((1+(ii-1)*M):(M+(ii-1)*M));
end

n = 0:1:(M-1);
hamming = 0.54 - 0.46*cos(2*pi*n/(M-1));
U = (1/M)*sum(hamming.*hamming);

P_n = zeros(L, M);
for ii = 1:L
   P_n(ii,:) = X_divs(ii,:).*hamming;
end

f = -0.5:1/N:(0.5-(1/N));
cosine = 0; sine = 0;
P_f = zeros(L, N);

for ii = 1:L
   for F = 1:length(f)
      cosine = 0; sine = 0;
      for jj = 1:M
         cosine = cosine + cos(2*pi*f(F)*jj)*P_n(ii,jj);
         sine = sine + sin(2*pi*f(F)*jj)*P_n(ii,jj);
      end
      idx = floor((N - length(f))/2)+F;
      P_f(ii, idx) = (cosine^2 + sine^2)/(M*U);
   end
end

Pw_f = zeros(1, N);
for ii = 1:L
   Pw_f = Pw_f + P_f(ii,:);
end

Pw_f = Pw_f./L;

[H, W] =  freqz(1,A,N/2);

figure();
subplot(211);
```

```
l1 = (abs(H).^2).*std_dev^2;
l2 = flip(l1);
l = [l2' l1'];
plot(f, l);
grid on;
xlabel('f');ylabel("Actual PSD");title("Known PSD using H(f)");

subplot(212);
plot(f, Pw_f);
grid on;
xlabel('f');ylabel("Estimated PSD");title("Estimated PSD using Welch Method");
```