Digital Signal Processing Lab

Experiment 5

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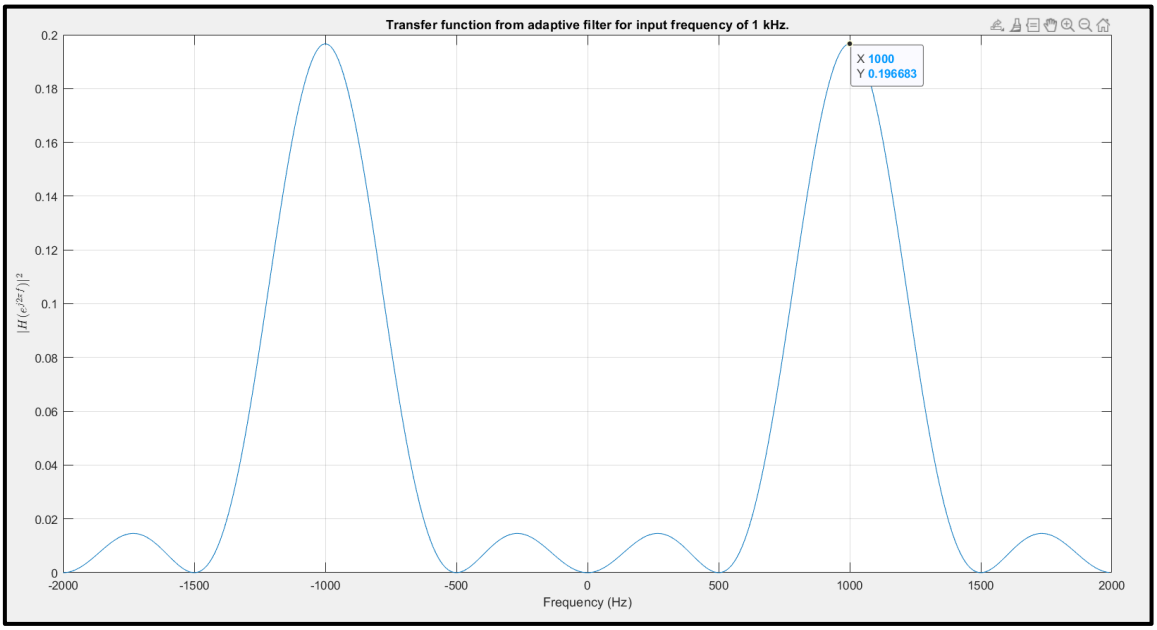
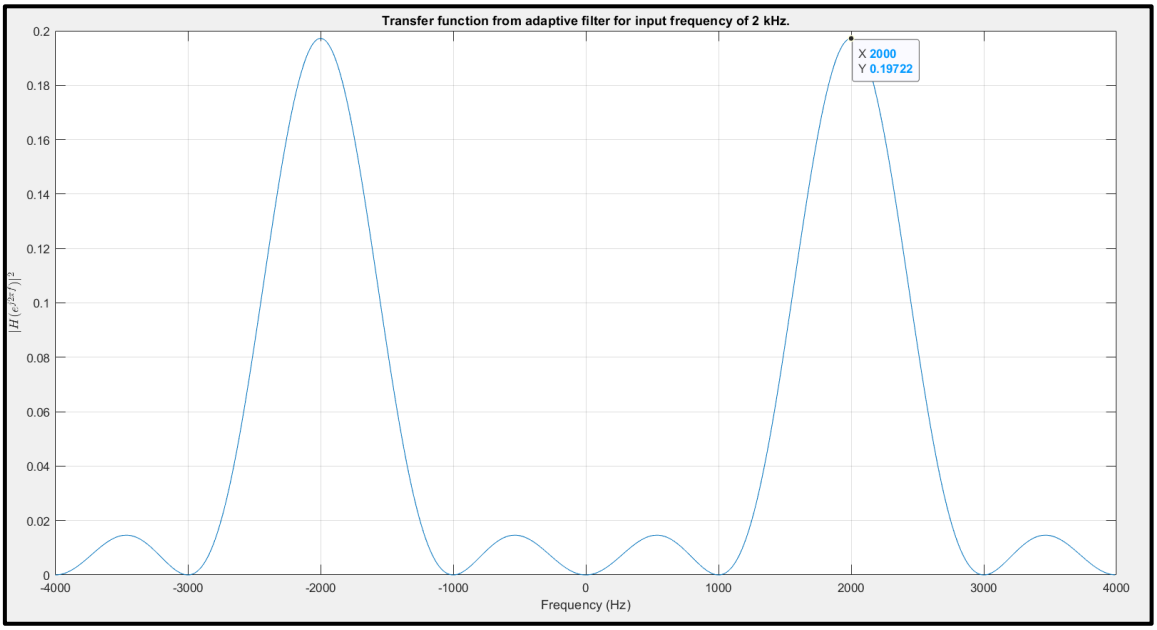
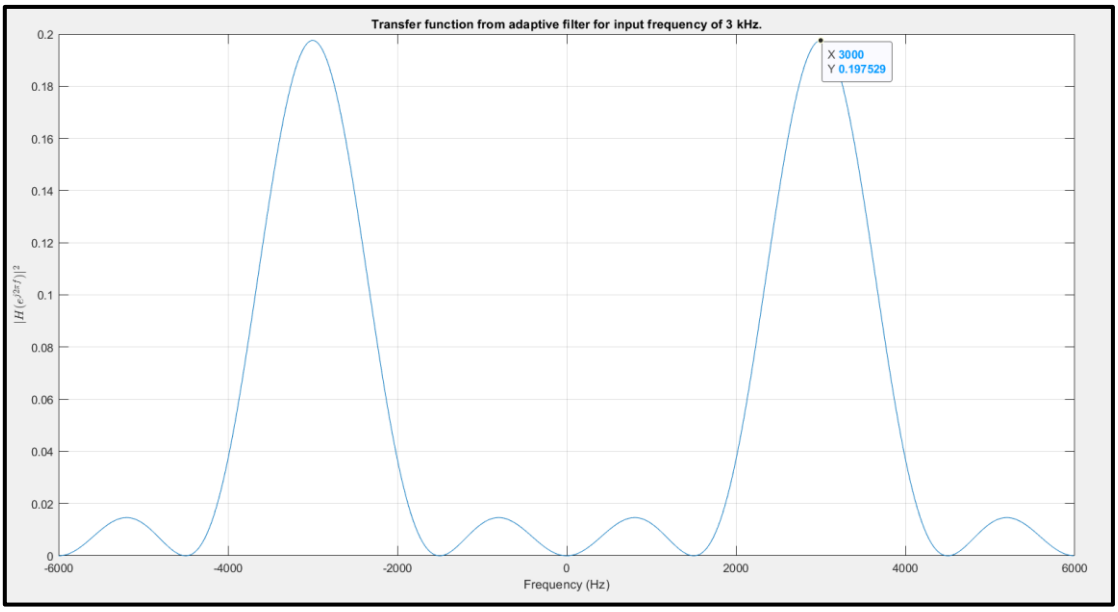
Aim:

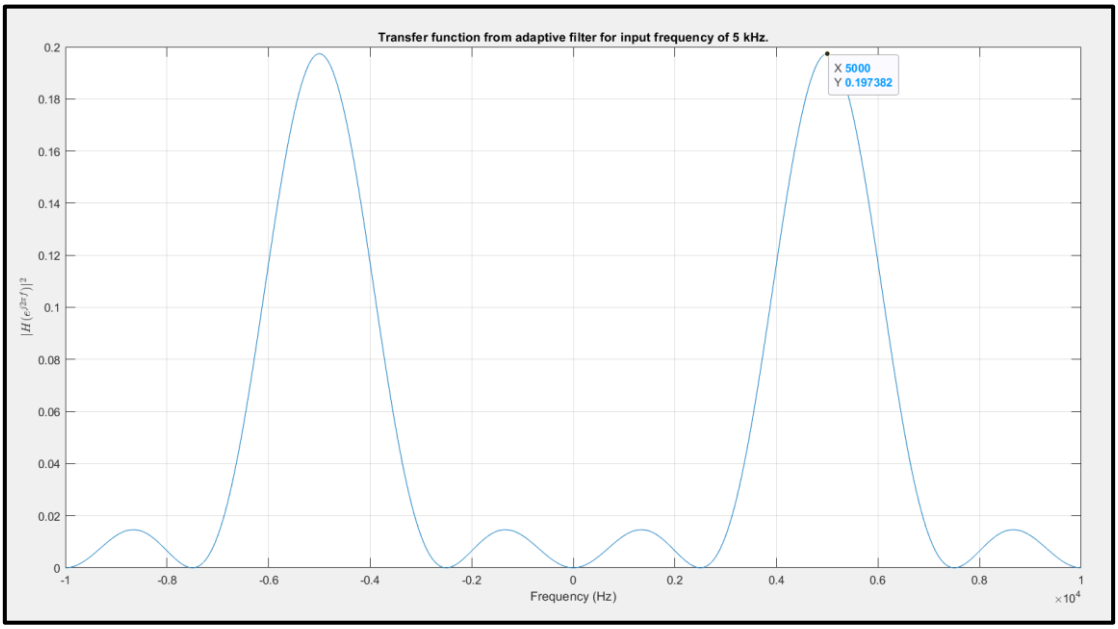
Designing an Adaptive Line Enhancer/Adaptive Filter

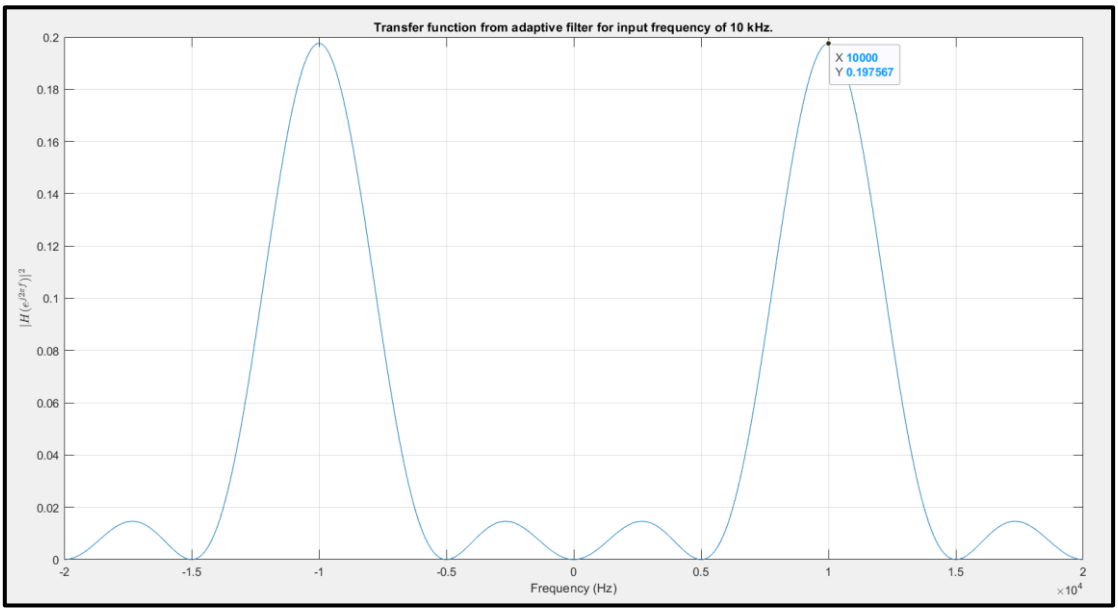
Plots:






Transfer function from adaptive filter for input frequency of 3 kHz.
X 3000
Y 0.197529
$|H(e^{j2\pi f})|^2$
Frequency (Hz)


Transfer function from adaptive filter for input frequency of 5 kHz.
X 5000
Y 0.197382
$|H(e^{j2\pi f})|^2$
Frequency (Hz)
$\times 10^4$


Transfer function from adaptive filter for input frequency of 10 kHz.
X 10000
Y 0.197567
$|H(e^{j2\pi f})|^2$
Frequency (Hz)
$\times 10^4$

Code:

```
clc
clear all
close all

for k = [1,2,3,5,10]
f = k*1000;
fs = 4*f;
t = 0:1/fs:0.1-1/fs;
N = length(t);
f_range = -fs/2:fs/N:fs/2-fs/N;
m = 8; mu = 1e-4; epsilon = 1e-6;

x = 2*sin(2*pi*f*t)';
h = zeros(m,1);

x_n = buffer(x, m, m-1);
x_n = flip(x_n, 1);

y = x_n'*h;
diff = (x-y);
error = zeros(m, N);
for ii = 1:N
    error(:, ii) = x_n(:, ii)*diff(ii);
end
update = sum(error,2);
h_new = h + mu*update/N;
change = sum((h_new-h).^2)/sum(h.^2);

while change >= epsilon
    h = h_new;
    y = x_n'*h;
    diff = (x-y);
    for ii = 1:size(x_n,2)
        error(:, ii) = x_n(:, ii)*diff(ii);
    end
    update = sum(error,2);
    h_new = h + mu*update/N;
    change = sum((h_new-h).^2)/sum(h.^2);
end

figure();
spectrum = fftshift(abs(fft(h, N)).^2);
[M, I] = max(spectrum);
fprintf("Maximum Value at f = %d Hz\n", abs(f_range(I)))
plot(f_range, spectrum);
grid on;
xlabel('Frequency (Hz)'); title("Transfer function from adaptive filter for input frequency of "+k+" kHz.")
ylabel('$|H(e^{j2\pi f})|^2$', 'Interpreter', 'latex');
end
```