Mikhail Grushko - BE110 - PSET 4

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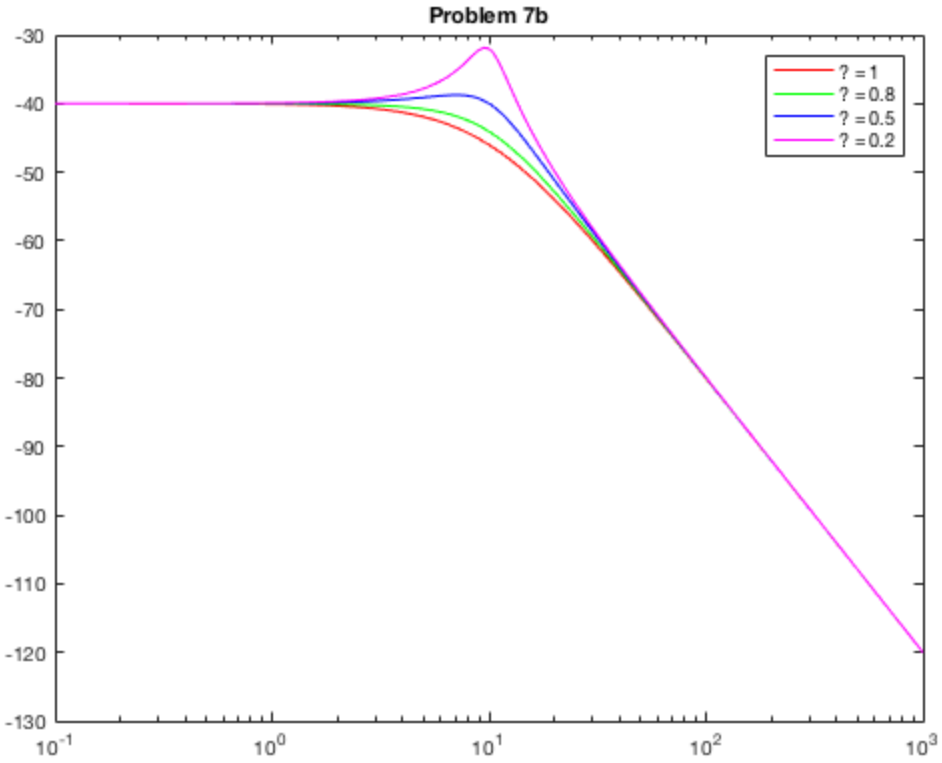
Cleanup

```
clearvars;
close all;
clc;
```

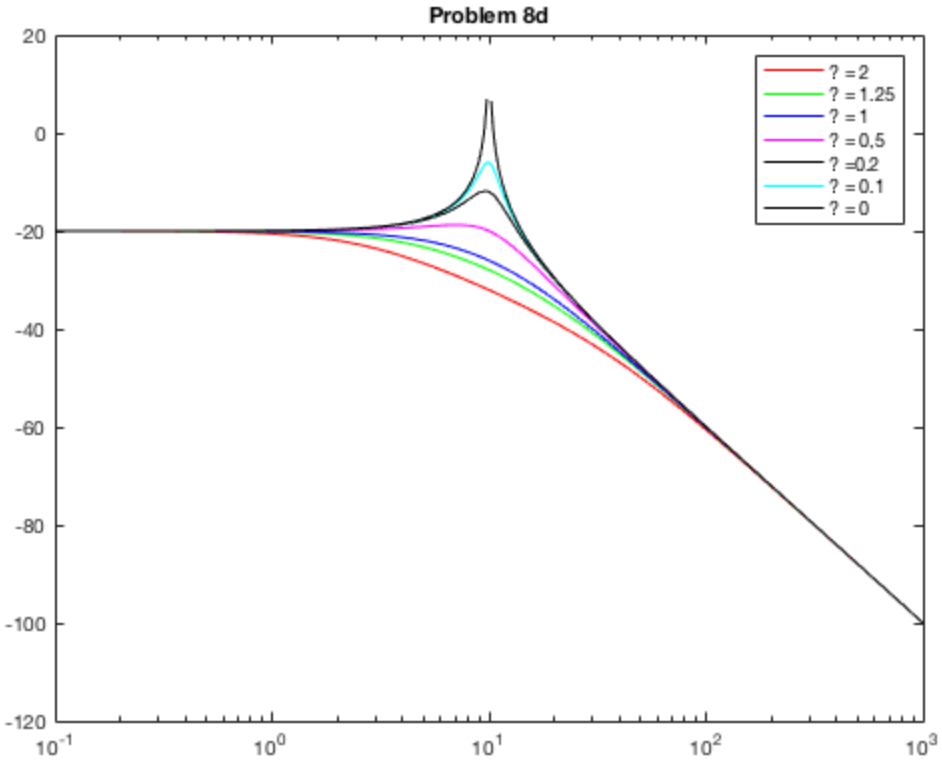
Problem 7b

```
j = sqrt(-1);
w = 10.^(-1 : 0.01 : 3);

w0 = 10;

zeta = [1, 0.8, 0.5, 0.2];

color = ['r', 'g', 'b', 'm'];

for i = 1 : 4
    H = 1./((j*w).^2+2*zeta(i)*w0*(j*w)+w0^2);
    Hdb=20*log10(abs(H));
    plot(w,Hdb,color(i));
    set(gca,'xscale','log')
    hold on;
end
title('Problem 7b');
legend('? = 1', '? = 0.8', '? = 0.5', '? = 0.2');
```



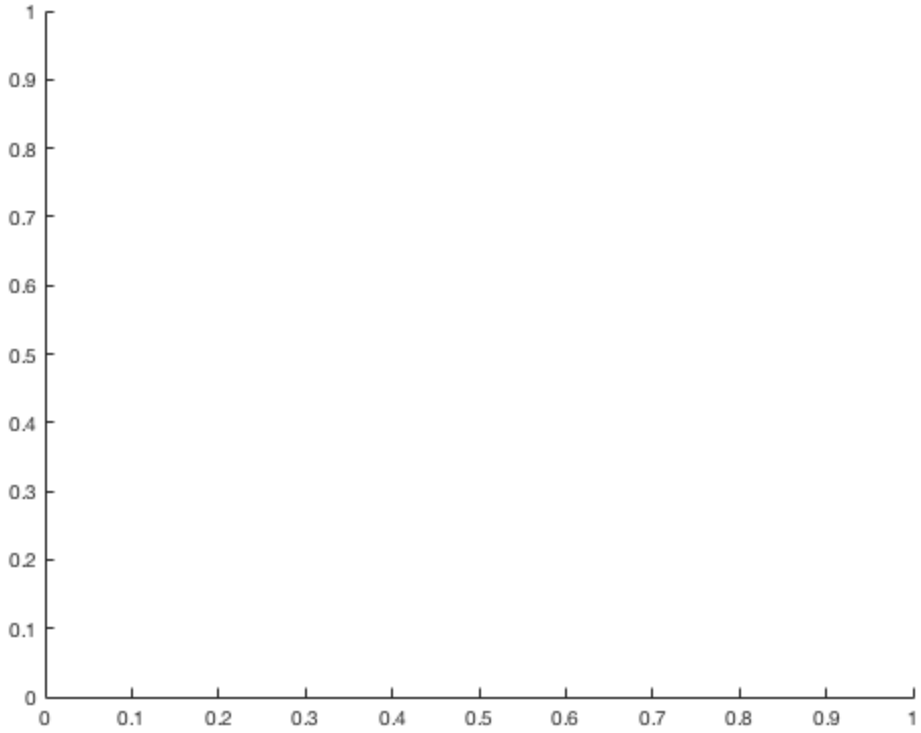
Problem 8d

```
zeta = [2, 1.25, 1, 0.5, 0.2, 0.1, 0];
b = zeta*2*0.1*10;
j = sqrt(-1);
w = 10.^(-1 : 0.01 : 3);
color = ['r', 'g', 'b', 'm', 'k', 'c', 'k'];

figure;
for i = 1 : 7
    H=1./(0.1*(j*w).^2+b(i)*(j*w)+10);
    Hdb=20*log10(abs(H));
    plot(w,Hdb,color(i));
    set(gca,'xscale','log');
    hold on;
end
title('Problem 8d');
legend('? = 2', '? = 1.25', '? = 1', '? = 0,5', '? =0.2', '? = 0.1'
 , '? = 0');
```



Problem 8e

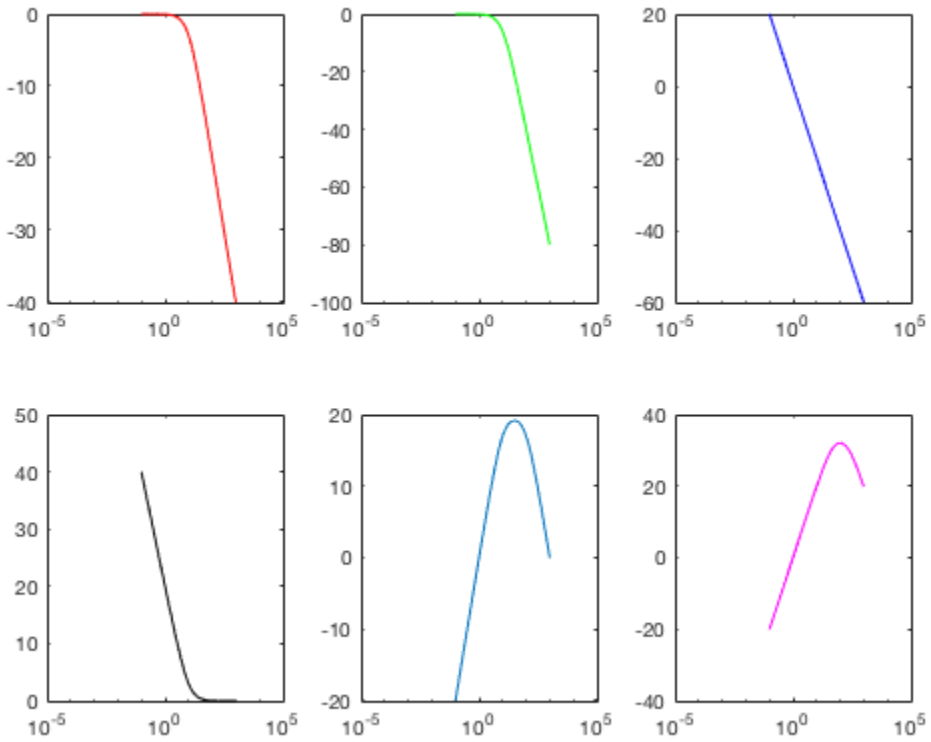
```
figure;
for i = 1 : 7
    H=tf(1./(0.1*(j*w).^2+b(i)*(j*w)+10));
    Y = step(H);
%     plot(t,Y,color(i));
    hold on;
end
```



Problem 9

```
w = 10.^(-1 : 0.01 : 3);
figure;
subplot(2,3,1);
H=1./(j*w/10+1);
Hdb=20*log10(abs(H));
plot(w,Hdb,'r');
set(gca,'xscale','log')% define H & make the plot

subplot(2,3,2);
H=1./(j*w/10+1).^2;
Hdb=20*log10(abs(H));
plot(w,Hdb,'g');
set(gca,'xscale','log')% define H & make the plot

subplot(2,3,3);
H=1./(j*w);
Hdb=20*log10(abs(H));
plot(w,Hdb,'b');
set(gca,'xscale','log')% define H & make the plot

subplot(2,3,4);
H=(10./(j*w))+1;
Hdb=20*log10(abs(H));
```

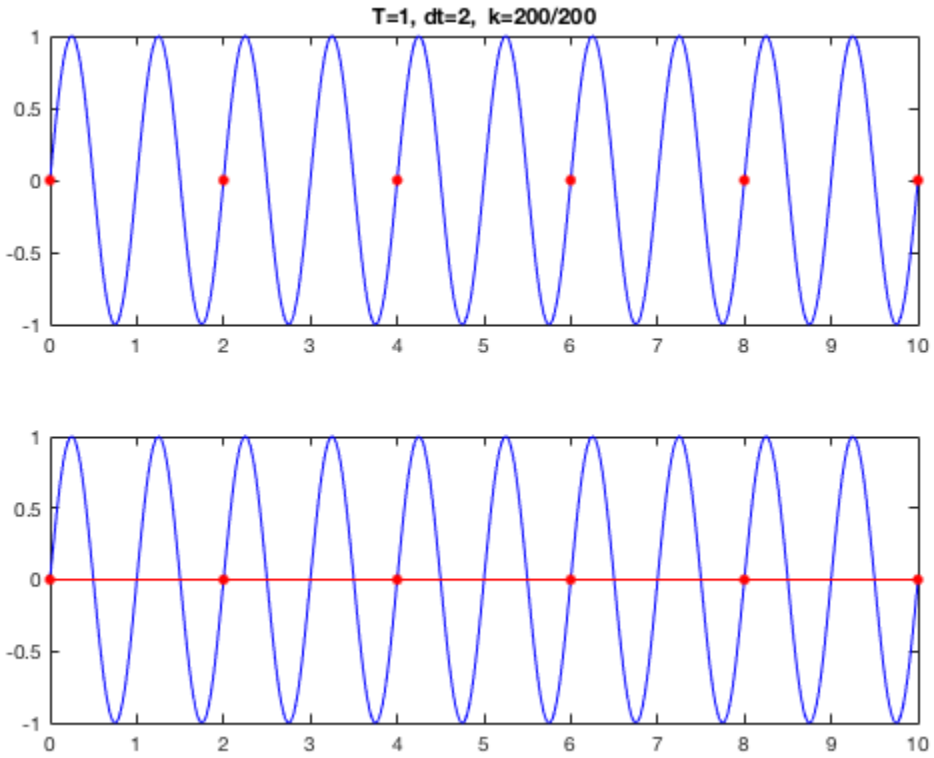
```
plot(w,Hdb,'k');
set(gca,'xscale','log')% define H & make the plot

subplot(2,3,5);
H=(j*w)./(((j*w./10) + 1).*((j*w./100) + 1));
Hdb=20*log10(abs(H));
plot(w,Hdb);
set(gca,'xscale','log')% define H & make the plot

subplot(2,3,6);
H=(j*w)./(((j*w./50) + 1).*((j*w./200) + 1));
Hdb=20*log10(abs(H));
plot(w,Hdb,'m');
set(gca,'xscale','log')% define H & make the plot
```



Problem 10a

```
figure;
t=0:.01:10;
x=sin(2*pi*t);
% define t with an initial sampling interval dt=0.01 and define x(t)to
 have
% period=1
for k=1:200
% for loop that incrementally changes the sampling interval
    is=1:k:length(t);
```

```
    ts=t(is);
    xs=x(is);
    %set the new dt tok*dt&then plot the original x (blue) and the
 sampled x(red)
    subplot(211);
    plot(t,x,'-b',ts, xs,'.r','markersize',16);
    title(['T=1, dt=',num2str(k*0.01), ',  k=',num2str(k),'/200']);
    subplot(212); plot(t,x,'-b',ts, xs,'.-r','markersize',16); pause
    % hit the SPACEBAR to advance to next plot
end
% this code flips thorough sampling rates.  The lower plots is the
 same as
% the upperbut with the reddots connected
```

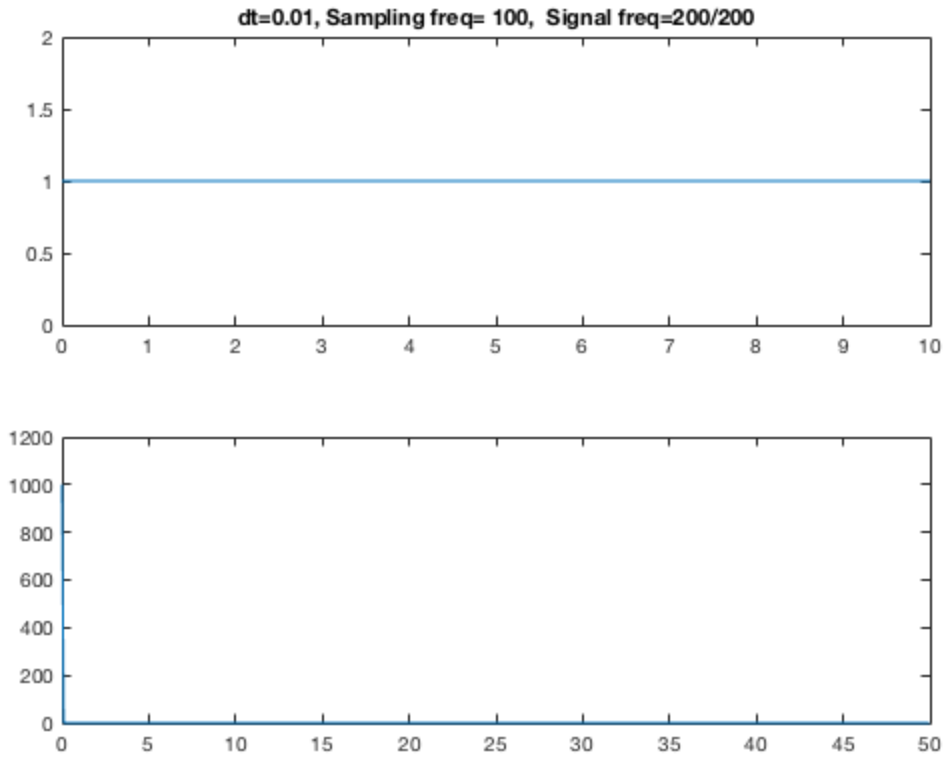


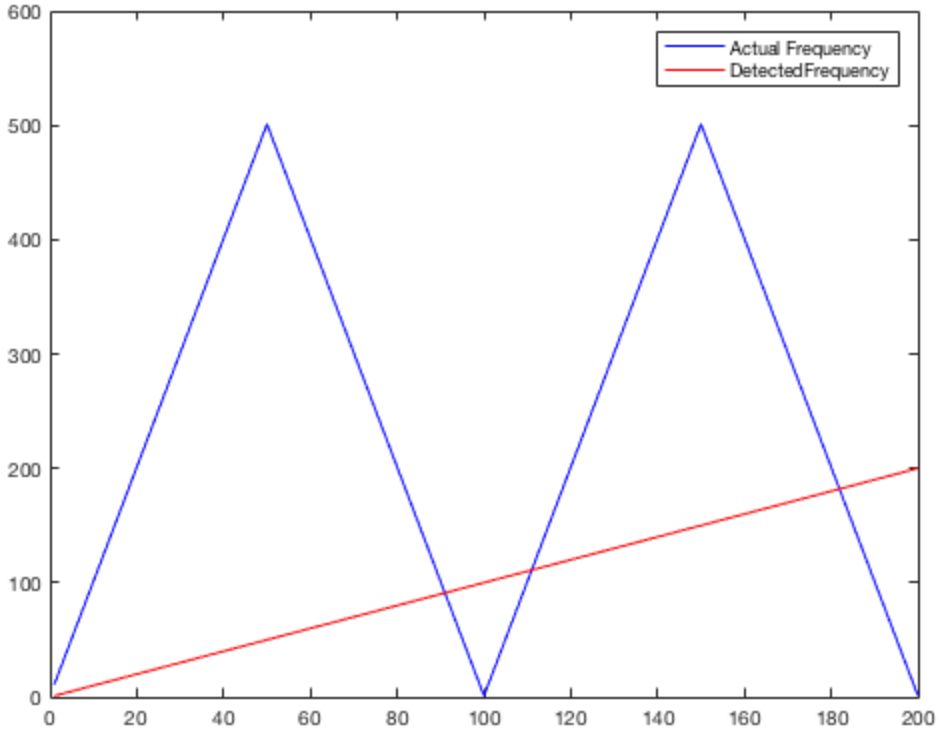
10a: As I am flipping through the sampling frequencies, I observe the effect known as aliasing. Aliasing is generally observed in the Discrete-Time Fourier Transform, where only a single fundamental sampling frequency ω_o. At higher ω_o (significantly higher than period T), the DTFT does an accurate job of representing the original wave. However, at $\omega_o = 0.5T$, aliasing effect begins to occur, due to the fact that one cannot unambiguously interpret the samples, creating multiple signals that are aliases of each other (i.e. all of the aliases can produce the sampling obtained).

Problem 10b

```
figure;
dt=0.01;
t=0:dt:10;
```

```
N=length(t);
% define t with a sampling interval dt=0.001
for k=1:200
% for loop that incrementally changes the frequency
    x=cos(2*pi*k*t);
 %set the new frequencytok
 subplot(211);
 plot(t,x);
 title(['dt=0.01, Sampling freq= 100,  Signal
 freq=',num2str(k),'/200']);
 % plot x(t)
 X=fft(x);
 X=X(1:round(N/2)); f=(0:round(N/2)-1)/(N*dt);
 % findthe DFT of x(t) thenremove the redundant freqs
 subplot(212);
 plot(f,abs(X));% plot X(f)in the lowerplot
 f_actual(k)= k;
 f_detected(k)= find(X == max(X(:)));; %MODIFY THIS LINE
    pause;
 % pressthe SPACEBAR to advance to next frame(or hold it downto
 advance rapidlly)\
end

figure;
plot(f_actual, f_detected, '-b',f_actual, f_actual, '-r');
legend({'Actual Frequency','DetectedFrequency'})
```





This is another way of demonstrating the aliasing problem when doing the Discrete-Time Fourier Transform. However, this time we're exploring DTFTs at different signal ω_o, but the same sampling frequency. What happens as we move towards higher signal frequencies, we see repeating frequencies, which is a sign of aliasing. The pattern also follows the Nyquist law, which states that a signal must be sampled at a rate greater twice as ω_o.

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