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Project 3

**Introduction:**

This report will detail the computation of the Fourier transform of the following function:

$$x(t) = e^\wedge(-2t) * u(t)$$

These calculations were done utilizing MATLAB. Once we calculate the Fourier transform, we also utilized MATLAB to get the amplitude plot and phase plot.

**Process:**

First and foremost we must calculate the Fourier transform. The formula for Discrete Time Fourier transform is as follows:

$$\text{Discrete FT (DFT)}$$
$$X(k) = \sum_{n=0}^{N-1} x(n) e^{-j\omega_k n}$$
$$k = 0, 1, \ldots, N-1$$

In Matlab, however, we utilize the command fft() to take the DFT of our function, x(t). The code and its comments can be seen below:

```
%Knowing |X(w)| =(approx)= 1/w
T_0 = 4; %Choosen because X(4) = e^-8 wgucg is nearly 0 and N0 = T0=T = 254.6
N_0 = 256;%So doing some even rounding by a factor of 1/64 I chose 4 and 256.
T = T_0/N_0;%Basic equation for T
t = (0:T:T*(N_0-1))';%range for t
x = T*exp(-2*t);
x(1) = T*(exp(-2*T_0)+1)/2;
X_r = fft(x); %Using fft command to solve this DFT
r = [-N_0/2:N_0/2-1]';
omega_r = r*2*pi/T_0;
omega = linspace (-pi/T,pi/T,4097); %limits for graph
X = 1./(j*omega+2);

%Plotting Amplitude
subplot (211);
plot(omega, abs (X), 'k', omega_r, fftshift (abs(X_r)), 'ko');
xlabel ('\omega'); ylabel ('|X(\omega)|')
axis ([-0.01 40 -0.01 0.51]);

%plotting phase, the difference from amplitude being angle() instead of
%abs() command being utilized.
subplot (212);
plot(omega, angle(X)*180/pi, 'k', omega_r, fftshift (angle(X_r)*180/pi));
xlabel ('\omega'); ylabel ('\angle H[e^{j \omega}] [deg]');
```

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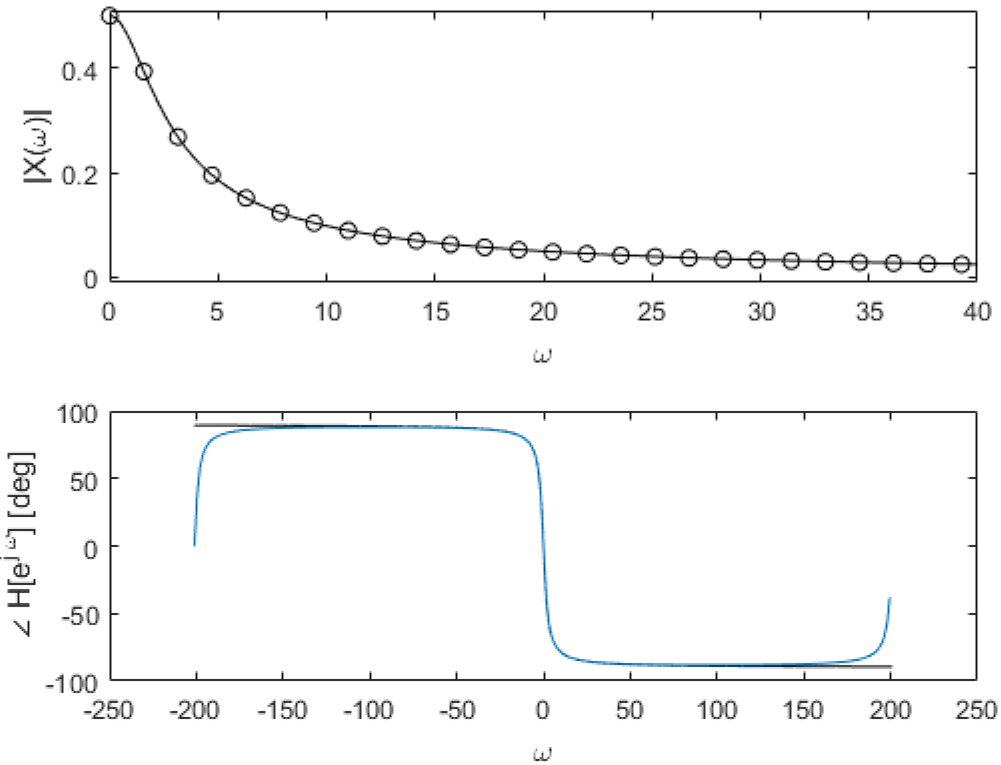
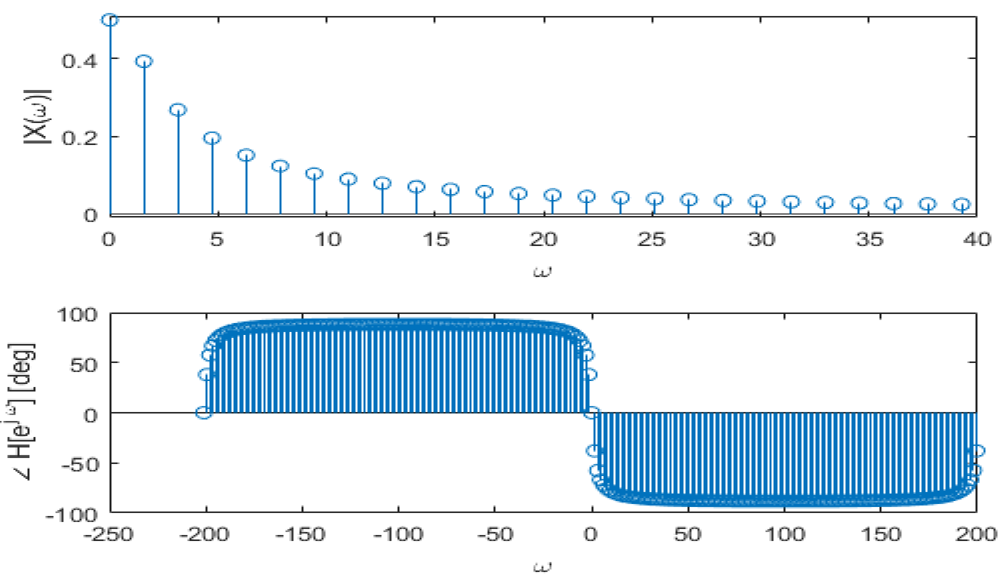
This code results in the following graphs:




From the respective plots of our functions amplitude (top) and its phase (bottom), we can see what indeed looks like the response of our functions DFT. The amplitude graph relates closely to the actual functions normal plot, as it asymptomatically approaches 0 on the Omega axis.



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Similarly, we can see the respective amplitude and phase plots with the stem() command are looking proper as well. We have a distinctive jump of discontinuity at T = 0 at .5. From these spectra we can see we have a clearly perfect agreement between the two sets of data.