MATLAB Homework #2

Sean Hwang

00280-85752

ECE 538

Digital Signal Processing I

Fall 2020

(A) $h_0^{(2)}[n] = \frac{1}{\sqrt{2}}\{1, 1\}$ and $h_1^{(2)}[n] = \frac{1}{\sqrt{2}}\ \{1, -1\}$.

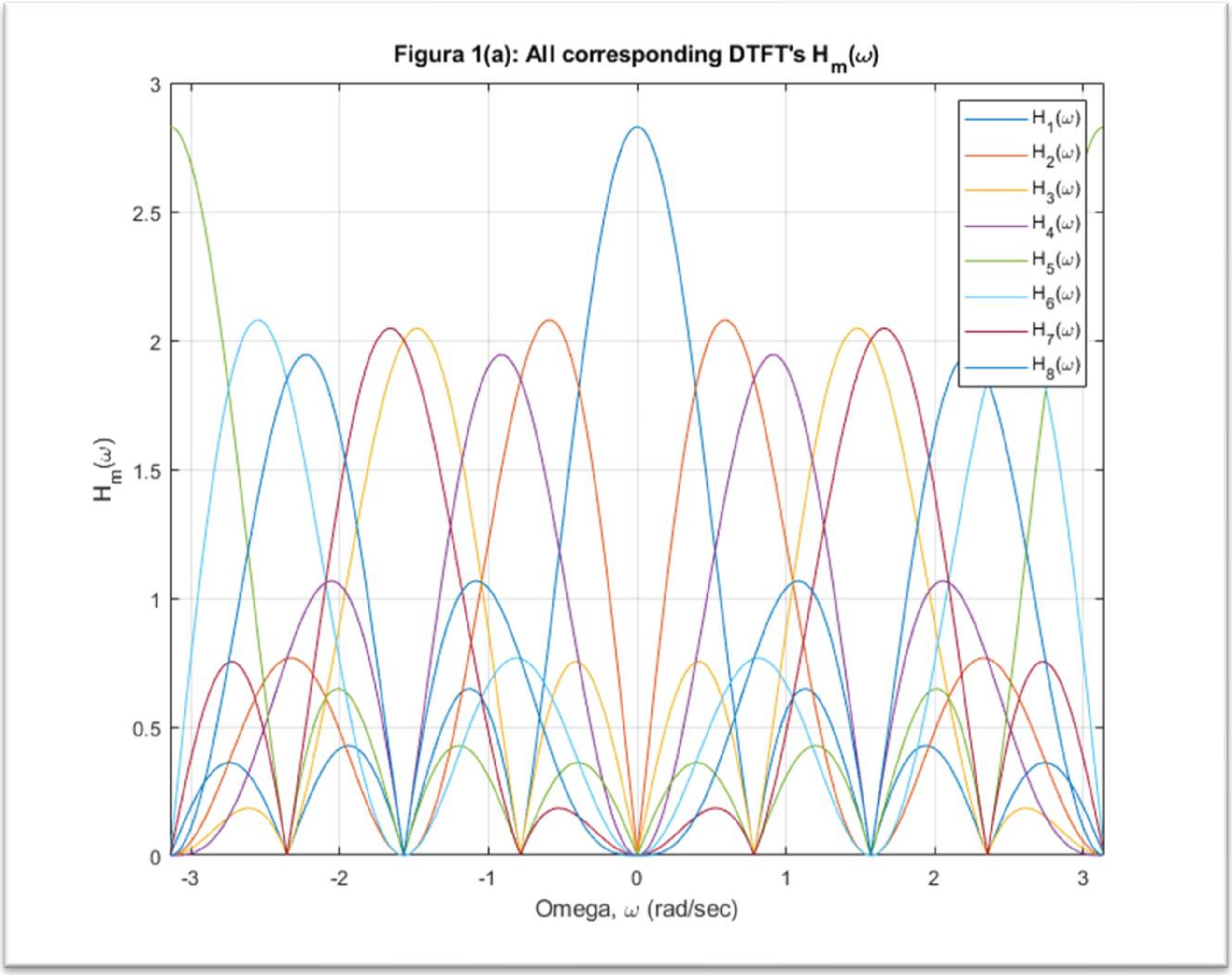

Figure 1(a): All corresponding DTFT's $H_m(\omega)$

1	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	0	1	0	0	0	0	0
0	0	0	1	0	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	1

Table 1: 8x8 matrix of HH^H

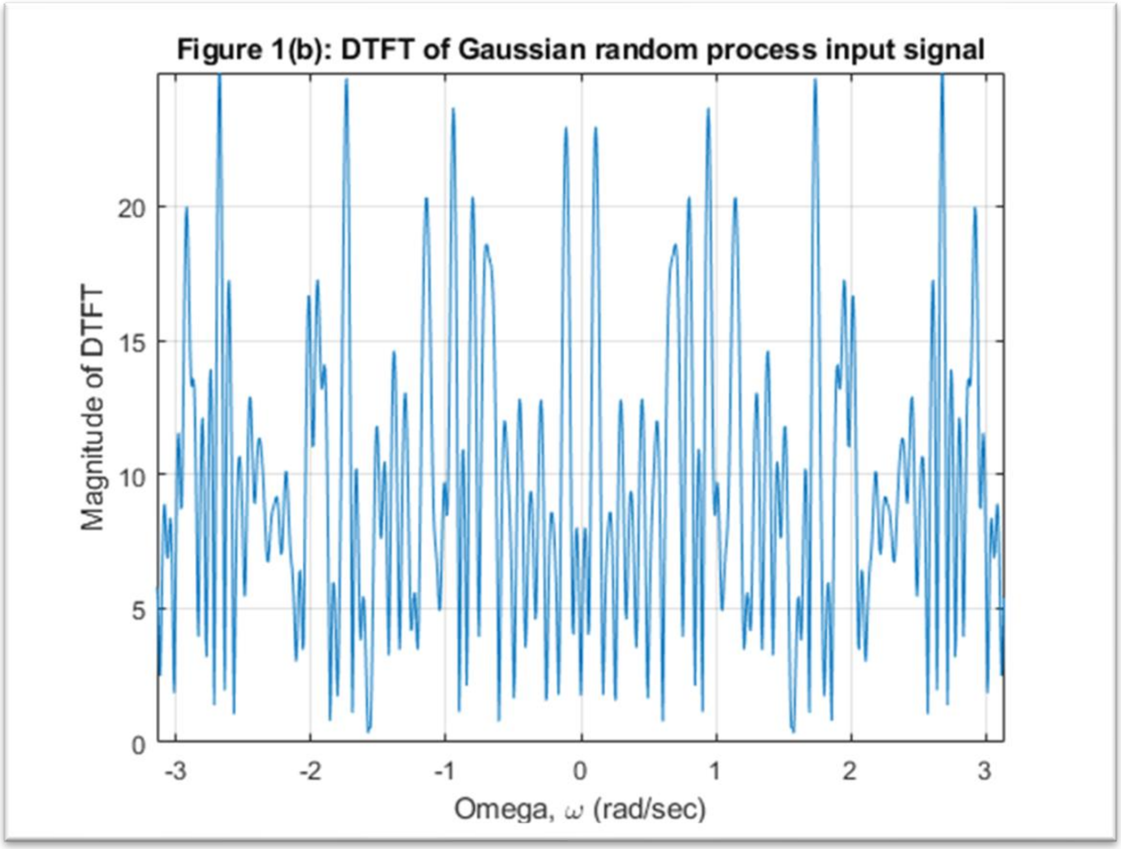

Figure 1(b): DTFT of Gaussian random process input signal

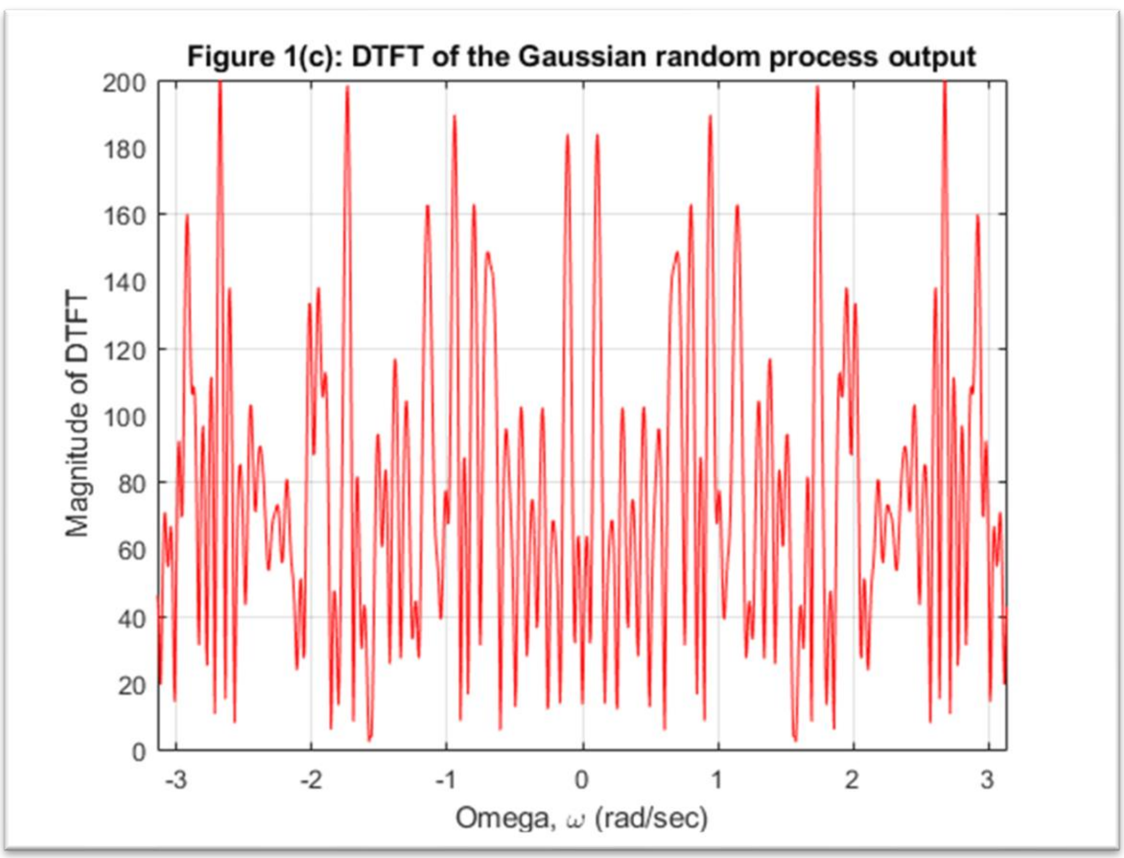

Figure 1(c): DTFT of the Gaussian random process output

(B) $h_0^{(2)}[n] = h_{sr}[n-16]$, $n = 0, 1, ..., 31$, $h_1^{(2)}[n] = (-1)^n h_0^{(2)}[n]$, and $\beta = 0.35$ where

$$h_{sr}[n] = \sqrt{2}\left\{\frac{2\beta\cos[(1+\beta)\pi(n+.5)/2]}{\pi[1-4\beta^2(n+.5)^2]} + \frac{\sin[(1-\beta)\pi(n+.5)/2]}{\pi[(n+.5)-4\beta^2(n+.5)^3]}\right\}, n = -16, ..., 1, ..., 15.$$

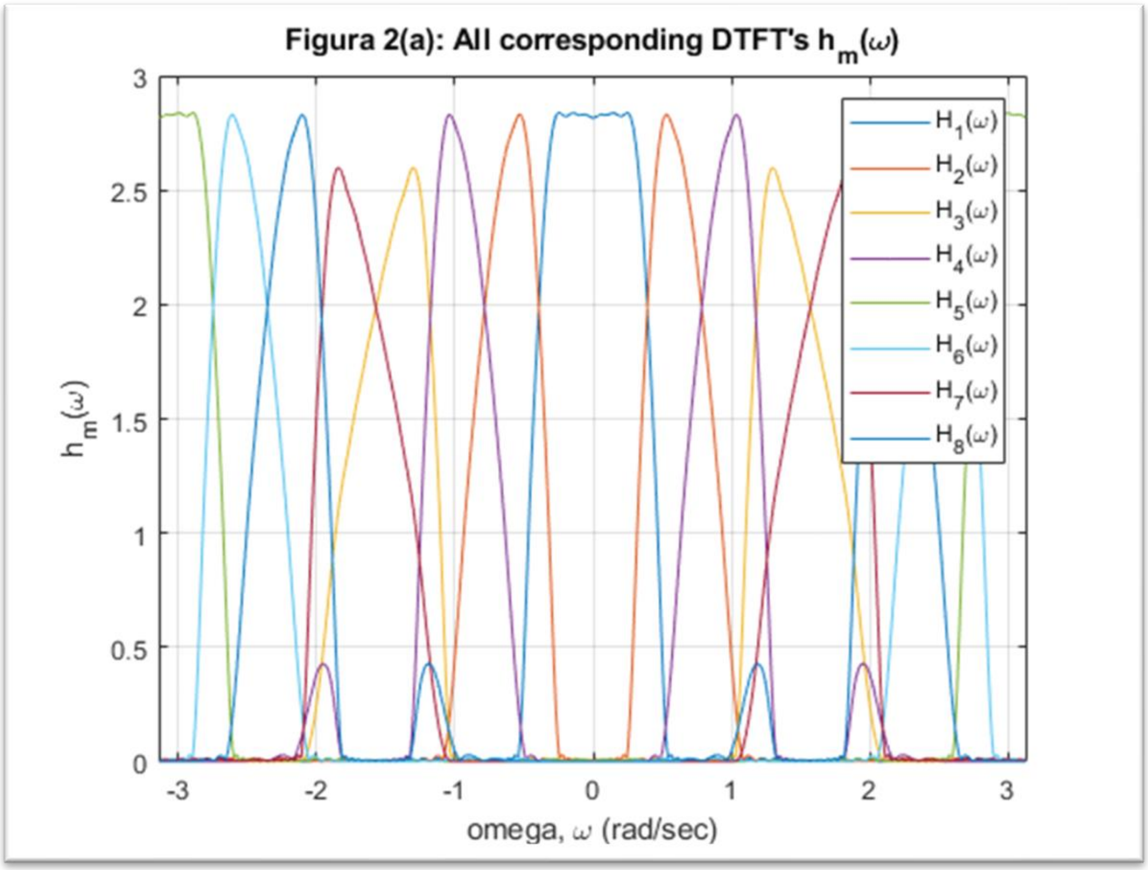

Figure 2(a): All corresponding DTFT's $H_m(\omega)$

1.000002	-4.77E-17	-2.13E-17	7.03E-07	2.15E-16	3.47E-17	-8.43E-17	-1.79E-17
-4.77E-17	0.999864	-7.03E-07	1.11E-16	3.47E-17	6.27E-17	-3.93E-17	-5.70E-17
-2.13E-17	-7.03E-07	1.000164	9.79E-18	-8.43E-17	-3.93E-17	2.03E-16	-1.21E-17
7.03E-07	1.11E-16	9.79E-18	0.999511	-1.79E-17	-5.70E-17	-1.21E-17	-4.44E-17
2.15E-16	3.47E-17	-8.43E-17	-1.79E-17	1.000002	-4.77E-17	-2.13E-17	7.03E-07
3.47E-17	6.27E-17	-3.93E-17	-5.70E-17	-4.77E-17	0.999864	-7.03E-07	1.11E-16
-8.43E-17	-3.93E-17	2.03E-16	-1.21E-17	-2.13E-17	-7.03E-07	1.000164	9.79E-18
-1.79E-17	-5.70E-17	-1.21E-17	-4.44E-17	7.03E-07	1.11E-16	9.79E-18	0.999511

Table 2: 8x8 matrix of HH^H for B

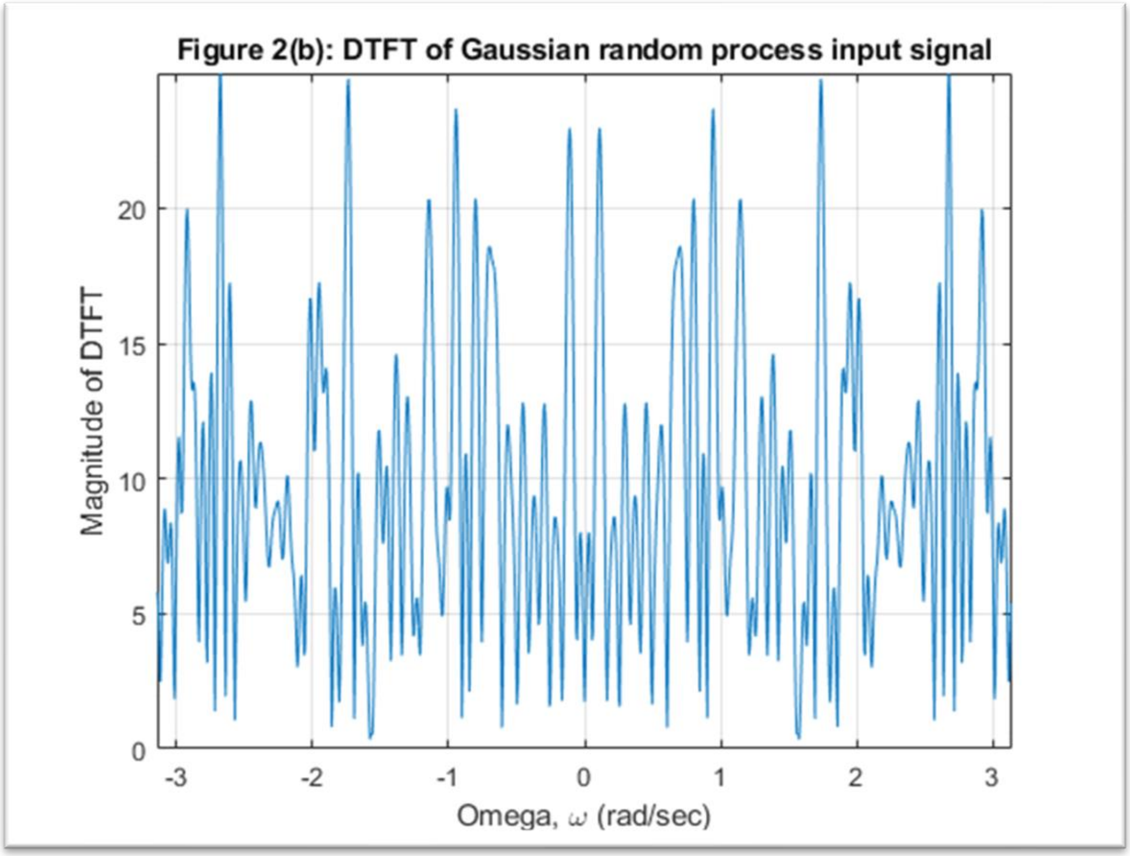

Figure 2(b): DTFT of Gaussian random process input signal

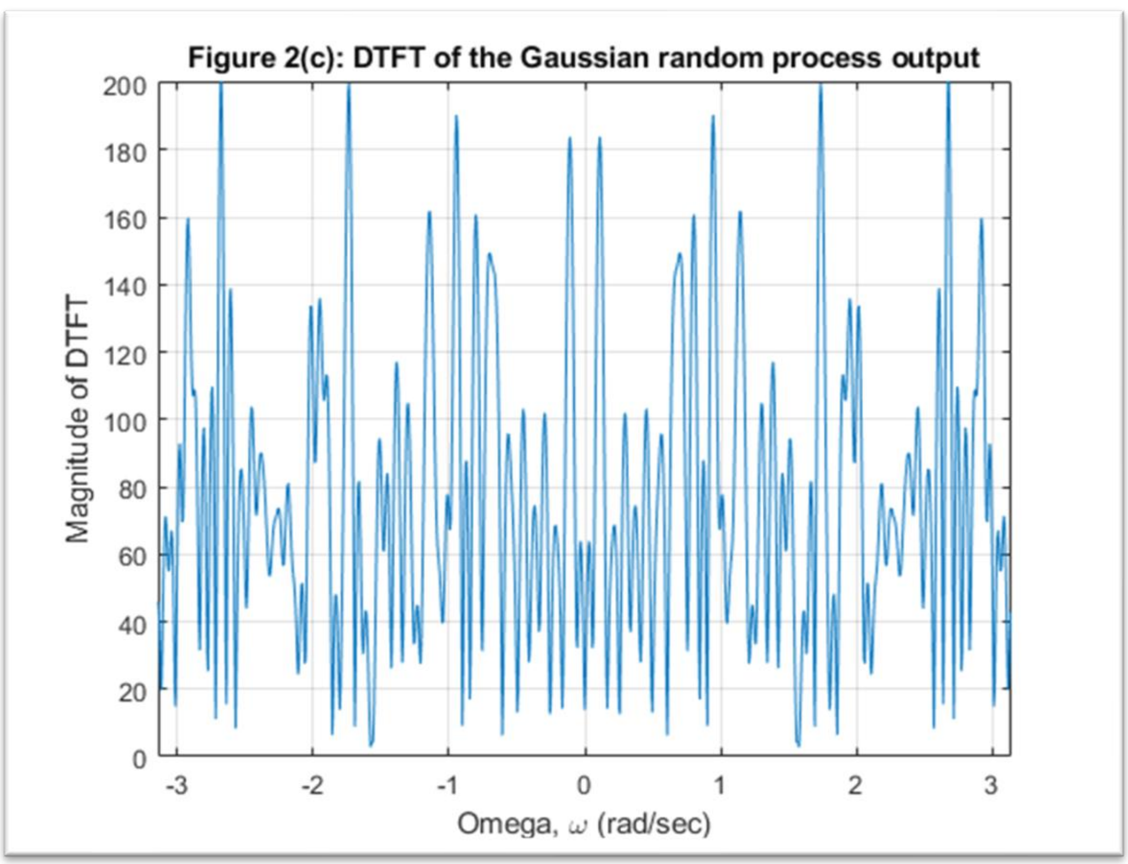

Figure 2(c): DTFT of the Gaussian random process output

(C) $h_0^{(2)}[n] = h_{sr}[n-24]$, $n = 0, 1, ..., 47$, $h_1^{(2)}[n] = (-1)^n h_0^{(2)}[n]$, and $\beta = 0.1$ where

$$h_{sr}[n] = \sqrt{2}\left\{\frac{2\beta\cos[(1+\beta)\pi(n+.5)/2]}{\pi[1-4\beta^2(n+.5)^2]} + \frac{\sin[(1-\beta)\pi(n+.5)/2]}{\pi[(n+.5)-4\beta^2(n+.5)^3]}\right\}, n = -24, ..., 1, ..., 23.$$

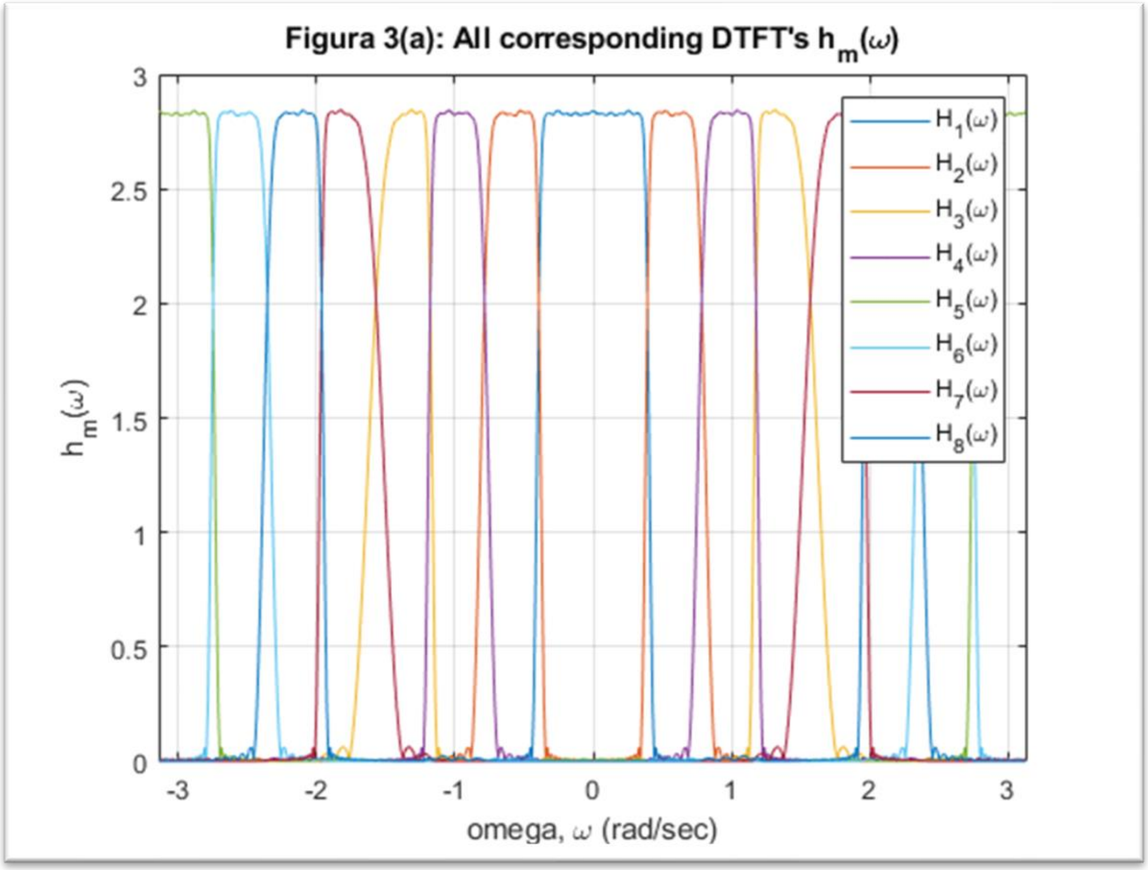

Figure 3(a): All corresponding DTFT's $H_m(\omega)$

0.999892	-2.50E-16	2.91E-16	3.64E-07	-4.86E-17	6.94E-18	2.78E-17	-8.67E-17
-2.50E-16	0.999822	-3.64E-07	1.67E-16	6.94E-18	-3.89E-16	6.94E-18	6.94E-17
2.91E-16	-3.64E-07	0.999833	2.78E-17	5.55E-17	-4.16E-17	1.11E-16	5.55E-17
3.64E-07	1.67E-16	2.78E-17	0.999095	-8.67E-17	6.94E-17	4.16E-17	6.07E-17
-4.86E-17	6.94E-18	5.55E-17	-8.67E-17	0.999892	-2.50E-16	2.91E-16	3.64E-07
6.94E-18	-3.89E-16	-4.16E-17	6.94E-17	-2.50E-16	0.999822	-3.64E-07	-5.55E-17
2.78E-17	6.94E-18	1.11E-16	4.16E-17	2.91E-16	-3.64E-07	0.999833	-8.33E-17
-8.67E-17	6.94E-17	5.55E-17	6.07E-17	3.64E-07	-5.55E-17	-8.33E-17	0.999095

Table 2: 8x8 matrix of HH^H for C

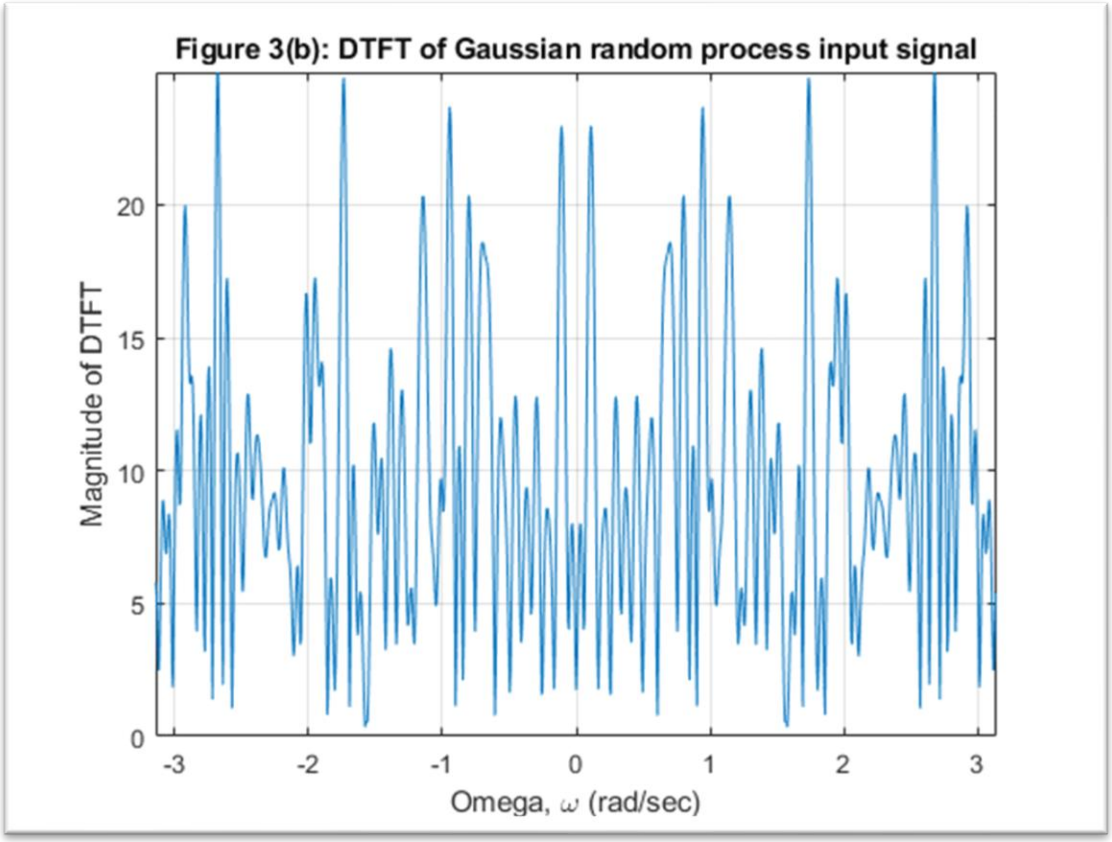

Figure 3(b): DTFT of Gaussian random process input signal

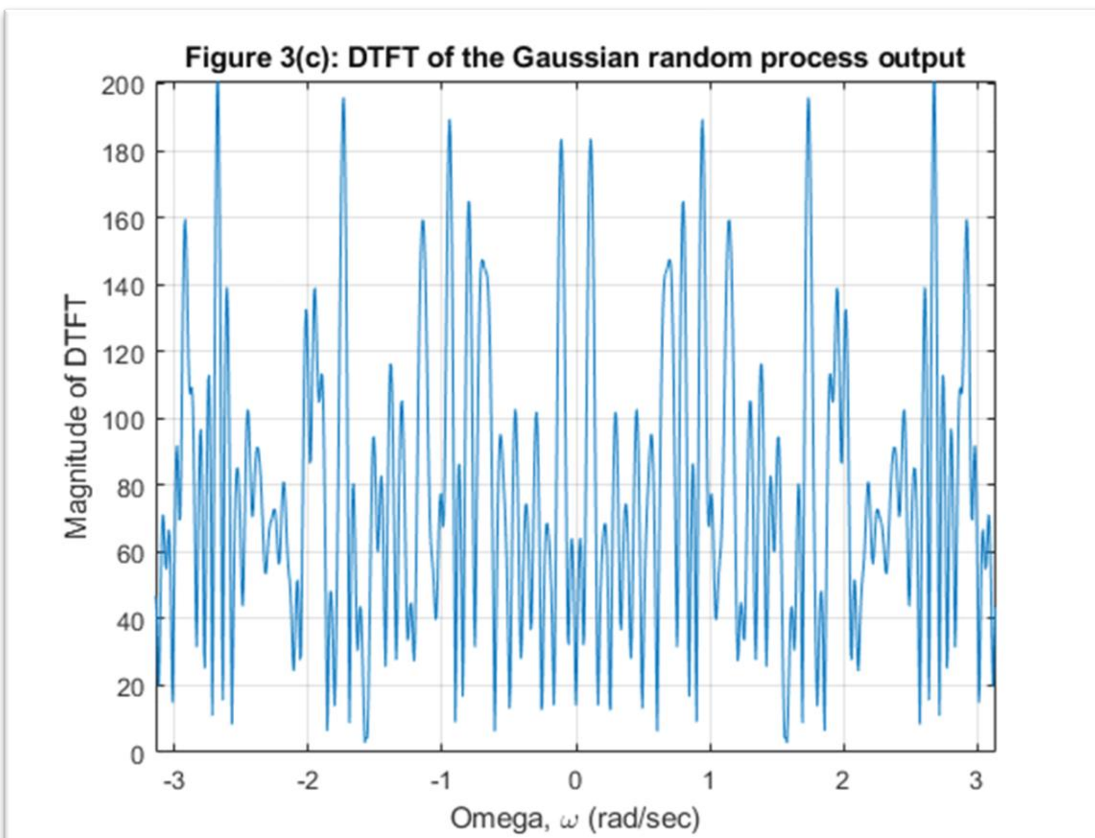

Figure 3(c): DTFT of the Gaussian random process output

Observations and conclusion from the experiment:

The computer experiment was conducted successfully, and a M=8 channel perfect reconstruction filter bank was synthesized from a three stage three-structured PR filter bank. The biggest, and most obvious observation that I was able to make from this experiment was that the DTFT magnitude from the output of filter was 8 times greater than the gaussian random process signal that was inputted to the filter. This is a definitive proof that the three stage tree-structured PR filter bank was successfully synthesized to an M=8 channel uniform PR filter bank according to Noble's Identity. The plot of DTFT of the input signal and the output have an identical shape, but the two plots only differ in the magnitude of signal with output amplified to the factor of 8.

Part D

i) Problem 2 from Exam 3 for Fall 2015
ii) Problem 1 from Final Exam for Fall 2011