**2)**

Below are results for the Fourier transform of the function, where the analytic solution has been computed for a given using the complex integration technique, and the numeric solution has been computed using the Fast Fourier Transform. The FFT was computed using N points, and the integration was performed over the range [-L, L]. For the values presented below, N was set to 2^14, and L was set to 2^11. As one would expect, given the properties of the FFT, the greatest error is found at In order to reduce this error, a very large range over which the integration is performed is required. This necessitates a large N as well, as it was found that must be less than unity for the solution to be accurate, where.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Analytic Solution | Numeric Solution | Percent Error |
| 0.000 | 3.1416 | 3.1406 | -0.0311 |
| 0.002 | 3.1368 | 3.1369 | 0.0036 |
| 0.003 | 3.1320 | 3.1319 | -0.0013 |
| 0.005 | 3.1272 | 3.1272 | 0.0006 |
| 0.006 | 3.1224 | 3.1224 | -0.0004 |
| 0.008 | 3.1176 | 3.1176 | 0.0002 |
| 0.009 | 3.1128 | 3.1128 | -0.0002 |
| 0.011 | 3.1080 | 3.1080 | 0.0001 |
| 0.012 | 3.1033 | 3.1033 | -0.0001 |
| 0.014 | 3.0985 | 3.0985 | 0.0001 |
| 0.015 | 3.0938 | 3.0938 | -0.0001 |
| 0.017 | 3.0890 | 3.0890 | 0.0001 |
| 0.018 | 3.0843 | 3.0843 | 0.0000 |
| 0.020 | 3.0796 | 3.0796 | 0.0000 |
| 0.021 | 3.0748 | 3.0748 | 0.0000 |
| 0.023 | 3.0701 | 3.0701 | 0.0000 |
| 0.025 | 3.0654 | 3.0654 | 0.0000 |
| 0.026 | 3.0607 | 3.0607 | 0.0000 |
| 0.028 | 3.0560 | 3.0560 | 0.0000 |
| 0.029 | 3.0514 | 3.0514 | 0.0000 |
| 0.031 | 3.0467 | 3.0467 | 0.0000 |
| 0.032 | 3.0420 | 3.0420 | 0.0000 |
| 0.034 | 3.0373 | 3.0373 | 0.0000 |
| 0.035 | 3.0327 | 3.0327 | 0.0000 |
| 0.037 | 3.0280 | 3.0280 | 0.0000 |
| 0.038 | 3.0234 | 3.0234 | 0.0000 |
| 0.040 | 3.0188 | 3.0188 | 0.0000 |
| 0.041 | 3.0141 | 3.0141 | 0.0000 |

# Matlab Code

%Written by Michael Crawley for ME 818, HW #4, Problem #2

clear;clc;

fun = @(x) 1./(1+x.^2);

funhatanalytic = @(xi) pi\*exp(-abs(xi));

N = 2^14;

L = 2^11;

omega = pi\*N/2/L;

dx = 2\*L/(N);

x = -L:dx:L-dx;

dxi = 2\*pi/N/dx;

xi = -omega:dxi:omega-dxi;

f = fun(x);

k = 0:(N-1);

fhatnum = f\*(dx\*((-1).^k)'\*((-1).^k).\*exp(-2\*pi\*1i\*(k'\*k)/N));

% plot(xi,abs(fhatnum),xi,funhatanalytic(xi)); xlim([-10 10]);

I = N/2+1:N/2+41;

fid=fopen('H4P4.txt','w');

fprintf(fid,['ME 818 Homework 4, Problem 2\nCompleted by Michael Crawley on ',date,'\n']);

fprintf(fid,'N = %d, L = %d\n',[N; L]);

fprintf(fid,'\nxi\t\tNumeric Soln\tAnalytic Soln\tPercent Error\n');

fprintf(fid,'%1.3f\t\t %3.4f\t\t %3.4f\t\t %3.4f\n',[xi(I); fhatnum(I); funhatanalytic(xi(I));100\*(fhatnum(I)-funhatanalytic(xi(I)))./funhatanalytic(xi(I)) ]);

fclose(fid);