

Numerical Harmonic Analysis (MTH 656)

Homework due Monday, April 7, 2008.

Problem 2. Write a function M-file that implements the discrete non-cyclic convolution

$$z_k = \sum_{l=-q}^{q-1} g_{k-l} f_l, \quad k = -q, \dots, q-1$$

where q is a power of 2 using FFTs. Devise a suitable test to show that the program works correctly.

(20 points)

Problem 3. Write a function M-file that implements the chirp-z transform for fast evaluation of

$$\hat{f}_k = \sum_{l=-q}^{q-1} f_l e^{-iklu/q}, \quad k = -q, \dots, q-1$$

where q is a power of 2 and u is arbitrary. Devise a suitable test to show that the program works correctly and demonstrates that the execution time is $O(q \log q)$.

(20 points)

Problem 4. Use your program from problem 3 to approximate

$$\int_{-2}^2 (4 - x^2)^5 e^{-ix\xi} dx$$

for $\xi = k/10$, $k = -128, \dots, 127$. Plot your result and print out the value for $\xi = 0.4$.

(10 points)

Problem 5. Using your program from problem 3 write a function M-file that implements the Fast Fourier Transform for arbitrary length N . Devise a suitable test to show that the program works correctly and demonstrates that the execution time is $O(N \log N)$.

(20 points)