

Polytechnic University of Puerto Rico
Department of Electrical Engineering
Master's Degree in Electrical Engineering

Course Syllabus

Course Title : Algorithms for Digital Signal Processing

Course Code : [EE 7740](#)

Credits : Three (3) credits

Duration : One academic quarter.

Schedule : Forty-five credit hours per course.

Prerequisites : [EE 6010](#): Mathematical Methods for Signal Processing

Course Description

This course provides an introduction to the field of advanced digital signal processing algorithms, in particular to Fast Algorithms for Discrete Fourier Transforms, Discrete Linear and Cyclic Convolutions. Transforms such as the Discrete Cosine Transform, the Hartley Transform, the Walsh-Hadamard Transform and others are also reviewed. The course does extensive use of MATLAB and other mainstream software packages for computer implementation and as an aid to understand the structure of the different algorithms. The course requires a research project, research report or paper reviews.

Justification

Even though DSP processors are becoming faster and faster the search for fast algorithms that can process huge amount of data in real time, or as fast as possible, is still an important research subject. This is true not only for the obvious applications related to national defense, but also in applications related to geophysics, medical and earth sciences. The course, in addition, provides an opportunity for the student to tackle very interesting research subjects regarding this field, such as automatic derivation and implementation of signal processing algorithms.

Objectives

To provide an adequate introduction, through the study of selected DSP algorithms, to the field of algorithms for Discrete Fourier Transform and Convolution.

Textbook

Fast Algorithms for Digital Signal Processing (1985)

by Richard E. Blahut

1st Edition

Addison Wesley

ISBN: 978-0201101553

Topics Covered

1. Review of Abstract Algebra.
2. Review of Basic Digital Signal Processing Concepts. DTFT, DFT, Linear Systems, Sampling, Linear Convolution, Circular Convolution, Filtering, the Z Transform, Properties Resulting from Real Data and Certain Symmetries.
3. Direct Calculation for the DFT.
4. The Goertzel Algorithm for the DFT.
5. Decimation in Time FFT algorithm
6. Decimation in Frequency FFT algorithm.
7. The Prime Factor Algorithm (PFA).
8. Fast Convolution using the FFT.
9. Cook-Toom Algorithm.
10. Description of other Transforms.
11. Advanced Topic 1: The Tensor Product:
12. Tensor Product and Stride Permutations.
13. Cooley-Tukey FFT Algorithms, Variants and Implementations.
14. Good Thomas PFA.
15. Agarwal-Cooley Convolution Algorithm.
16. Advanced Topic 2: Automatic Implementation of Signal Processing Algorithms:
17. The SPL Language and Programming Environment.
18. Advanced Topic 3: Research Paper Reviews and Project.

Evaluation Criteria

Final course grade will be determined, unless otherwise accorded in class, based on the following scale:

100-90	A
89-80	B
79-70	C
69-60	D
59- 0	F

The number of tests and percentages are determined by the instructor. Homework is suggested to be 0% to 15% of the final grade. A midterm exam (suggested: 25% to 30% of final grade) and the final exam (suggested: 30% of final grade). A final research

project, research report or paper review is required. An oral presentation is required. (Suggested: 25% to 30% of final grade).

Course History

April, 2002; prepared by Marvi Teixeira, Ph.D., P.E.

May, 2002; revised by Roman Lopez, Ph.D.

Jan, 2008; revised by Marvi Teixeira, Ph.D., P.E.

April, 2008; revised by Marvi Teixera, Ph.D, P.E.

Bibliography

Algorithm Collections for Digital Signal Processing Applications Using MATLAB. (2007)

By E.S. Gopi

1st Edition

Springer

ISBN-13: 978-1402064098

Algorithms for Statistical Signal Processing. (2002)

By J. G. Proakis, C. M. Rader, F. Ling, C. L. Nikias, M. Moonen, I. K. Proudler.

1st Edition

Prentice Hall

ISBN : 0-13-062219-2

Digital Signal Processing Algorithm: Number Theory, Convolution, Fast Fourier Transforms and Applications. (1998)

By H. Krishna Garg

1st Edition

CRC Press

ISBN: 0-8493-7178-3

Fourier-Related Transforms, Fast Algorithms and Applications. (1997)

By O. Ersoy

1st Edition

Prentice Hall.

ISBN: 0-13-6423312-2

Signal Processing Algorithms in MATLAB. (1996)

By S. D. Stearns and R. A. David

1st Edition

Prentice Hall

ISBN: 0-13-045154-1

Circulant Matrices. (1994)

By P. J. Davis.

2nd Edition

Chelsea Publishing

ISBN: 0-8284-0338-4

DFT/FFT and Convolution Algorithms. Theory and Implementation. (1991)

by C. S. Burrus and T. W. Parks.

1st Edition

John Wiley & Sons.

ISBN:0-471-81932-8

C Language Algorithms for Digital Signal Processing. (1991)

By P. M. Embree and B. Kimble.

1st Edition

Prentice Hall

ISBN: 0-13-133406-9

Algorithms for Discrete Fourier Transform and Convolution. (1989)

By R. Tolimieri, M. An and C. Lu.

1st Edition

Springer Verlag.

ISBN: 0-387-97118-1

Digital Signal Processing

Applications to Communications and Algebraic Coding Theories

By Salvatore D. Morgera and Harri Krishna

Academic Press Inc.

ISBN: 0-12-506995-2

Fast Algorithms for Digital Signal Processing. (1987)

By R. E. Blahut

1st Edition

Addison Wesley

ISBN: 0-201-10155-6

DFT/FFT and Convolution Algorithms. Theory and Implementation. (1985)

By C. S. Burrus and T. W. Parks.

1st Edition

John Wiley & Sons.

ISBN:0-471-81932-8

Fast Transforms. Algorithms, Analyses, Applications (1982)

by D. F. Elliot and K. R. Rao

1st Edition
Academic Press
ISBN: 0-12-237080-6

Number Theory in Digital Signal Processing. (1979)
By J. H. McClellan and C. M. Rader
1st Edition
Prentice Hall
ISBN: 0-13-627349-1

The Fast Fourier Transform.(1974)
By E. O. Brigham
1st Edition
Prentice Hall
ISBN: 0-13-307496-X

