UNIVERSITY OF MANITOBA | Electrical and Computer Engineering

ECE7440 – T66
FAST ALGORITHMS IN COMPUTATIONAL ELECTROMAGNETICS

COURSE OUTLINE - WINTER 2019

Course Objectives

Fast algorithms of computational electromagnetics enable error-controllable solutions of complex scattering and radiation problems with linear complexity in CPU time and memory. The course covers both established algorithms such as Fast Multipole Method and Fast Fourier Transform based methods as well as more recent algorithms based on theory of Hierarchical Matrices and Tensor Train decomposion. The objective of the course is to provide the students with both theoretical background of the algorithms and give them hands-on experience with their implementation.

Contact hours

39 lectures
8 homework assignments (discussed in the following class)
3 credit hours.

Prerequisites

ECE7440: Integral Equations in Computational Electromagnetics
Note: course material has significant mathematical and programming content (MATLAB or C++).

Course content

FFT-based fast algorithms
- Conjugate-Gradient FFT algorithm (CG-FFT)
- Pre-corrected FFT algorithm (PFFT)

Multipole-based fast algorithms
- 2D Fast Multipole Method (FMM) in Statics
- 3D Multi-Level Fast Multipole Method (MLFMM) in Electromagnetics

H-matrix-based fast algorithms
- H-matrix formation
- Adaptive Cross Approximation
- Multiplication of H-matrix with a vector
- H-LU Decomposition

Tensor-Train-based fast algorithms
- SVD-based Construction of the Tensor Trains
- Iterative Approach to Construction of Tensor Train
- Use of Multipole Expansions for Construction of Tensor Train

Textbooks

[1] J.-M. Jin, “Theory and Computation of Electromagnetic Fields,” Wiley and IEEE Press, 2010.
[2] W.C. Chew, J.-M. Jin, E. Michielssen, and J. Song, editors, “Fast and efficient algorithms in computational electromagnetics”, Boston: Artech House, 2001.

Evaluation

The final course grade will be determined from a student's performance in the exam, homeworks, and final project. The weighting of each of these components will be as follows:

Component	Value	Details
Final Exam	50%	
Homework	25%	8 homework reports
Term project	25%	Project report

Note:

- The voluntary withdrawal date for this course is **March 20, 2019**.
- Attendance at lectures is essential for successful completion of this course. Students must satisfy each evaluation component in the course.
- It is the responsibility of each student to contact the instructor if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with Sections 4 and 6 of the Regulations dealing with incomplete term work, deferred examinations, and attendance and withdrawal.

Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the General Academic Regulations and Requirements of the University of Manitoba, Section 7.1, students are reminded that plagiarism or any other form of cheating in examinations, assignments, laboratory reports or term tests is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty.

Instructor

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