UNIVERSITY OF MANITOBA

Department of Electrical & Computer Engineering
Graduate Course Outline

FALL 2018

ECE 7650-T18 – Advanced Matrix Algorithms

COURSE DESCRIPTION:

Linear systems of equations arise frequently in engineering problems, and solving large-scale systems of equations can be computationally demanding. This course focuses on learning advanced algorithms for solving large systems of linear equations and developing an understanding of the performance that can be expected from these techniques.

COURSE OBJECTIVE:

This course aims to provide students with the tools to implement and assess the capabilities of different algorithms for solving large systems of linear equations. While theoretical aspects will be an important part of the course, focus will be placed on the algorithmic formulation of the methods and their implementation on standard computing platforms. Time permitting, algorithm modifications for both parallel/distributed computing systems and co-processing systems such as general purpose graphics processing units (GPGPUs) will be discussed.

PRE-REQUISITES:

A background in linear algebra that is normally obtained in an undergraduate electrical and computer engineering curriculum is essential. The course work will be largely based in applications and will require programming. For the most part the programming language can be chosen flexibly, including MatLab, however we may occasionally make use of existing software that will require specific languages (C/C++/Java/Python). Programming is a core component in this course; if you would like to know if your programming background is sufficient, please inquire with the instructor prior to registering.

CONTACT HOURS:

3-hours per week

COURSE CONTENT:

The following topics will be covered. Emphasis and additional topics will be selected based on class interests.

- Basic concepts: vectors, matrices, eigenvalues, inner products, vector norms, matrix norms, subspaces.
- Canonical matrix forms and special matrices.
- Matrix decompositions: LU, QR and singular value decompositions.
- Sparse matrices: graphs, orderings and storage formats.
- Large matrix equations in engineering: Depending on students' interests and focus.
- Basic iterative methods for solving systems of linear equations.
- Projection and Krylov subspace methods.
- Preconditioning iterative solution methods.
- Compression techniques (time permitting and based on interest): adaptive cross approximation, hierarchical matrices.
- Parallel matrix algorithms (time permitting and based on interest).
- Select topics on solving over- and under-determined systems of linear equations (time permitting).

HOMEWORK:

The evaluation in this course will include homework assignments and one project. Both will consist of theoretical and applied problems with emphasis on applications. Implementing algorithms and/or using pre-existing software packages to solve linear systems of equations would be considered typical application-based assignment problems.

TEXTBOOK:

While there is no required textbook, we will proceed based on material primarily from:

1. Y. Saad, *Iterative Methods for Sparse Linear Systems,* 2nd Ed., SIAM, 2003.
2. G. Golub and C. Van Loan, *Matrix Computations*, 4th Ed., John Hopkins University Press, 2013.
3. G. Strang, *Introduction to Linear Algebra,* 4th Ed., Wellesley-Cambridge Press, 2009.

EVALUATION:

Your final course grade is determined by your performance in assignments, term test, and a final examination. The weighting of each of these components is as follows:

COMPONENT	NO	VALUE %	TOTAL VALUE	DETAILS / ADDITIONAL INFO
Assignments	4	5%	20	
Project	1	20%	20	Student selected with instructor approval.
Midterm Exam	1	20%	20	
Final Examination	1	40%	40	Sit-down or take-home to be determined in class.
TOTAL			100	

GRADE SCALING

Letter	Mark
A+	95-100
A	85-94
B+	80-84
B	70-79
C+	65-69
C	55-64
D	45-54
F	<45

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year

INSTRUCTOR INFO:

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Office Hours: .....TBD or by appointment. Please include “ECE 7650” in the subject of any email correspondence.

VOLUNTARY WITHDRAW:

Monday, 19 November 2018

REQUIREMENTS/REGULATIONS

Student Responsibilities: It is the responsibility of each student to contact the instructor if he/she is uncertain about his/her standing in the course and his/her potential for receiving a failing grade. Students should also familiarize themselves with Sections 4 and 6 of the Regulations dealing with, among others, incomplete term work, deferred examinations, attendance and withdrawal, etc..

Lectures: Attendance at lectures is essential for successful completion of this course. Students must satisfy each evaluation component in the course.

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 is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university) regardless of media

- examinations
- assignments
- laboratory reports
- term exams

A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty

Please refer any questions regarding Academic Integrity to your course instructor.

***Plagiarism:** to steal and pass off (the ideas or words of another) as one's own; use (another's production) without crediting the source