CES 712
INTRODUCTION TO PARTICLE METHODS
(Fall 2007)

Time & Place:

- First Class — October 24
- Last Class — November 29
- Lectures — 12:30–14:20 on Wednesdays and 13:30–14:20 on Thursdays in HH/207
- Computer Labs — N/A

Instructor: Dr. Bartosz Protas
Office HH 326, Ext. 24116, Email: bprotas@mcmaster.ca
Office Hours: 13:30–14:30 on Tuesdays and 14:30–15:30 on Thursdays

Teaching Assistant: N/A

Course Webpage: http://www.math.mcmaster.ca/~bprotas/CES712a

Outline of the Course: Following a review of the Green's function formalism for differential equations, we will show that a variety of continuous problems in physics and engineering (fluid & solid mechanics, plasma physics, etc.) may be reduced to a system of N interacting "particles", the so–called "N–body problem". We will then discuss various computational aspects of this problem, including kernel regularization techniques, modeling diffusive effects, conservation proprieties and acceleration strategies (different particle–mesh and multipole expansion methods). These ideas will be illustrated with MATLAB codes that will be developed and analyzed during the lectures.

Topics:

Dates	Topics
Oct 24 — Oct 25	particle systems, Lagrangian vs. Eulerian representation of continuous systems
Oct 31	N–body problems
Nov 1	regularization (smoothing)
Nov 7 — Nov 8	particle–particle, particle–mesh and particle–particle–particle–mesh methods
Nov 14	fast mutipole methods
Nov 15	conservation properties & symplectic integrators
Nov 21 — Nov 22	deterministic & stochastic representation of diffusive effects
Nov 28	vortex methods in hydrodynamics
Nov 29	wrap–up

Course Objectives: By the end of the course students should be able to develop and implement a finite element method for typical PDEs encountered in science and engineering.

Secondary References:

1. R. W. Hockney and J. W. Eastwood, "Computer Simulation Using Particles", Taylor & Francis, (1988).
2. G.-H. Cottet and P. D. Koumoutsakos, "Vortex Methods: Theory and Practice", Cambridge University Press, (2000).
3. "Particle Methods for Fluids", lecture notes, INRIA, (1997).

Software: All of the computational examples will be presented using MATLAB. Students are encouraged to purchase "The Student Edition of MATLAB" to be able to work with MATLAB at home.

Prerequisites: Partial Differential Equations, Introductory Numerical Analysis and Numerical Algebra, basic programming skills in MATLAB

Assignment: There will be one homework assignment which will be posted on November 21 and will be due on November 28 by midnight. Solution to the assignments should be submitted to the instructor via E–mail using the template provided. The solutions will be posted on the course webpage.

Class Quiz: There will be one in–class quiz on November 15. It will last 50 minutes. The quiz will cover analytical issues only (no programming). Only the McMaster standard calculator Casio fx-991 will be allowed during the quiz.

Final Exam: The course will be completed by a take–home final examination. It will be handed out during the last class on November 29 and will be due on December 3 (hour TBA).

Marking scheme:

- Final exam — 60%
- Quiz (50 min) — 20%
- Homework assignment — 20%

The instructor reserves the right to change the final mark at his discretion in exceptional situations. In such cases, however, the mark may only be increased.

Excused Absences: Exemptions from the assignment or quiz for valid reasons are possible, but must be requested from the instructor. In the event of an exemption, no make up test or assignment will be administered, but your course grade will be re–weighted by increasing the weight of the final examination to compensate for the missed test or assignment.

Academic Integrity: You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g., the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at `http://www.mcmaster.ca/academicintegrity`. The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g., the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

Important Notice: The instructor reserves the right to modify elements of the course and will notify students accordingly (in class and post any changes to the course website).