CES 717
FOUNDATIONS OF COMPUTATIONAL FINITE ELEMENT METHODS
(Fall 2007)

Time & Place:

- First Class — September 6
- Last Class — October 18
- 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/CES717a

Outline of the Course: This module will offer an introduction to computational aspects of the finite element method (FEM). First we will survey the relevant mathematical background including the theory of weak solutions to partial differential equations (PDEs), Galerkin method, interpolation with piecewise polynomials and Gaussian integration. Then we will focus on algorithmic and programming issues such as mesh generation, suitable data structures, assembly of stiffness matrices and load vectors. Finally, we will discuss solution techniques applicable to the resulting sparse algebraic systems. We will illustrate these concepts with MATLAB codes developed to solve a family of partial differential equations of the elliptic type in two spatial dimensions.

Topics:

Dates	Topics	Chapters from the textbook
Sept 6 — Sept 12	introduction, model PDEs, weak solutions	1, 2
Sept 13	Galerkin Method	3
Sept 19 — Sept 20	interpolation using piecewise polynomials	4
Sept 26	convergence	5
Sept 27 — Oct 3	mesh data structures	6
Oct 4 — Oct 10	programming FEM	7
Oct 11 — Oct 17	solution of sparse algebraic systems	10,11,12
Oct 18	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.

Primary Reference:

1. M. S. Gockenbach, “Understanding and Implementing the Finite Element Method”, SIAM, (2006).

Secondary References:

2. K. Atkinson and W. Han, “Theoretical Numerical Analysis: A Functional Analysis Framework”, Springer (TAM 39), (2001).

3. A. Ern and J.-L. Guermond, “Theory and Practice of Finite Elements”, Springer (AMS 159), (2003).

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 October 10 and will be due on October 17 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 September 27. 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 October 18 and will be due on October 22 (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).