

Carleton University

Department of Mechanical & Aerospace Engineering

Winter 2018

MECH 5605 Finite Element Analysis I

Instructor: Prof. Mostafa El Sayed
Contact info: E-mail: Mostafa.elsayed@carleton.ca; Phone: 4138; Office: CB3206.
Lectures 3 hours/week (Wednesdays and Fridays; 1:00-2:30 pm); Room ME 4342
Office hour: 1 hour on Fridays (3:00 to 4:00 pm) or by appointment.

Course Objective

The primary aim of this course is to impart a basic understanding of the finite element method as applied to engineering problems. We will try to open up the “black box” of finite element packages; therefore after this course you should be able to develop your own working finite element code and/or the user subroutines for the use with commercial codes.

Topics include:

1. Introduction and Overview of the Method

Overview of the FEM is introduced. seven basic steps to the solution of any FEM problem including discretizing, interpolation, element properties, assembly, application of boundary conditions, solve and post-processing are summarized.

2. Direct Stiffness Approach

For several simple example problems, finite element equations are derived directly from physical principles. Examples include one-dimensional heat conduction, two-dimensional truss and two-dimensional constant stress triangle elements.

3. Mathematical Approach

Rigorous mathematical approach is required to derive finite element equations for more complex problems. The method of weighted residuals (Galerkin’s method) is introduced, which will be used in the following chapters.

4. Two-Dimensional Heat Transfer

Two-dimensional finite element equations are derived from the mathematical approach for heat transfer problems. Both heat conduction and convection problems will be discussed. The elements derived include both triangular and quadrilateral isoparametric elements.

5. Two-Dimensional Elasticity

Using the mathematical approach, two-dimensional finite element equations are derived for stress analysis. Both triangular and quadrilateral isoparametric elements are discussed.

6. Special Topics

Discussions are conducted on several special/practical aspects of finite element analysis.

Recommended Text Book

K.H. Huebner and E.A. Thornton, “The Finite Element Method for Engineers”, (John Wiley and Sons, 2nd, 3rd or 4th Edition).

Lecture Notes

Lecture notes will cover all materials. In addition to the recommended text book, a reference book list is also provided at the end of this outline. These can be used as supplementary reading/problem-solving materials for the course.

Problem Analysis

Problems will be assigned through the course. No credit will be given for the problem analysis but you are strongly advised to study and attempt to answer the assigned problems. Solutions for the assignments will be made available later on.

Exams

Mid-Term: 1.5 hour; Final 3 hours. (Lecture notes and calculator only, no example problems will be permitted).

Marking Scheme

5 Assignments (8% each)	20%
Midterm	20%
Final Examination	60%
Total	100%

Reference List

R.D. Cook, D.S. Malkus and M.E. Plesha, “Concepts and Applications of Finite Element Analysis”, (3rd Edition, John Wiley & Sons, 1989).

K.J. Bathe, “Finite Element Procedures in Engineering Analysis”, (Prentice Hall, 1996).

O. Zienkiewicz and R. Taylor, “The Finite Element Method”, (4th Edition, 1989).

Academic Integrity Statement for Graduate Course Outlines:

Plagiarism and cheating at the graduate level are viewed as being particularly serious and the sanctions imposed are accordingly severe. Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy (See <http://www2.carleton.ca/graduate-studies/policies-and-guidelines>). The Policy is strictly enforced and is binding on all students. Plagiarism and cheating – presenting another’s ideas, arguments, words or images as your own, using unauthorized material, misrepresentation, fabricating or misrepresenting research data, unauthorized co-operation or collaboration or completing work for another student – weaken the quality of the graduate degree. Academic dishonesty in any form will not be tolerated. Students who infringe the Policy may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from full-time studies; a refusal of permission to continue or to register in a specific degree program; academic probation; or a grade of Failure in the course.

Accommodation Statement

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: <http://www2.carleton.ca/equity/>

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: <http://www2.carleton.ca/equity/>

Academic Accommodations for Students with Disabilities: The **Paul Menton Centre** for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your **Letter of Accommodation** at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable) at <http://www2.carleton.ca/pmc/new-and-current-students/dates-and-deadlines/>

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at <http://www2.carleton.ca/equity/>