CONCORDIA UNIVERSITY
FACULTY OF ENGINEERING & COMPUTER SCIENCE
DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

# MECH 460/4 T- FINITE ELEMENT ANALYSIS
# WINTER 2012

## INSTRUCTOR:

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## Lectures:

M-W---- (13:15-14:30) SGW MB-S1.401

## Laboratory:

Lab TI M------ (10:35-13:05) Week(1) SGW H-847
Lab TJ M------ (10:35-13:05) Week(2) SGW H-847

## OBJECTIVES:

a) To teach the fundamental concepts, procedures, methodologies, and various theoretical aspects of the Finite Element Method (FEM), and the ways in which these are applied to the analysis of mechanical engineering problems.
b) To develop the ability of the students to apply all the above-mentioned aspects involved in this field to practical problems, and to enhance it through adequate training in the solution of representative yet simple problems.
c) Commercial software packages (ANSYS and CATIA) currently used in industry for design purposes will be introduced and students will be trained to become familiar with their utilization.

## Design Soft Skill:

The following Design soft skill will be included in this course.
Engineering Tool Usage: An ability to create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.
TEACHING: In the present course, this aspect/skill is considered and the teaching/development of this skill is incorporated throughout the course in the course lectures and in the laboratory component of the course.
PRACTICE – Problems given in the assignments and project will involve significantly the activities and tools as mentioned in the above.
EVALUATION –The grade for assignments is given below. The project report and presentation will be assessed for the corresponding components in the grade for project.

## TEXT:

D. L. Logan, *A First Course in the Finite Element Method,* 5th SI Edition, Cengage Learning, 2012.

## GRADING:

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|---|---|---|
| Assignments: | 10% | |
| Labs: | 15% | |
| Class test (scheduled on Monday, February 27th, 2012): | 25% | Open-book test |
| Final examination (scheduled during regular exam period) | 50% | Open-book exam |

**Topics:**

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| **1. The Stiffness or Displacement Method**<br>Element Stiffness, Displacement, and Force Matrices. Element Stiffness Equation. Assembly Process: From Element Equations to System Equations. Structure Stiffness, Displacement, and Force Matrices. Incorporation of Boundary Conditions. Solution Process. |
| **2. Bar and Truss Elements**<br>Bar and Truss Stiffness Equations; Element Local and Global Coordinate Systems. Local Element Stiffness, Displacement, and Force Matrices. Global Stiffness Matrix and force matrix. Energy equivalent nodal loads. Incorporation of Boundary Conditions. Calculation of Stresses and Strains. |
| **3. Beam and Frame Elements**<br>Beam Stiffness Equation. Local Element Stiffness matrix. Frame Element: Beam Element with Combined Bending and Axial Deformations. Element Local and Global Reference Axes. Global Stiffness Matrices for Beam and Frame Elements. Energy equivalent nodal forces and moments. Incorporation of Boundary Conditions. Calculation of Stresses and Strains. |
| **4. Element Equations for Continuum Elements**<br>Stresses and Strains. Strain-displacement Relations. Stress-Strain Relations. Shape (Interpolation) Functions. Derivation of Stiffness Equations using Potential Energy. Equivalent Nodal Force Vectors due to Surface Forces, Body forces, Initial Stresses and Initial Strains. |
| **5. Two-Dimensional Elements**<br>Plane stress and Plane Strain Elements. Shape functions. Stiffness and Mass Matrices. Treatment of Body Forces, Surface Forces and Thermal Strains. Natural Coordinates and Isoparametric Formulation. |
| **6. Weighted Residual Methods**<br>Basic Functions. Residual and Error. Method of Moments. Galerkin Method. Boundary Value Problems. |
| **7. Non-structural Problems:**<br>Finite Element Model for Heat Transfer with Convection. |

**LABORATORY**

3 hours/week, alternate weeks; Lab manual will be posted in MOODLE.

**LAB # 1:** STATIC ANALYSIS: TRUSS STRUCTURES

**LAB # 2:** STATIC ANALYSIS: FRAME STRUCTURES

**LAB # 3:** STATIC ANALYSIS: 2-D PROBLEMS

**LAB # 4:** DYNAMIC ANALYSIS (MODAL ANALYSIS-TRANSIENT ANALYSIS)

**LAB # 5:** NON-STRUCTURAL PROBLEMS (THERMAL and FLUID ANALYSIS)

**LAB # 6:** INTRODUCTION to CATIA

**NOTE:**

1. Assignments will be posted in MOODLE. Students should submit assignments in class. After marking, they will be returned in class. Solutions will be posted in MOODLE after the due dates.

2. The expectation of originality form must be attached to the front of all assignments and lab reports.

3. The class test is optional. There will be no make-up test for class test. Students who did not write class test will write the final exam for 75%.

4. The two particular calculator models that will be allowed in ENCS undergraduate final exams are, the Sharp EL 531 and the Casio FX-300 MS. Make sure you bring any one of these two models. The same will be applicable for class test.

5. Cell phones and other electronic devices are not allowed in the exams. Please note that just turning the cell phone off is not ok, it must not be in the student's possession.

6. The Lab is **mandatory.** Students must complete satisfactorily all the labs in order to obtain a passing grade in the course.

7. In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.