ENS-309 Computer-Aided Engineering

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Instructor:	Eralp Demir
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Class hours/place:	

Office Hours: After class, or by appointment

Main References:

- Paul M. Kurowski, *Engineering Analysis with SOLIDWORKS®* Simulation 2019, SDC Publications, 2019.
- Shanin S. Nudehi, John R. Steffen, *Analysis of Machine Elements Using SOLIDWORKS®* Simulation 2019, SDC Publications, 2019.
- Paul M. Kurowski, *Vibration Analysis with SOLIDWORKS®* Simulation 2019, SDC Publications, 2019.
- Paul M. Kurowski, *Thermal Analysis with SOLIDWORKS®* Simulation 2019 and Flow Simulation 2019, SDC Publications, 2019.
- John Matsson, *An Introduction to SOLIDWORKS® Flow Simulation* , SDC Publications, 2019.

Objectives: Course teaches how to perform engineering analysis using a computer software. Basics descriptions for analysis will be defined. A brief theoretical background will be provided at the beginning of each topic. Students will learn how to perform engineering analysis using a computer software. The design and analysis aspects will be discussed concerning the manufacturing constraints. All the concepts will be illustrated on worked examples.

Prerequisites:

- ENS-209 Computer-Aided Design
- IE-309 Manufacturing Processes-I (optional)

Learning Outcomes:

- Mathematical background for computer aided analysis
- Master a computer software for analysis simulations
- Mechanical analysis: static structural analysis, assembly analysis (joints, interference fits, etc.), analysis of machine elements, and vibration analysis
- Thermal analysis: problems involving conduction, convection, radiation, steady-state and transient heat flow problems
- Fluid analysis: fluid flow analysis, steady-state and time-dependent flows, thermofluid analysis (i.e. heat exchanger design)

Tentative Course Outline:

Week 1: Basics
Basic descriptions

- What is Finite Element Analysis?
- Finite Element Analysis used by Design Engineers
- Objectives of FEA for Design Engineers
- What is SOLIDWORKS® Simulation?
- Fundamental steps in an FEA project Errors in FEA
- A closer look at finite elements: mesh, elements, nodes, etc.
- What is calculated in FEA?
- How to interpret FEA results
- Units of measure
- Using online help
- Limitations of Static studies

Weeks 2-4: Mechanical - static structural

- Static equilibrium - force balance (Newton's 2nd Law)
- Example applications: a hollow plate, L-bracket, link
- 2D problems

Weeks 5-7: Mechanical - joining elements

- Curved beam analysis
- Stress concentration analysis
- Thin and thick walled pressure vessels
- Contact analysis
- Interference fit analysis
- Bolted joint analysis
- Design optimization

Weeks 8-10: Vibration Analysis

- Dynamic equilibrium (Newton's 2nd Law)
- Introduction to modal analysis
- Time response and frequency response of discrete systems
- Frequency response

- Vibration absorption

Week-10-12 Thermal analysis

- Energy balance equation
- Heat transfer by conduction, convection, radiation
- Steady-state and transient thermal analysis
- Examples: hollow plate, L-bracket, round bar, thermal analysis of a coffee mug

Week-12-14 Fluid analysis

- Continuity equation
- Introduction to fluid analysis using SOLIWORKS® Flow Simulation
- Examples: Flat plate boundary layer, flow past a sphere and a cylinder, flow over a rotating cylinder, flow past an airfoil, pipe flow
- Thermofluid analysis: flow across a bank of cylinders, heat exchanger design

Week-14-15 Topology optimization
Use of topology optimization tool at introduction to design for 3D printing.

Computer Programming: SOLIDWORKS® Simulation, Flow Simulation (2019 or higher)

Grading Policy: Lab assignments (30%), Project (20%), Midterm (20%), Final (30%).

Class Policy:

- Regular attendance is mandatory.