Department of Mechanical Engineering

ME441– Computer Simulation and Analysis in Mechanical Engineering

Elective

Catalog Description: **ME 441 (2-2-3)**

This course covers various topics in Computer-Aided Design (CAD) and Computer-Aided Engineering (CAE). The course provides an in-depth understanding and skill of constructing 2-D drawings using well-known commercial CAD package, and integrating 3-D solid modeling techniques into simulation, and analysis animation of new designs using commercial CAD/CAE software. The students will have hands-on experience to analyze Structure, Heat Transfer, and Computational Fluid Dynamics problems by using several different software packages. The course also focuses on CAD Product Data Exchange using both Direct Database conversion and International Standards based conversion methods between major CAD/CAE systems. Typical industrial applications will be illustrated.

Prerequisites: ME 430 – Introduction to Computer Aided Design

Textbook(s) Materials Required:

1. AutoCAD 2006 Tutorial First Level: 2D Fundamentals by Randy H. Shih, SDC Publications, 2006
ISBN 1-58503-199-2
2. Extensive lecture notes can be downloaded from instructor's website

Reference(s) (Not Required):

1. User's Guide of software packages used in the course
2. Computational Fluid Dynamics by T.J. Chung, Cambridge University Press, 2002
ISBN 0-521-59416-2

Commercial Software Packages:

1. AutoCAD by Autodesk Inc.
2. Pro/ENGINEER and AutobuildZ by PTC Inc.
3. ANSYS Workbench and Classic by ANSYS Inc.
4. Fluent and Gambit by Fluent Inc.

Course Supervisor: Dr. Herli Surjanhata

Pre/Co-requisite by topic

1. Computer skills in managing directory, subdirectory and files.
2. Engineering graphics including the visualization of three dimensional object
3. Solid modeling techniques using CAD software package and data exchange between CAD systems
4. Basic knowledge of structure, thermal and fluid mechanics analyses related to mechanical engineering

Course Objectives[1]:

1. To develop and enhance the student's skills in using modern 2-D CAD tool to create detailed drawings of machine parts. (A, B, C, D, E)
2. To develop student's skills in converting 2-D drawing to parametric 3-D solid model, and export 3-D CAD model into various formats that can be imported into CAE software packages for analysis. (A, B, C, D, E)
3. To develop the student's skills in proper modeling, meshing, and setting up material properties, loads, and constraints for computer simulation and analysis (e.g. structural, thermal and computational fluid dynamics) and then solve the problem using CAE software packages. (A, B, C, D, E)
4. To provide the student with some knowledge in multi-physics analysis – interaction between structure, thermal and electric. (A, B, C, D, E)
5. To provide the student with some knowledge and analysis skills to interpret and draw conclusion the results of computer analysis. (A, B, C, D, E)

Topics[2] :

1. Custom and ANSI standard border and title block for detailed drawings using 2D CAD package – metrics and imperial units. Review of rules of dimensioning technique. (3 hrs)
2. Review of first and third angle projections, orthographic views, auxiliary view and sectional views. (3 hrs)
3. Coordinate and Geometric Dimensioning Tolerancing (GDT) in mechanical engineering. (3 hrs)
4. Transforming 2-D drawing into 3-D solid model using CAD systems. (3 hrs)
5. Export 3-D solid model from one CAD system to another CAE system for analysis. (2 hrs)
6. Linear and non-linear in structural analysis including buckling and modal analysis. Concept of non-linearity in structural analysis – large deflection, and the resulted von Mises stress, contact stress and displacement are obtained and displayed using CAE software package. Stress and displacement resulted from rotating disk using computer. (9 hrs)
7. Computer simulation and analysis for thermal transient, steady state, and thermal stress. (4 hrs)
8. Concept of multi-physics analysis with MEMS simulation as example. (3 hrs)
9. Computational Fluid Dynamics: use pre-processor to generate 2-D and 3-D mesh and boundary zones. Export the mesh and solve the problem in different software package and display the results. Background of CFD is introduced. (3 hrs)
10. Laminar, turbulent flows through various examples, assignments and projects. (9 hrs)

Evaluation Method:

1. Exam
2. Homework
3. Project

Schedule: Lecture: 1 hours, per week
Laboratory:2 hours, per week

Professional Component: Engineering Science and Design

Program Objectives Addressed: A, B, C, D, E

Course Outcomes[3]:

Objective 1

1.5 Using 2-D software commercial package students will demonstrate an ability to correctly generate orthographic views, auxiliary view, sectional views of machine part complete with proper dimensioning, tolerancing, and GDT. (o) (a, b, e, g, i, k)
1.6 Student will use modern software to do many assignments. (o) (a, b, e, g, i, k)

Objective 2

2.1 Students will demonstrate an ability to transform 2-D drawing generated in one CAD system 3-D solid model created in other solid modeling CAD system. Data exchange between CAD systems is implemented. (o) (b, e, i, j, k)
2.2 Student will use two different software packages to do assignment (project). (o) (b, e, i, j, k)

Objective 3

3.1 Students will demonstrate an ability to correctly generate finite element analysis model for structure and thermal analyses, generate mesh and boundary zones of finite volume method for CFD. (o) (a, e, i, k)
3.3 Students will demonstrate an ability to solve linear and non-linear structural, thermal, and flow problems using commercial software packages. (o) (a, e, i, k)
3.4 Student will use software to do assignments including projects. (o) (a, e, i, k)

Objective 4

4.1 Students will demonstrate an ability to determine engineering design problem that involves interaction between heat, stress, and electric (multi-physics environment), generate the model using a proper element type, and then solve the problem. o) (a,c,e,h,i,k)
4.2 Students will demonstrate the use of commercial software for multi-physic type problems. (o) (a,c,e,h,i,k)

Objective 5

5.1 Students will demonstrate an ability to analyze and display the results such as von Mises stress, displacement, temperature, pressure, and velocity etc. obtained from computer analysis. (o) (a,b,c,e,g,h,k)
5.2 Students will demonstrate an ability to draw a conclusion from computer generated results by doing assignments. (o) (a,b,c,e,g,h,k)

Prepared by: Herli Surjanhata Date: September 26, 2006

[1] Capital Letters in parenthesis refer to the Program Objectives of the Mechanical Engineering
Department. Listed in Sec 2 d Tables B-2-9, B-2-12. Table B-2-8 links Program Objectives with the ABET a-k Criterion.

[2] Topi**c** numbers in parenthesis refer to lecture hours. (three hours is equivalent to 1 week)

[3] Outcome numbers in parenthesis refer to evaluation methods used to assess the student performance. Lower case letters in parenthesis refer to ABET a-k outcomes.