Department of Mechanical Engineering

ME 430 – Introduction to Computer Aided Design

(Required)

Catalog Description: ME-430 (2-2-3)

Students study the basic concepts of CAD – Computer Aided Design as applied to Mechanical Engineering design problems; Topics include numerical techniques, computer graphics, geometric modeling, design optimization, and databases for design. The laboratory uses current CAD software packages for mechanical design. Projects involve applications of the basic principles using student's own as well as available software.

Prerequisites: CIS 101 – Computer Programming and Problem Solving
Math 222 – Differential Equations

Textbook(s) Materials (Not Required):

Extensive lecture notes can be downloaded from instructor's website

Reference(s) (Not Required):

Zeid, I., Mastering CAD/CAM ; McGraw-Hill, New York, 2005

Commercial Software Packages:

Pro/ENGINEER by PTC 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. Fundamental concept of mechanism, structure, and thermal analyses related to mechanical engineering

Course Objectives[1]:

4. To provide the student with some knowledge or understanding of the CAD/CAM hardware – integration and networking, basic computer graphics, CAD software, and standards for communicating product definition data between CAD systems. (A, B, C, D, E)
5. To gain understanding of various representation schemes of model, CAD database coordinate systems, parametric form of modeling, and geometric transformation. (A, B, C, D, E)
6. To develop the student's skills in generating solid model of mechanical parts, assemble them to be a functional product, and produce the detailed and production drawings as design communication. (A, B, C, D, E)
7. To develop the student's skill in mechanism design (kinematics, dynamics analysis and animation), and finite element method in determining stress, displacement and temperature distributions. (A, B, C, D, E)

Topics[2] :

14. Product Life Cycle and Roles of CAD in Design Process (Synthesis and Analysis). Structure of Software GUI and Basic & Advanced Types of Protrusion. (1 hr)
15. CAD/CAM Hardware – CAD/CAM Systems – Hardware Configurations (Mainframe, Workstation and PC Configurations). Graphics Displays hardware in Computer Graphics. Hardware Integration and Networking. (1 hr)
16. CAD/CAM Software – Database Coordinate Systems and Sketch Planes (Working Coordinate System, Model Coordinate System, and Screen Coordinate System - Projections). (1 hr)
17. Model Representation Schemes – Wireframe Modeling, Surface Modeling, and Solid Model Creation Techniques (Constructive Solid Geometry, Boolean Operations, and Parametric Modeling). (1 hr)
18. Dimensioning & Tolerancing Techniques; Multi-view Projections & Auxiliary View; Type of Sectional Views. (1 hr)
19. Matrices of Coordinate Systems Transformation: Homogeneous Coordinate System, and Mathematical Development of Working, Model & Screen Coord. Systems Relationships. (1 hr)
20. Curves Representation – Analytical and Free Form Curves: Bezier, B-Spline & NURBS. (1 hr)
21. Assembly Design Modeling – Assembly constraints, optimization, and mechanism design (kinematics and dynamics analyses using CAD). (1 hr)
22. Mechanism Design – Type of Joints and Degree of Freedom in Mechanism Design
23. Theory of Failures – von Mises Stress etc. Introduction to Plastic Injection Machines
24. Finite Element Analysis (FEA) – P-Method and H-Method, Steps in FEA Modeling, Convergence Techniques. FEA – 2-D and 3-D Analysis, Element Types, Singularities. (1 hr)
25. Matrices of Geometric Transformation – Translation, Scaling, Reflection & Rotation. (1 hr)
26. Standards Exchange Between CAD Systems – Direct method and Neutral files (IGES, DXF, and STEP). (1 hr)
27. Hands on experience using available software through various parts creation and projects – Lectures on particular exercise are in depth and demonstrations are given. (43 hrs in total spreading in the 14 weeks semester).

Evaluation Method:
1. Exam
2. Homework
3. Project

Schedule: Lecture: 1 hours, per week
Laboratory: 3 hours, per week
Professional Component: Engineering Science and Design
Program Objectives Addressed: A, B, C, D, E

Course Outcomes[3] :
Objective 1
1.3 Learn the role of CAD to speed up and optimize design process. (o) (h, i, j, k)

1.4 Understand the hardware components, configuration in CAD system, and CAD software that facilitates the design process. Recognize the standards needed for exchanging part data from one particular CAD system to another. (o) (a, c, d, i, j, k)

Objective 2

2.1 Knowledge of model representation schemes, curves representations and geometric transformation using matrices. (m, o) (a, e, i, j, k)

2.2 Understand mathematical development of working, model, and screen coordinate systems relationships. (m, o) (a, e, i, j, k)

Objective 3

3.1 Students will demonstrate an ability to generate parts in CAD software by extrusion, revolving, blending, sweeping, surface modeling technique etc. Also, recognize the mass properties of the solid model can be computed automatically by CAD software. (o) (a, e, i, j, k)

3.2 Students will demonstrate an ability to create an assembly of many component parts, checking interference etc. (o) (a, e, i, j, k)

3.3 Students will demonstrate an ability to generate detailed drawings, production drawing with Bill of Materials. Understand the existence of associativity between solid model and drawing – change in the model will be automatically reflected in the drawing and vise versa. (o) (a, e, i, j, k)

3.4 Student will use software to do assignments including projects. (o) (a, e, i, j, k)

Objective 4

4.1 Students will demonstrate an ability to motion analysis with animation (e.g. kinematics and dynamics) in mechanism design. (o) (a, e, i, j, k)

4.2 Student will demonstrate an ability to perform p-method of FEA to determine stress and displacement in structure analysis, temperature and heat flux distribution in thermal analysis. (o) (a, e, i, j, k)

4.3 Students will demonstrate the use of commercial software for structure and thermal type problems. (o) (a, e, i, j, k)

Prepared by: Herli Surjanhata Date: September 27, 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.