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Course Description - CAD/CAM Systems

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1 Introduction

The document provides a description of a training course on CAD/CAM Systems.

2 Overview

Contemporary approaches for computer-aided design and modeling (CAD / CAM) systems are presented. Specifics of both hardware and software are reviewed, as far as algorithms and implementations used in geometrical modeling, geometry-based physical calculations and models optimizations. Practical part includes getting experience with typical CAD systems.

3 Course objectives

Students will learn how to

- Create computer-aided designs for different application areas in modern software systems
- Chose appropriate CAD/CAM tool for specific task
- Understand technologies on which different CAD/CAM components are based, including 2D/3D graphics and rendering techniques, computed-based physical modeling and optimization algorithms

4 Course duration

58 hours:
Lectures – 32 hours
Practical classes – 16 hours
Independent work – 10 hours

5 Prerequisites

Experience with a general purpose desktop computer interfaces is assumed.
Knowledge and experience with higher mathematics and basic principles of algorithmization are highly recommended.

6 Hands-on training

Hands-on exercises include:

- ✓ Basic CADs for geometry and solid-state modeling
- ✓ 3D visualization approaches
- ✓ CADs in microelectronics
- ✓ FEM modeling

7 Course content

Lecture 1.

Short information about development of CAD. CAD/CAM/CAE in integrated design and manufacture systems.

Automation in the life-cycle of a product

Lecture 2.

CAD/CAM/CAE subsystems. Types of software and classification. CAD hardware, specialized control and output devices.

Lecture 3.

Types of 3D printers. Rapid prototyping: stereolithography, solid ground curing, laminated object modeling. 3D model scanning

Lecture 4.

Geometry modeling in CAD. Drawing primitives. Translation of coordinates, rotation, object transformation. Transformation matrices.

Lecture 5.

Parametric curves. Mathematical representation. Bezier curve. B-spline. NURBS. Interpolation curves.

Lecture 6.

Curve-based surfaces. Bezier, B-spline, NURBS surfaces. Surface interpolation .

Lecture 7.

Clipping non-visible lines and surfaces. Line and polygon clipping algorithms. Artist's algorithm. Z-buffer..

Lecture 8.

Models visualization. Rendering basics. Light sources. Ambient and direct lightning. Point and volumetric light sources. Diffuse and gloss reflection.

Lecture 9.

Objects shading. Phong and Gauraud models. Photorealistic rendering basics. Direct and backward ray tracing. Parallel processing of data and render farms.

Lecture 10.

Physical modeling based on geometry models. FEM basics. Analysis stages in FEM. Calculation example.

Lecture 11.

Mesh generation for the FEM calculation. Generating nodes and constructing elements. Mesh usage basics.

Lecture 12.

Node creation by Cavendish and Shimada methods. Elements creation by Li method, Delaunay triangulation, topological and geometrical decomposition.

Lecture 13.

Grid-based elements creation methods. Set transformations: transfinite and isoparametric transformations.

Lecture 14.

Optimization methods in CAD. The optimization problem. Limits: inside and outside penalty functions. Search methods classification

Lecture 15.

Gradient descent method. combinatorial optimization. Metropolis and simulated annealing algorithms.

Lecture 16.

Genetic algorithms. Basic principles, encoding and selection mechanisms.

8 Method of evaluation

Evaluation Item	The Number of Times	Evaluation Proportion	Remarks
attendance		20%	80% of the classes
midterm exam			
final exam	1	20%	
final report			
test			
presentation			
discussion	4	10%	
homework		20%	
practice task	8	30%	All the practice tasks should be completed
etc			