



KTH, Machine Design  
System and Component Design  
Kjell Andersson

## **Course-PM HT19: MF2019 CAD 3D-modeling and visualization, 6 credits**

### **Course description**

CAD models are important information carriers in product development companies. The models help to create a common understanding between individuals and groups with different types of expertise. The models can be used for various downstream applications, for example to produce load cases to check the design criteria using finite element analysis (FEA) or make photorealistic renderings.

The course mainly covers virtual prototyping with parametric solid models, but participants will also be introduced to basic surface modeling. In addition, participants will have the opportunity to model synchronously (also called direct modeling), with the opportunities and the difficulties it brings.

The course has three assignments to help students practice to: 1) create part and assembly models; 2) work in harness-, sheet metal- and rendering environment and 3) make a force and motion analysis of a mechanism model and transfer the information to a FE analysis. All assignments will be presented by means of communicative images and/or movies.

The second part of the course consists of an individual project assignment; the participant should make a detailed CAD model of a product that he/she chooses. The modeled product must contain both electronic components and moving mechanisms. Each participant will also assess another student's model in a peer review.

### **Learning objectives**

After completing the course the student should be able to:

- Create a CAD part with product manufacturing information (PMI) in a system context.
- Create a CAD assembly with mixed technological content, e.g. mechanical and electrical parts.
- Master modeling modules (i.e. applications and environments) in a CAD system for the design of machine components.
- Make a force- and motion analysis of a mechanism model.
- Making interference analysis.
- Create communicative representations of CAD-models to present and describe the design and behaviour of a product.

## Admission and course registration

Admission to the course is done via the Student counseling. Course registration is done at “Mina sidor”. Students who fail/miss to enroll or need to re-register should contact student expedition: [expnord@itm.kth.se](mailto:expnord@itm.kth.se).

## Pre-requisites

This course continues on from the previous courses:

- MF1044/MF1039 or similar, that address some common machine elements
- MF1045/MF1015/MF1040 or similar, where the student completes a technical product development project in a group.

Other students wishing to take the course should have a BSc or MSc in Machine Design or similar, and should be able to:

- Structure, formulate and write a technical report using a word processing program, e.g. Word.
- Present results using presentation software such as Power Point.
- Perform basic CAD-modelling in any CAD system (i.e. create part- and assembly-models, generate exploded views, to export 3D models in an appropriate image format and create drawings from a 3D-model).
- Perform basic analyses of machine elements.

## Canvas page

The course round is administered using a course activity in Canvas ([kth.instructure.com](http://kth.instructure.com)) entitled “MF2019 CAD 3D HT19-1 CAD 3D-modelling and Visualization”, which will be published at the beginning of the course. Students log on to Canvas with their KTH ID. In order to get access to the course activity, you must be formally admitted to the course. Through the course activity, students get access to lecture presentations, and materials for the assignments and project. The course activity is also used for handing in assignments and receiving feedback.

## Literature

Innovation in Product Design: From CAD to Virtual Prototyping by Monica Bordegoni and Caterina Rizzi (e-book from KTH Library). Not required for the course.

## Solid Edge ST

The course makes use of the CAD system Solid Edge 2019 in the ordered (traditional) modeling environment. Students can download and install the software on their own computer via KTH Software Download, [www.kth.se/en/student/kth-it-support/software/download](http://www.kth.se/en/student/kth-it-support/software/download). Instructions to set up Solid Edge 2019 to work in the ordered modeling environment can be found in the course activity in Canvas. If you are going to work on your own computer you also have to download Dynamic Designer Motion (or Motion Professional) which is free with Academic Licences: [www.design-simulation.com/DDM/SolidEdge/ddm\\_academic1.php](http://www.design-simulation.com/DDM/SolidEdge/ddm_academic1.php)

## Teaching activities

The exercises and the project are supported by scheduled teaching in the form of:

- Lectures (L) (4 x 2h) with theory and examples linked to the assignments and project.
- Seminar (SEM) (1 x 1h) where the students reflect on the project in groups of three.
- Computer exercises (CE) (10 x 3h) where the students work individually with the assignments or their project and have the possibility to ask the teachers short questions.

A project proposal must be reviewed and approved before the project can commence. In addition, a mandatory seminar will be held in conjunction with project selection, especially to determine which modelling modules (applications and environments) are relevant for the selected product.

The table below shows the preliminary schedule and deadlines. Detailed schedule with time and location can be found on KTH course web.

W44	L1 (M33)	28/10, 15-17	Course introduction, CAD, assignment 1, Part and assembly
	CE1	29/10, 15-18	Assignment 1
	CE2	30/10, 9 – 12	Assignment 1
W45	D1	4/11, 23.55	<b>Deadline Assignment 1</b>
	L2 (M33)	4/11, 15-17	Assignment 2, Mechanism modeling
	CE3	5/11, 15-18	Assignment 2
	CE4	6/11, 9-12	Assignment 2
	D2	8/11, 23:59	<b>Deadline Project Proposal</b>
W46	D3	11/11, 23.55	<b>Deadline Assignment 2</b>
	L3 (M33)	11/11, 15-17	Assignment 3, Modeling tools & environs
	SEM (M36)	12/11, 8-9	Seminar group 1, <b>mandatory</b>
	SEM (M36)	12/11, 9-10	Seminar group 2, <b>mandatory</b>
	CE5	12/11, 15-18	Assignment 3
	CE6	13/11, 9-12	Assignment 3
W47	D4	18/11, 23:55	<b>Deadline Assignment 3</b>
	L4 (M33)	18/11, 15-17	Surface modelling, Summary report
	CE7	19/11, 15-18	Project work
	CE8	20/11, 9-12	Project work
W48	CE9	27/11, 9-12	Project work

## System and Component Design

W49	CE10	4/12, 9-12	Project work
W50		10/12, 15-18	No scheduled work
	D5	13/12, 23:55	<b>Deadline Project</b>
W51			No scheduled work.
W52			No scheduled work.
W1			No scheduled work.
W2	D6	10/1, 23:55	<b>Deadline Peer Review</b>

### Course requirements and examination

To pass the course, the following need to be submitted and approved.

**Assignments** (3 credits). Three individual assignments (on topics introduced during lectures) must be delivered at the deadlines shown in the timetable. There are two scheduled computer exercises for each assignment. Assignments have the grade scale P/F, and all three must be passed during this course round. If not, all assignments have to be re-done at a later course round. If you need to revise or complete an assignment after it has been assessed, it shall be handed in no later than five working days after you have received the notice.

**Project** (3 credits). The individual project part of the course has a grade scale A-F, including the possibility of Fx. This reflects your final grade for the course. (Note: If the grade Fx is given, the missing material must be added and approved before the next course round. If not, the whole project part of the course must be re-done at a later course round.) If the project is not submitted within the current course round, the project can only be submitted twice a year (May and December) in conjunction with other course rounds. You cannot finish the project part without passing the assignments. The course is constantly developing and the possibility of credit for course sections that are completed more than two years back in time may be lost, in whole or in part.

### Project

The project should be performed individually. Start by selecting an existing product or a product idea that you want to model. You can either make a more or less exact model of an existing product, with dimensions that you have carefully measured or found in product data sheets (i.e. reverse engineering), or you can create your own design. The modelled product must contain both electronic components and moving mechanisms. Electronic components may be overseen if you have a complex mechanical mechanism.

Note that the product should be explained in the report with the aid of your CAD-model. You should not describe the modeling techniques (e.g. how to make a sweep feature) you have used. Make good use of your CAD-model to explain the design and behaviour of the product (add text and arrows to the figures in order to help the readers). You should have about 20 unique parts in the project, but if you have parts that are complex, e.g. a brake caliper or a shell to a drilling machine, this number is not relevant. Add **detailed PMI (i.e. tolerances and possibly surface treatment and manufacturing**

## System and Component Design

**information) to** one interesting, or for the design critical, part file. Make sure you make use of relevant modeling modules in Solid Edge, i.e. if you have sheet metal in your product; model that part within the Sheet Metal environment. Analytical standard expressions are built into such modules (for example maximum allowed bend radius for sheet metals; pass or fail for a gear when modeled within engineering reference) – information that may – if relevant – be added to the report. If you make FEM simulations, be clear and present the simulation set-up (type of study, loads, constraints etc).

Your animation and rendered image(s) should have a purpose. The purpose may be to put the product in context, to understand its size, working area and in what environment it can be used. It is ok to let images take up space in the technical report - pictures where the parts cannot be discerned serve no purpose. You are welcome to make use of 2D drawings to explain a complex part, just be sure that it is correct and add it to appendix. However, make use of 3D PMI as far as possible. The language of the report should be English and name parts and assemblies in English, both the report and the CAD-model will be reviewed by a fellow student. The report and the CAD-model reflect your final grade, a guideline for the assessment of the technical report is shown in Table 1. The number of pages usually varies from 10 to 20, but it is the content and report structure that matters, not the number of pages.

*Table 1. Guideline for the assessment of the technical report. To get the grade A you have to meet C and E criteria's.*

<i>Grade</i>	<i>Criteria</i>
A	Product design and behaviour is educational and clearly presented. The student makes use of relevant and motivated models, modeling modules, analyses and terminology to describe the product characteristics.
C	The report should be neatly structured, easy to follow. The product is presented both with text and with relevant images. The model presented is realistic and there are technical reflections of the results.
E	The report has an illustrated front page, abstract, content list, introduction (with background purpose and delimitations as paragraphs) and description of the product with text and illustrative and explanatory images with the aid of the CAD-model (e.g. a complete model image, an exploded view, a section view and a rendered image).

Before you start working with your project, you'll have to upload a filled in Word document - Project Proposal and Scope to Canvas. Deadline for Project proposal submission is 8th of November at 23:55. You are welcome to upload it before the deadline. Bring two printed copies of your project proposal to the seminar.

You submit your project by uploading your report (pdf file), animation and your CAD-model (zip-file) in Canvas. Grading of the project is based on the Project assessment protocol, see Appendix A. The protocol can help you verify that you have not missed something that is assessed and scored. Deadline for Project submission is 13th of December 2019 at 23:55.

You have to deliver a peer review of another student's project in order to pass the project part. The peer review will consist of a filled in assessment protocol (document in Canvas). Deadline for Peer review submission is 10th of January 2020 at 23:55.

Project assessment protocol CAD 3D-modeling and visualization MF2019  
KTH, Machine Design,  
System and Component Design

**Appendix A**

**Modeling (max 25)**

Scope (e.g. number of parts and/or complexity)	1 2 3 4 5	
Modeling methods (i.e. has relevant features been used)	1 2 3	
Modelling modules diversity (e.g. DDM, engineering reference, harness, sheet metal, tubing etc.)	1 2 3 4 5	
Model tree structure (e.g. naming of features, parametrized models)	1 2 3	
3D PMI part model	1 2 3	
Animation(s)*	1 2 3	
Parts and subassemblies are assembled and named properly (main asm)	1 2 3	

\*The animation(s) should be uploaded as a movie file together with the model. It should be explained in the report, make a snapshot for the report.

**Report (max 21)**

Communication and reflections of design and behaviour of the product (e.g. reflect on product weight, size, design criteria's, working area, wire length and type, sheet metal thickness & material)	1 2 3 4 5	
Report structure, see Table 1 in course-PM	1 2 3 4 5	
The use of CAD terminology	1 2	
Exploded view(s)	1 2 3	
Rendered view(s)	1 2 3	
Relevance of used images**	1 2 3	

\*\*Do they fulfill a purpose to describe the design and behaviour of the product and are they linked to a descriptive text of the product

Grade A: 42-46, grade B: 37-41, grade C: 32-36, grade D: 27-31, grade E: 22-26.

Name:		
Date:		
Grade:		