



KTH, Machine Design  
System and Component Design

## **Course PM - MF2019 CAD 3D-modeling and visualization VT22, 6 credits**

### **Course description**

This course supports virtual prototyping. Designers and engineers need a common understanding of the performance aspects of the design before physical prototyping. Students create 3D CAD models that support efficient collaboration between individuals and groups of individuals with different competence types in this course. The models are useful for various purposes, such as eliminating interferences between parts, studying the operating range of a mechanism, or generating operating loads to check the design criteria using Finite Element Analysis.

The course main content covers the feature-based parametric modeling technique, which consists of two elements: a feature tree and fully parameterized wireframes employed for protruding solid features.

Structurally course is based on two parts.

The first part consists of three assignments and is intended to help students practice various tools in different modelling environments. All assignments are introduced by means of communicative images and/or movies.

The second part of the course is an individual project assignment. The participant has to 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 students model in a peer review.

### **Learning objectives**

After completing the course, the student should be able to:

- Create a CAD model with product and manufacturing information (PMI) from a system perspective.
- Create a CAD model with mixed technical contents, e.g. mechanical and electric components.
- Be familiar with modeling modules/tools (i.e., different applications and environments) in a CAD system for design of machine elements.
- Make force and motion analysis of a mechanism model.
- Carry out interference analyses.
- 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 made 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 from 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-modeling in any CAD system (i.e., create part- and assembly-models, generate exploded views, 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 entitled "MF2019 CAD 3D HT21-1 CAD 3D-modeling and Visualization". Students log on to Canvas with their KTH ID. To get access to the course activity, you must be formally admitted to the course. Students get access to lecture presentations and materials for the assignments and project through the course activity. 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 available from KTH Library). It is not required for the course.

### **Solid Edge**

The course uses the CAD system Solid Edge 2021, mostly in the ordered (traditional) modeling environment. Students can download and install the software on their 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)

If you are going to work on your 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 three assignments and the project.
- Mandatory seminar (SEM) (1 x 2h) where participants reflect on the project task in groups of three to five. Participants should present a few images of product proposals, at least two, in a ppt presentation or similar. This should be uploaded to Canvas in due time before the seminar. Keypoints: What's the purpose of the model? What downstream activities are going to be used? Are they relevant for the selected product?
- Computer exercises (CE) (11 x 3h) where participants are able to work individually with the assignments or project and can get help with short technical CAD environment related questions.

The table below shows the preliminary schedule and deadlines.

W12	L1	21/3, 15-17	Lecture 1
	CE1	22/3, 15-18	Assignment 1
	CE2	23/3, 9-12	Assignment 1
W13	<b>D1</b>	<b>28/3, 23:59</b>	<b>Deadline Assignment 1 (A1)</b>
	L2	28/3, 15-17	Lecture 2
	CE3	29/3, 15-18	Assignment 2
	CE4	30/3, 9-12	Assignment 2
	<b>D2</b>	<b>1/4, 23:59</b>	<b>Deadline Prep. for seminar</b>
W14	<b>SEM</b>	<b>4/4, 15-17</b>	<b>Seminarium, mandatory</b>
	<b>D3</b>	<b>4/4, 23:59</b>	<b>Deadline Assignment 2 (A2)</b>
	L3	5/4, 13-15	Lecture 3
	CE5	5/4, 15-18	Assignment 3
	<b>D4</b>	<b>5/4, 23:59</b>	<b>Deadline Project proposal</b>
	CE6	6/4, 9-12	Assignment 3
W15	<b>D5</b>	<b>11/4, 23:59</b>	<b>Deadline Assignment 3 (A3)</b>
	L4	11/4, 15-17	Lecture 4
	CE7	12/4, 15-18	Project work
	CE8	13/4, 9-12	Project work
W17	CE9	27/4, 9-12	Project work
W18	CE10	4/5, 9-12	Project work
W19	CE11	11/5, 9-12	Project work
W20	<b>D6</b>	<b>20/5, 23:59</b>	<b>Deadline Project final submission</b>
W22	<b>D7</b>	<b>3/6, 23:59</b>	<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 **6<sup>th</sup> May 2021**.

**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 make a more or less exact model of a product, with dimensions that you have carefully measured or found in product data sheets (i.e., reverse engineering), re-design a product, or design a new product. The modelled product must contain both electronic/hydraulic components and a moving mechanism. 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 information) to one interesting part or assembly file, or for the design critical. Make sure you use relevant modeling tools 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 tools (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 use 2D drawings to explain a part, be sure that it is correct, and add it to the 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. A fellow student will review both the report and the CAD-model. The report and the CAD-model reflect your final grade. A guideline for the assessment of the technical report is shown in Table 1.

*Table 1. Guideline. To get grade A you have to meet C and E criteria.*

<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 environments, modeling modules/tools, 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).

A project proposal must be reviewed and approved before the project can commence. You have to upload a filled in Word document - Project Proposal and Scope to Canvas. The deadline for Project proposal submission is **5<sup>th</sup> April 23.59**. You are welcome to upload it before the deadline.

You submit your project by uploading your report (pdf file), animation, and CAD-model (zip-file) in Canvas. The 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. The deadline for the project is **20<sup>th</sup> May 23.59**.

You have to deliver a peer review of another student's project to pass the project part. The peer-review will consist of a filled-in assessment protocol (document in Canvas). The deadline for Peer review submission is **3<sup>d</sup> June 2021 23.59**.

Welcome to the course!

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Course responsible

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## 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 and are models parametrized)	1	2	3			
Modeling environment and tools diversity (e.g., DDM, engineering reference, harness, sheet metal, etc.)	1	2	3	4	5	
File structure (e.g., is the main assembly is easy to find)	0			1		
Model tree structures (e.g., naming of features, parts, and subassemblies)	1	2	3			
3D PMI part model	1	2	3			
Animation(s)*	1			2		
Parts and subassemblies are assembled and named correctly (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), use relevant CAD terminology	1	2	3	4	5	
Report structure, see Table 1 in course-PM	1	2	3			
Modeling constraints and input data are clearly defined, and someone else should be able to repeat it	1	2	3	4	5	
Exploded view(s)	1	2	3			
BOM(s)	1					
	2					
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.

### Comment:

Name:		
Date:		
Grade:		