MF2011 Systems engineering (9cr)

Course-PM

Spring 2021

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Canvas activity: ***MF2011 VT21-1 Systems Engineering***

KTH Maskinkonstruktion

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Background

Systems engineering requires a holistic view and multidisciplinary cooperation and a systematic approach.

Desired effects, such as long life, small energy losses and good cooling, and *undesired effects*, such as high cost, high weight, large deformations, vibrations and noise are two types of technical effects that are intimately related to most mechanical and electromechanical systems. An *optimal technical design* can be defined as the design that in the best possible way maximizes the most important desired effects and/or minimizes the most dominant undesired effects. For a design to be optimal from customer, as well as society and enterprise perspectives it must also possess many other important properties despite from purely technical properties. Development and design of advanced technical systems prerequisites a good treatment of technical complexity and uncertainty and efficient cooperation between individuals and groups of individuals with different types of competence. Collaborative tools are tools designed to help people involved in a common task achieve goals. Collaborative computer based tools, such as integrated CAD and CAE software, is the basis for computer supported collaborative engineering work.

Aim

The main goal is that the students shall develop their capabilities to treat systems engineering from a holistic and lifecycle perspective (interaction with the environment, existing and future customer needs and demands, the technological development, etc.). Further more, the course aims at that the students shall acquire a thorough knowledge of available methods and frameworks for product modeling (CAD), and geometry-based simulations (CAE), as well as industrially relevant strategies and methods for integrated management of all product information during the products entire lifecycle, i.e. product lifecycle management (PLM).

A student that has completed the course shall:

- be able to integrate and apply component knowledge to systems engineering;
- be able to describe common models for planning and executing systems engineering;
- have planned and performed model-based collaborative systems engineering with the support from a system CAD-model and related simulation models;
- have applied systematic function decomposition, analysis and synthesis;
- have performed a DSM-based analysis of the architecture of a complex product;
- have performed a simulation with a condensed FE model;
- have performed a qualitative risk analysis with the aid of Fault-Tree Analysis (FTA);
- be able to elaborate on the business motives for using PDM-, PLM-, CAD- and CAE-in technical development and engineering;

Course components

- Lectures (12 x 2 hours) (75% attendance required):

  Digital Zoom-based Lectures on systems engineering topics

- Exercises (4 x 2 hours):

  Practical exercises on topics introduced at a preceeding lecture.

  Each exercise is performed in group, and the results must be documented, uploaded to Canvas, and approved.

- Systems engineering literature seminars (3 x 2 hours) (Compulsory attendance):

  Each student, or alternatively a group of students, is appointed one/several reports/articles from the supplied course material on the seminar topic and prepares a 10-15 minute oral presentation of the studied material. The presentation must be uploaded to Canvas, no later than the day before the presentation. The seminars are digital Zoom-based activities.

- Project meetings (5x2 hours) & Pulse meetings (4x2 hours) (Compulsory attendance):

  Basically project decision gate & deviation meetings.

- Project work (non-scheduled) (Individual and group responsibility to plan and attend):

  See the project task document (published later) for the generic individual and group deliverables.

  Specific deliverables are defined at the project meetings.

- Project presentation (4 hours) seminar (Compulsory attendance):

  Each project group writes a report and makes a 20 minute oral (Powerpoint-) presentation of their subproject.

- Personal electronic log book (non-scheduled) (Individual assignment):

  Each individual writes a personal log book (a diary) describing the main topics in all lectures, exercises and literature seminars and project work, personal reflections and the personal learnings gained from all these activities, and an ending discussion/conclusions/suggestions.

Final grading

Final grading (A-F) is based on the following three level scheme:

- Level 1 (Grading E or D) – Participation at the lectures, passed exercises and active participation at the seminars and in the project work + a destrictive personal electronic log book on all course topics and project activities
- Level 2 (Grading C or B) – passed level 1 + individual (good quality) contributions to project group deliverables + an addition of reflections on each course topic and project activity to personal electronic log book.
- Level 3 (Grading A or B) – passed level 2 + an addition of final analysis/ reflections/suggestions on the project process and outcome and own learning outcomes to personal electronic log book

Prerequisites

The course is at an advanced level, and prerequisites is a Bachelor in Mechanical Engineering, or similare.

Course literature

1 - Course material on Canvas LMS.

2 - INCOSE, 2006, “Systems engineering handbook, version 3”, INCOSE-TP-2003-002-03.

Course coordinator

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Scheme, Spring 2021

	Period 3	Time	Location	Lecture (L)/ Excercise (E)/ Seminar (S)/ Project (P) **Pending** means "no scheduled activity"
W3	Wednesday 20 Jan	10-12	Digital	**L1:** Introduction to systems engineering & Systems development models
	Friday 22 January	10-12	Digital	**L2:** Model-based systems engineering
W4	Tuesday 26 January	13-15	Digital	**L3:** Collaborative design
	Wednesday 27 Jan	13-15	Digital	**P0:** Project start and Gate 0 meeting
	Friday 29 January	10-12	Glader/Prosit	**E1**: *Collaborative engineering (top-down modeling*
	Friday 29 January	12:00	Canvas	***Groupl upload of wish for project group to Canvas P0 – Project Group wish assignment***
W5	Tuesday 2 feb	13-15	Digital	**L4:** Systematic function design
	Thursday 4 feb	12:00	*Canvas*	***Group presentations uploaded to Canvas Literature seminar 1assignment***
	Friday 5 feb	10-12	Digital	**S1:** Systems Engineering literature seminar ***S1***
W6	Tuesday 9 Feb	13-15	Digital	**L5:** Systems architectures
	Wednesday 10 Feb	13-15	Digital	**L6:** Function analysis
	Friday 12 Feb	10-12	Butter, Trötter	**E2**: *Function-means representation*
W7	Tuesday 16 Feb	13-15	Digital	**P1/P2: Group presentation** of system ***requirements list*** and systems ***architecture definition***
	Frisday 19 Feb	10-12	Digital	**L7:** Robust & intelligent modules
W8	Tuesday 23 Feb	13-15	Digital	**Project pulse meeting #1**
	Friday 26 Feb	10-12	Digital	**P3:** Project Gate 3 meeting (system architecture definition)
W9	Tuesday 2 March	13-15	Digital	**Not used**
	Wednesday 3 Mar	13-15	Digital	**E3:** *Module clustering*
	Thursday 4 March	12:00	*Canvas*	***S2 presentations uploaded to Canvas as assignment***
	Friday 5 March	10-12	Digital	**S2:** Architecting litterature seminar

	Period 4	Time	Location	Lecture (L)/ excercise (E)/ seminar (S)
W12	Tuesday 23 Mar	13-15	Digital	**L8: System reliability & FTA**
	Wednesday 24 Mar	13-15	Digital	**L9: Design aspects of reliability**
	Friday 26 March	10-12	Digital	**Project pulse meeting #2**
W13	Tuesday 30 Mar	13-15	Digital	**L10:** Submodeling, Static and dynamic condensation & Submodeling
	Wednesday 31 Mar	13-15 y	Digital	**Prending**
W15	Tuesday 13 Apr	13-15	Glader/Trötter & Digital	**E4:** *System dynamics with component mode synthesis & Submodeling*
	Wednesday 14 Apr	13-15	Digital	**Project pulse meeting #3**
	Friday 16 April	10-12	Digital	**Prending**
W16	Friday 23 April	10-12	Digital	**P4:** Project Gate 4 meeting (subsystem definition & integration)
W17	Tuesday 27 Apr	13-15	Digital	**L11:** System verification and validation
	Wednesday 28Apr	13-15	Digital	**P5:** Project Gate 5 meeting (system integration)
	Friday 30 Apr	10-12	Digital	**L12:** Collaborative design enabled by PDM/PLM
W18	Thursday 6 May	12:00	Canvas	***S3 presentations uploaded to Canvas as assignment***
	Friday 7 May	10-12	Digital	**S3:** Reliability and safety literature seminar
W19	Tuesday 12 May	13-15	Digital	**Project pulse meeting #4**
W20	Friday 21 May	8-12	Digital	**P6: Project presentation seminar**
W21	Friday 21 May	23:59	*Canvas*	**Final Project report & model + personal log book** upload