MF2011 Systems engineering (9cr)

Course-PM

Spring 2013

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KTH Social: www.kth.se/social/course/MF2011/

Course e-mail: mf2011@md.kth.se
Bilda activity: MF2011 Spring 2013

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), product data management (PDM), 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 a distributed collaborative technical design project with the support from a master CAD-model and related simulation models;
- have applied systematic function analysis and synthesis;
- have performed a DSM-based analysis of the architecture of a complex product;
- be able to describe the most industrially relevant product model standards and neutral formats that enable collaborative engineering, and be able to discuss their pros and cons;
- 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 (14 x 2 hours) (75% attendance required):

  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 Bilda, and approved.

- Systems engineering literature seminars (4 x 2 hours) (Compulsory attendance):

  Each student 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 Bilda, no later than the day before the presentation.

- Project meetings (7x2 hours) (Compulsory attendance):

  Basically project decision gate workshops.

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

  See the project task document for the generic individual and group deliverables.

  Specific deliverables are defined at the project meetings.

- Project presentation (2 hours) seminar (Compulsory attendance):

  Each project group writes a report and makes a 15 minute oral (Powerpoint-) presentation of their subproject.

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.
- Level 2 (Grading C or B) – passed level 1 + individual (good quality) contributions to project group deliverables.

- Level 3 (Grading A or B) – passed level 2 + a well performed oral examination or deepened project deliverable.

Prerequisites

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

Course literature

1 - Course material on Bilda.

2 - Michael F. Ashby, "Materials Selection in Mechanical Design", Elsevier Butterworth-Heinemann, 2005.

3 - Anton van Beek, “Advanced engineering design. Lifetime performance and reliability”, TU Delft, 2006.

Course coordinator

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Scheme, Spring 2013

	Period 3 (w 2-10)	Time	Location	Lecture (L)/ Excercise (E)/ Seminar (S)/ Project (P) **Pending** means "no scheduled activity"
V03	Monday 14 jan	13-15	M22	**L1:** Introduction to systems engineering
	Wednesday. 16 jan	10-12	M22	**L2:** Systems development models
	Friday 18 Jan	23:59		Choice of literature for S1 uploaded to Bilda
V4	Monday 21 jan	13-15	M22	**P0:** Project start and Gate 0 meeting
	Wednesday 23 jan	10-12	M22	**L3:** Collaborative design
	Thursday 24 jan	10-12	Kloker	**E1**: Collaborative engineering
V5	Monday 28 jan	13-15	M22	**Pending**
	Wednesday 30 jan	10-12	M22	**L4:** Systematic function design
	Friday 1 feb	23:59		Choice of literature for S2 uploaded to Bilda
V6	Monday 4 feb	13-15	M22	**Pending**
	Wednesday 6 feb	10-12	M22	**L5:** Systems architecture
	Thursday 7 feb	10-12	Kloker	**E2**: Module clustering
V7	Monday 11 feb	15-17	M22	**L6:** Function analysis
	Wednesday 13 feb	10-12	M35	**S1:** Systems engineering literature seminar
V8	Monday 18 feb	13-15	M22	**P1/P2: Individual delivery** of system ***requirements list*** and systems ***architecture definition***
	Wednesday 20 feb	10-12	M23	**S2:** Modularization litterature seminar
V9	Monday 25 feb	13-15	M22	**P3:** Project Gate 3 meeting (system architecture definition)
	Wednesday 27 feb	10-12	M22	
	Friday 29 feb	23:59		Choice of literature for S3 uploaded to Bilda
V10	Monday 4 mar	13-15	M22	**Pending**
	Wednesday 6 mar	10-12	M37	**L7:** System reliability **L8:** Reliability/safety, FTA & FMEA
	Thursday 7 mar	10-12	Kloker	**S3:** Reliability literature seminar

	Period 4 (w 12-22)	Time	Location	Lecture (L)/ excercise (E)/ seminar (S)
W12	Tuesday 19 mar	13-15	M22	**Pending**
	Wednesday 20 mar	10-12	M22	**L9:** Design aspects of reliability
	Friday 22 mar	10-12	M37	**P4:** Project Gate 4 meeting (subsystem definition & integration)
W13	Tuesday 26 mar	13-15	M22	**L10:** Dynamics-related phenomena and mechanisms
	Wednesday 27 mar	0-10	M22	**L11:** Static and dynamic condensation
	Wednesday 27 mar	10-12	Kloker	**E3**: System dynamics with component mode synthesis
W14				
W15	Tuesday 9 april	13-15	M22	**L12:** System verification and validation
	Wednesday 10 april	10-12	M22	**L13:** Collaborative design enabled by PDM/PLM
	Friday 12 april	10-12	M37	**Pending**
	Friday 12 april	23:59		Choice of literature for S4 uploaded to Bilda
W16	Tuesday 16 april	13-15	M22	**P5:** Project Gate 5 meeting (system integration)
	Wednesday 17 april	10-12	M22	**Pending**
	Friday 19 april	10-12	Kloker	**Pending**

W17	Tuesday 23 april	13-15	M22	**L14: Submodeling**
	Wednesday 24 april	10-12	M22	**E4:** Submodeling
	Friday 26 april	10-12	M22	**Pending**
W18	Tuesday30 april	13-15	M22	**P6:** Project Gate 6 meeting (system verification)
	Friday 3 may	8-10	M22	**S4:** PLM literature seminar
	Friday 3 may	10-12	Kloker	**Pending**
W19	Tuesday 7 may	13-15	M22	**Pending**
	Wednesday 8 may	10-12	M22	**P7:** Project Gate 7 meeting (system validation)
W20	Tuesday 14 may	13-15	M22	**S5/P8: Project presentation seminar**
	Wednesday 15 may	10-12	Kloker	**Pending**
W22	Wednesday 29 may	12:00	Bilda	**Final Project report & model** delivery