MF2011 Systems engineering (9cr)

Course-PM

Spring 2012

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Course webpage: http://www.kth.se/itm/inst/mmk/edu/inst_kurser/md/MF2011/

Course e-mail: mf2011@md.kth.se
Bilda activity: MF2011VT2012

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- and tribological 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 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.

- 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) – passed level 2 + a well performed oral examination or deepened project deliverable.

Prerequisites

The course is at an advanced level, and prerequisites are the basic courses Design and Product Realization (DoP) Components, Product Realization Components for M, or Product

Realization for T, and either one of the Project Courses in Machine Design/Integrated Product Development, or alternatively the course Model-based Product Development, or similare.

Course literature

1 - Course material.

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 2011

	Period 3 (w 2-10)	Time	Location	Lecture (L)/ Excercise (E)/ Seminar (S)/ Project (P) **Pending** means "no scheduled activity"
V03	Wednesday 18 jan	10-12	M23	**L1:** Introduction to systems engineering
	Friday. 20 jan	08-10	M23	**L2:** Systems development models
	Friday 20 Jan	23:59		Choice of literature for S1 e-mailed (mf2011@md.kth.se)
V4	Tuesday 24 jan	15-17	M23	**P0:** Project start with guest lecture and Gate 0 meeting
	Wednesday 25 jan	08-10	M23	**L3:** Collaborative design
	Friday 27 jan	10-12	Glader	**E1**: Collaborative engineering
V5	Tuesday 31 jan	15-17	M23	**S1:** Systems engineering literature seminar
	Wednesday 1 feb	10-12	M23	**L4:** Systematic function design
	Friday 3 feb	23:59		Choice of literature for S2 e-mailed (mf2011@md.kth.se)
V6	Tuesday 7 feb	13-15	M23	**L5:** Systems architecture
	Wednesday 8 feb	10-12	M23	**L6:** Function analysis
	Friday 10 feb	08-10	Prosit	**E2**: Function analysis
V7	Wednesday 15 feb	10-12	M23	**S2:** Modularization litterature seminar
	Friday 17 feb	8-10	M23	**P1/P2: Individual delivery** of system ***requirements list*** and systems ***architecture definition***
V8	Friday 24 feb	8-10	M23	**P3:** Project Gate 3 meeting (system architecture definition)
	Friday 24 feb	23:59		
V9	Wednesday 29 feb	10-12		Choice of literature for S3 e-mailed (mf2011@md.kth.se)
V10	Wednesday 7 mar	8-10	M22	**L7:** System reliability **L8:** Reliability/safety, FTA & FMEA
	Friday 9 mar	10-12	M23	**S3:** Reliability literature seminar

	Period 4 (w 12-21)	Time	Location	Lecture (L)/ excercise (E)/ seminar (S)
W12	Wednesday 21 mar	13-15	M37	**L9:** Design aspects of reliability
	Friday 23 mar	15-17	M23	**P4:** Project Gate 4 meeting (subsystem definition & integration)
W13	Tuesday 27 mar	15-17	M22	**L10:** Dynamics-related phenomena and mechanisms
	Wednesday 28 mar	10-12	M23	**L11:** Static and dynamic condensation
	Friday 30 mar	15-17	Prosit	**E3**: System dynamics with component mode synthesis
W14				
W15	Tuesday 10 april	15-17	M22	**L12:** System verification and validation
	Wednesday 11 april	13-15	M23	**L13:** Collaborative design enabled by PDM/PLM
	Friday 13 april	15-17	M23	**Pending**
	Friday 13 april	23:59		Choice of literature for S4 e-mailed (mf2011@md.kth.se)
W16	Tuesday 17 april	13-15	M22	**P5:** Project Gate 5 meeting (system integration)
	Wednesday 18 april	13-15	M23	**Pending**
	Friday 20 april	10-12	-	**Pending**

W17	Tuesday 24 april	13-15	M35	**L14: Submodeling**
	Wednesday 25 april	10-12	To be decided	**E4:** Submodeling
	Friday 27 april	15-17	M23	**Pending**
W18	Wednesday 2 may	13-15	M23	**P6:** Project Gate 6 meeting (system verification)
	Friday 4 may	10-12	M23	**S4:** PLM literature seminar
W19	Tuesday 8 may	13-15	-	**Pending**
	Wednesday 9 may	10-12	M23	**P7:** Project Gate 7 meeting (system validation)
	Friday 11 may	10-12	M23	**Pending**
W20	Tuesday 15 may	13-15	B319, Brv 85	**S5/P8: Project presentation seminar**
	Wednesday 16 may	10-12	-	**Pending**
W22	Wednesday 30 may	12:00	Bilda	**Final Project report & model** delivery