Subject Guide – Machine Design Process

Shortened Name	MDP	**Semester**	1-2023
Class Time (weekly)	Mon, 13-16	**Lecture hours**	3h x 15w
Subject Code	090125104	**Assignment and self-study**	5h x 15w
ECTS credits	6	**Preparation for exam**	30
KMUTNB Credits	3(3-0-6)	**Total working hours/semester**	150

1 Revision date of this document, reasons for revision

- 21.06.2023

2 Course description

The course is split into two main parts:

Part 1: Review of drawing fundamentals; Drawing standards; Bolted and welded connections; Shaft-and-hub connections; Geometric irregularities and tolerances; Shaft bearings; Power transmission types, drives and gears.

Part 2: Systematic design process and methodology; Engineering design process; Requirements list; Conceptual design; Evaluation and selection solutions; Design rules.

3 Lecturer

- Dr.-Ing. Alex Brezing

4 Expected learning outcomes (in accordance with the MAE program ELOs)

Primary LOs (primary content of class, knowledge is explicitely evaluated (for example, by exams), larger share of overall grade)

- Ability to define a technical task or problem, to analyze/structure it and formulate a strategy to solve it (GELO 1)
- Awareness and sensitivity towards an engineer's responsibility for sustainability and aspects such as lifecycle costs, reliability, safety, engineering's impact on society and nature etc. (GELO 2)
- Knowledge and understanding of principles, techniques and methodology of *design* (SELO 1)
- Knowledge of the State-of-the-Art *of selected examples* of technical systems and technologies in the field (SELO 3)
- Ability to transform an actual technical scenario into a valid model that can be used for a design (SELO 4)

Secondary LOs (not primary content of class, but implicetly taught by application, for example by project work or assignments. Is evaluated, lower share of overall grade)

- Ability to write a professional-quality report on a research or problem-solving project (GELO 3)
- Ability to conduct a project as a team member, to take responsibility for contents and schedule, to deliver the results on time (GELO 4)
- Ability to present a project in front of a professional audience (GELO 6)
- Ability to manage a project as a team lead, to structure content and schedule, assign responsibilities, to follow up on progress and take measures to prevent delays, to act as the communication channel for the complete team (GELO 7)
- Knowledge and understanding of scientific fundamentals relevant for the understanding of the behaviour of solid bodies, structures, mechanisms and fluids in engineering applications (SELO 2)
- Ability to apply methodology and commercial CAD software to design and reverse engineer mechanical components/systems and consumer goods (SELO 6)
- Knowledge of engineering materials, modes of failure and degradation as well as applicable production techniques (SELO 7)
- Knowledge of appliccable laws, guidelines, regulations (SELO 8)

Note: These ELOs correspond to the Program ELOs (referenced in parantheses) but are specifically worded for this course by omissions and additions (in *italics*).

5 Assessment

Each student will be individually assessed based on the performance on assignments, a project and written exams, with the overall grade resulting from the shares as below:

Evaluated items	**shares**
Midterm exam, 120 minutes, on content of “part 1” of the class	30%
Final exam, 180 minutes, on content of “part 2” of the class	40%
Design Project: CAD design, team work, presentation, design report	30%
Total	**100%**

- Both exams are closed book and paper-based
- A project assignment is handed out in week 10, containing a detailed break-down of content and evaluated items. The students of each team have to assign responsibilities for the items among themselves and will be individually evaluated accordingly.

6 Teaching materials

- Power-Point presentations for lectures, handed over as reference and learning material
- Exercise-assignments for each week’s topic
- Solutions for exercise-assignments, handed over one week after exercise

7 Books and references

- G. Pahl, W. Beitz, J. Feldhusen, K-H. Grote: “Engineering Design: A Systematic Approach”, ISBN-13: 978-1846283185.

The book is not required to take part in the course but recommended background reading.

8 Course schedule

Week	Date	Activity, Class Title (unit number)	Evaluation %	Class Hours
1	07/08	Introduction, course and project overview (0), Drawing Standards 1 (1)		6
2	14/08	**NO CLASS**		
3	21/08	Drawing Standards 2 (2)		3
4	28/08	Joints & Connections (3)		3
5	04/09	Bearing of shafts (4)		3
6	11/09	Power transmission (5)		3
7	18/09	Geometrical irregularities and tolerances (6)		3
8	25/09	Tolerance Design and Documentation (7)		3
9	02/10	**Written Midterm Exam**	30%	
10	09/10	Engineering design process, requirements list (8)		3
11	16/10	Conceptual design 1 (9)		3
12	23/10	**NO CLASS (CHULALONGKORN MEMORIAL DAY)**		
13	30/10	Conceptual design 2 (10)		3
14	06/11	Conceptual design 3 (11)		3
15	13/11	Basic Rules of Embodiment Design 1 (12)		3
16	20/11	Basic Rules of Embodiment Design 2 (13)		3
17	27/11	**Final Exam**	40%	
18	04/12	**Final Presentation of the Design Project**	30%	3
		(Sums)	100%	45

9 Content details

Unit #	Title	Lesson (L) Contents
0	Introduction, course and project overview	• Definitions: design process, methodology etc. • Characteristics and history of design methodology • Introduction to drawing standards/machine elements
1	Drawing Standards 1	• Drawing sets, types of documents, standardization • Projection drawing and axonometric views • Elements of technical drawings, dimensioning
2	Drawing Standards 2	• Section views: fundamentals • Section types: full, half, local, offset, kinked • Broken and detail views
3	Joints & Connections	• Definitions and categorizations • Threads and bolted connections, pins and bolts • Shaft/hub connections
4	Bearing of shafts	• Bearing principles • Bearing arrangements, bearing types, fasteners • Sealings
5	Power transmission	• Definitions and categorizations, uniform & non-uniform • Traction drives • Gear drives
6	Geometrical irregularities and tolerances	• Definitions and categorizations • Dimensional tolerances and fits, ISO, general, systems • Tolerances of form and position, surface roughness
7	Tolerance Design and Documentation	• Case Study: design of a front-loading washing machine • Analysis of functions, assembly, forces and tolerances • Complete production drawings of housing and shaft
8	Engineering design process, requirements list	• Kinds of design, characteristics, fundamental approach • Technical specification, purpose/main task • Requirements management
9	Conceptual design 1	• Functional decomposition • Discursive methods to identifying solution principles • Case studies: energy dissipation principles (brakes etc.)
10	Conceptual design 2	• Systematic variation of conceptual solutions • Classification schemes • Heuristic and analogy methods to identify sol. principles
11	Conceptual design 3	• Morphological combination of concepts • Geometrical validation of concepts • Methods of technical evaluation
12	Basic Rules of Embodiment Design 1	• Hierachy/overview of rules of embodiment design • Basic rules: Simple and Clear • Case studies: Clear design of joints and bearings
13	Basic Rules of Embodiment Design 2	• Safe design: overview, liability and market acceptance • Safe Design: direct safety, indirect safety, warnings • Direct Safety Principles: safe-life, fail-safe, redundancy

10 Details on the evaluation of Expected Learning Outcomes

		MT-Exam	Final Exam	Project			
				Report	CAD-Design	Presen-tation	
		30%	40%	15%	10%	5%	
GELO1	Ability to define a design task or problem, to analyze/structure it and formulate a strategy to solve it	1.0%	5.0%	2.0%	1.0%	1.0%	**10%**
GELO2	Awareness and sensitivity towards an engineer's responsibility for sustainability…	3.0%	3.0%	1.0%			**7%**
SELO1	Knowledge and understanding of principles, techniques and methodology of design	3.0%	11.0%	2.0%			**16%**
SELO3	Knowledge of the State-of-the-Art of selected examples of technical systems and technologies in the field	5.0%	8.0%	1.0%	1.0%		**15%**
SELO4	Ability to transform an actual technical scenario into a valid model that can be used for a design	7.0%	5.0%	1.0%			**13%**
GELO3	Ability to write a professional-quality report on a research or problem-solving project			3.0%			**3%**
GELO4	Ability to conduct a project as a team member…			1.0%	1.0%	1.0%	**3%**
GELO6	Ability to present a project in front of a professional audience					3.0%	**3%**
GELO7	Ability to manage a project as a team lead			1.0%			**1%**
SELO2	Knowledge and understanding of scientific fundamentals…	2.0%	2.0%	1.0%	1.0%		**6%**
SELO6	Ability to apply methodology and commercial CAD software to design	2.0%	2.0%		4.0%		**8%**
SELO7	Knowledge of engineering materials, modes of failure and […] production techniques	2.0%	2.0%	1.0%	2.0%		**7%**
SELO8	Knowledge of applicable laws, guidelines, regulations	5.0%	2.0%	1.0%			**8%**