Subject Guide – Industrial Design Engineering

Shortened Name	IDE	**Semester**	2-2023
Class Time (weekly)	Tue, 9-12	**Lecture hours**	3h x 15w
Subject Code	090125111	**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

- 08.01.2024

2 Course description

The objective of the course is to prepare graduates for the development and design of consumer goods and vehicles in industrial practice. Such processes and the necessary knowledge and skills differ from traditional engineering design with regards to the users of the developed products, the collaboration with designers, the complexity of geometry and materials and production processes for mass-production.

The content covers:

- principles and guidelines of embodiment design, with a focus on the design of structures and structural parts and design rules for technologies of mass-production;
- structural design, with a focus on structures of road vehicles;
- human-body-centric design: ergonomics, anthropometrics, vehicle package design;
- theory and methodology of Industrial Design: vehicle styling, product language, market segmentation, user experience design.

The students will work on a design project in small teams during the semester. The students are evaluated by the results of the project, exams and assignments.

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 explicitly evaluated (for example, by exams), larger share of overall grade):

- Ability to define a task or problem, to analyze/structure it and formulate a strategy to solve it (GELO1)
- 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.(GELO2)
- Knowledge and understanding of principles, techniques and *methodology of design* (SELO1)
- Knowledge of engineering materials, modes of failure and degradation as well as applicable production techniques (SELO7)
- Knowledge, understanding and ability to consider the human body in design (SELO9)

Secondary LOs (not primary content of class, but implicitly 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 (GELO3)
- Ability to conduct a project as a team member, to take responsibility for contents and schedule, to deliver the results on time (GELO4)
- Ability to present a project in front of a professional audience (GELO6)
- 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 (GELO7)
- Knowledge and understanding of scientific fundamentals relevant for the understanding of the behavior of *structures and mechanisms* in engineering applications (SELO2)
- Ability to apply methodology and commercial CAD software to design and reverse engineer *vehicle structures, structural components and consumer goods* (SELO6)
- Knowledge of applicable laws, guidelines, regulations (SELO8)

Notes on ELOs:

- These ELOs correspond to the Program ELOs (referenced in parentheses) but are specifically worded for this course by omissions and additions.

5 Assessment

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

Evaluated items	**shares**
Midterm Exam	50%
Project (CAD-Design, report and presentation)	50%
Total	**100%**

- The midterm exam is closed book, paper-based, 180 minutes.
- A separate project assignment is handed out in week 11, 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

- Lecture slides and assignments are shared as electronic files.

7 Books and references

- G. Pahl, W. Beitz, J. Feldhusen, K-H. Grote: “Engineering Design: A Systematic Approach”, ISBN-13: 978-1846283185.
- H. Wallentowitz: “Structural Design of Vehicles”, lecture script of the class “Structural design of Vehicles” as taught at RWTH Aachen University (older edition), Forschungsgesellschaft Kraftfahrwesen Aachen mbH (fka), ISBN 3-925 194-xx-x

The books are not required to take part in the course but recommended background reading.

8 Course schedule

Week	Date (2024)	Activity, Class Title (unit number)	Evaluation %	Class Hours
2	09/01	Course Introduction, Principles of Embodiment Design (1)		3
3	16/01	Structural Design Process Overview (2)		3
4	23/01	ED-Guidelines 1: machining, assembly (3)		3
5	30/01	ED-Guidelines 2: injection-molding/plastics (4), ED-Guidelines 3: welding, sandwich structures (5)		3
6	06/02	Vehicle structures and structural features of road vehicle bodies (6)		3
6	08/02 (THU!)	Vehicle body stiffness and vibrations (7), Vehicle lightweight design (8)		3
7	NO IDE/SDM CLASS (RVVD Block Lecture)			
8	20/02	Production Procedures in Automotive (9)		3
9	NO IDE/SDM CLASS (FSMB Block Lecture)			
10	05/03	**Written Midterm Exam**	50%	3
11	12/03	Human-Body-Centric Design, Ergonomics (10)		3
12	19/03	The Vehicle Styling Process (11) Discussion of Design Project Assignment		3
13	26/03	Introduction Industrial Design Theory: Product Language (12)		3
14	02/04	Industrial Design Process, part 1 (13)		3
15	09/04	Industrial Design Process, part 2 (14) Case Studies related to the project (15)		3
16	NO IDE CLASS - SONGKRAN HOLIDAY			
17	23/04	**Design Review**		3
18	NO IDE CLASS (BUFFER WEEK)			
19	07/05	**Final Presentation of the Design Project**	50%	3
		(Sums)	100%	45

9 Content details

Unit #	Title	Lesson (L) Contents
1	Principles of Embodiment Design	• Course Overview and Introduction • Principles of Embodiment Design • Principles of: Division of Tasks, Bi-Stability, Self-Help
2	Structural Design Process Overview	• The Structural Function, Principles of Force Transmission • Overview of the Structural Design Process • Structural Topology
3	ED-Guidelines 1: machining, assembly	• Overview: Guidelines of Embodiment Design ("DfX") • Detailed: Df Machining, Df Assembly • Case-study: Designs of a junction box
4	ED-Guidelines 2: injection-molding/plastics	• Injection Molding: causes of warping, design measures • Snap-fits, living hinges, welding plastics • Case-study: Corvette plastic stabilizer link
5	ED-Guidelines 3: welding, sandwich structures	• Welded structures: design rules • Sandwich materials, failure modes, applications • Case-study: water-tank (steel-frame, sandwich)
6	Vehicle structures and structural features of road vehicle bodies	• Transport function, vehicle configurations, body structures • Features of Unibody and frame-type body structures • Bending, torsion and buckling of vehicle body members
7	Vehicle body stiffness and vibrations	• Body stiffness: definitions, relevance, design measures • Vibration systems in vehicles, design measures • Case study: BMW design progress over time
8	Vehicle lightweight design	• Lightweight design: materials and geometry, cost • Metals, composites: selection, parameters, recycling • Thin-walled geometry, lightweight-quality parameter
9	Production Procedures in Automotive (Sheet-Metal)	• Sheetmetal and profile forming and joining technologies • incl. tailored blanks, hydroforming, laser-welding etc. • Discussion of resulting possible design optimizations
10	Human-Body-Centric Design, Ergonomics	• Ergonomics: definitions, challenges, design strategies • Anthroprometrics: statistics, regional & temporal trends • Driver posture, vehicle package-design, design tools
11	The Vehicle Styling Process	• Terms & definitions: Class-A, G2-continuity, rendering… • Styling process and tools: sketching, CAS, clay-modelling • Case-studies: Dodge Charger, iPad surface modelling
12	Introduction Industrial Design Theory: Product Language	• Fundamentals: Maslow's motivational theory, Semiotics • Product Semantics: Offenbach Approach with examples • Case-studies: electronic door opener, Zippo lighter
13	Industrial Design Process, part 1	• Industrial Design Process • Market Segmentation, Value Proposition, SINUS-Milieus • Case-studies: Milieus of Thailand, TOYOTA Value Prop's
14	Industrial Design Process, part 2	• User Experience Design • Trend Board Method • Case-study: plastic home organizer
15	Case Studies in Individual Mobility	• Special Vehicle Structures • Special Solutions in Propulsion Systems • other casse studies related to the design project

10 Details on the evaluation of Expected Learning Outcomes

		MT-Exam	Project			Sums
			Report	CAD-Design	Presentation	
		50%	25%	20%	5%	
GELO1	Ability to define a task or problem, to analyze/structure it and formulate a strategy to solve it	10.0%	2.0%	1.0%	0.5%	**13.5%**
GELO2	Awareness and sensitivity towards an engineer's responsibility for sustainability …	5.0%	3.0%		0.5%	**8.5%**
SELO1	Knowledge and understanding of principles, techniques and methodology of design	10.0%	4.0%			**14.0%**
SELO7	Knowledge of engineering materials, modes of failure and … applicable production techniques	10.0%	4.0%	4.0%		**18.0%**
SELO9	Knowledge, understanding and ability to consider the human body in design		4.0%	4.0%	1.0%	**9.0%**
GELO3	Ability to write a professional-quality report		4.0%			**4.0%**
GELO4	Ability to conduct a project as a team member …		1.0%	1.0%	1.0%	**3.0%**
GELO6	Ability to present a project in front of a professional audience				2.0%	**2.0%**
GELO7	Ability to manage a project as a team lead		1.0%			**1.0%**
SELO2	Knowledge and understanding of scientific fundamentals …	5.0%	2.0%	2.0%		**9.0%**
SELO6	Ability to apply methodology and commercial CAD software to design	5.0%		8.0%		**13.0%**
SELO8	Knowledge of applicable laws, guidelines, regulations	5.0%				**5.0%**