Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Summer School "Systems Engineering and Design of Complex Systems"
Course code	47572
Scientific sector	Ing-Ind/16
Degree	Bachelor, Master and PhD level (beginners course)
Semester	2
Year	2022
Academic Year	2021-2022
Credits	2 ECTS
Modular	no

Total lecturing hours	8
Total lab hours	
Total exercise hours	12
Attendance	necessary
Prerequisites	/
Course page	

Specific educational objectives	The summer school aims at teaching both scientific foundations and practical methods of **Systems Engineering** and helps to develop specific professional skills. Fundamental principles of **Axiomatic Design (AD)** are reviewed, with insights and perspectives of over 30 years of teaching and practice. This should be of interest to beginners and to all levels of users. The latest methods for using AD, qualitatively and quantitatively, for selecting the best design solutions and for fostering innovations are presented. AD, originating with Nam Suh at MIT in the late 1970s, contends that all good designs comply with two axioms: maintaining independence of the functional elements and minimizing information content. AD can add value and reduce costs in designs and in the design process of products, software, mechanical systems, manufacturing systems and organizations. This tutorial is intended students, phd students, researchers and design practitioners, who might have never used Axiomatic Design as design theory, or who would like a fresh perspective.

Lecturer	Dr. Erwin Rauch (Free University of Bolzano, Italy), erwin.rauch@unibz.it With guest lectures of :

	Prof. Nam P. Suh (Massachussetts Institute of Technology MIT, Boston, USA) Prof. Chris Brown (Worcester Polytecnic Institute, MA, USA) Prof. David Cochran (Purdue University West Lafayette, IN, USA) Prof. Erik Puik (University of Applied Sciences Utrecht, Netherlands) Prof. Joseph Foley (University of Reykjavik, Iceland) Prof. Miguel Cavique (NOVA University Lisbon, Portugal)
Scientific sector of the lecturer	Ing-Ind/16
Teaching language	English
Office hours	To be agreed upon
Teaching assistant (if any)	Organizational support: Dr. Luca Gualtieri (Free University of Bolzano, Italy) Luca.gualtieri@unibz.it
Office hours	/
List of topics covered	The lecture hours cover the following topics: 1. Introduction in Axiomatic Design (AD) 2. Domains in AD 3. Customer Needs 4. Functional Requirements 5. Design Parameters 6. Process Variables 7. Constraints 8. Independence Axiom 9. Information Axiom 10. Design Matrix 11. Decomposition and Mapping process 12. MSDD design approach 13. Design of Complex Systems and practical examples (Software System Design and Integration, Mechanical Systems, Design of Manufacturing Systems, Design of Cyber-Physical Systems) Exercises: Case study elaboration in groups during the exercise hours. The summer school will be offered partly in remote (the lectures are held with international guest lecturers via live streaming). The exercises are held on-site in presence.
Teaching format	Frontal lectures (remote via live streaming), Exercises (Case study elaboration in groups)

Learning outcomes (ILOs)

Knowledge and understanding

1. The student knows the basics of Axiomatic Design,
2. The student knows the current methods and models for the design of complex systems.

Applying knowledge and understanding

3. The student applies and practices theoretical contents through exercises, case studies and project work. Theory contents are practiced through exercises using practical examples.
4. The students develop independently a decomposition of a complex problem.
5. Presentation techniques are trained using equipment such as flipcharts whiteboard.
6. In expert presentations, students have the opportunity to experience and see how Axiomatic Design can be applied to design products or modern manufacturing systems.

Making judgements

7. Depending on the situation in the company, the student can judge the use of appropriate methods, models and systems for the design of complex systems.
8. He is also able to distinguish between customer needs, functional requirements, design parameters and process variables.

Communication skills

9. The student can make professional discussions on Axiomatic Design and is able to structure, present and argue professional content.

Learning skills

10. The student learns both by frontal teaching (theory part) as well as by exercises in the classroom (exercises).
11. The student is able to enlarge his knowledge through self-study and consultation of scientific and technical texts.

Assessment

Formative assessment

Form	**Length /duration**	**ILOs assessed**
Exercises in the lecture room	After each lecture unit	2, 3, 10
Repeating before each lecture unit	10 min before each unit	1, 5, 9, 10, 11

	Group work | In the exercise hours | 1, 2, 5, 8, 9 **Summative assessment** **Form** | **%** | **Length /duration** | **ILOs assessed** Written exam with theory questions | 50% | 1 hour | 1, 2, 6, 8, 11 Project work during exercises | 50% - case studies and subsequent presentation of the results | 15 min of presentation | 2, 3, 4, 5, 7, 9, 10, 11
Assessment language	English
Evaluation criteria and criteria for awarding marks	Final evaluation by a single final grade. The final grade is calculated 50% from the results of the written exam and 50% from the results of the project work performed within the exercises. Criteria for the evaluation of the written examination: completeness and correctness of the answers. Criteria for the evaluation of the project work / case study: accuracy and completeness as well as creativity and innovation of the proposed solution and quality of presentation.

Required readings	Lecture notes and documents for exercise will be available on the reserve collections
Supplementary readings	• Suh, N. P. (1990). The principles of design (No. 6). Oxford University Press on Demand. • Suh, N. P. (2001). Axiomatic design: Advances and applications (the oxford series on advanced manufacturing). • Farid, Amro M., Suh, Nam P. (2016). Axiomatic Design in Large Systems Complex Products, Buildings and Manufacturing Systems • Suh, N.P., Cavique, M., Foley, J (2021). Design Engineering and Science. Springer