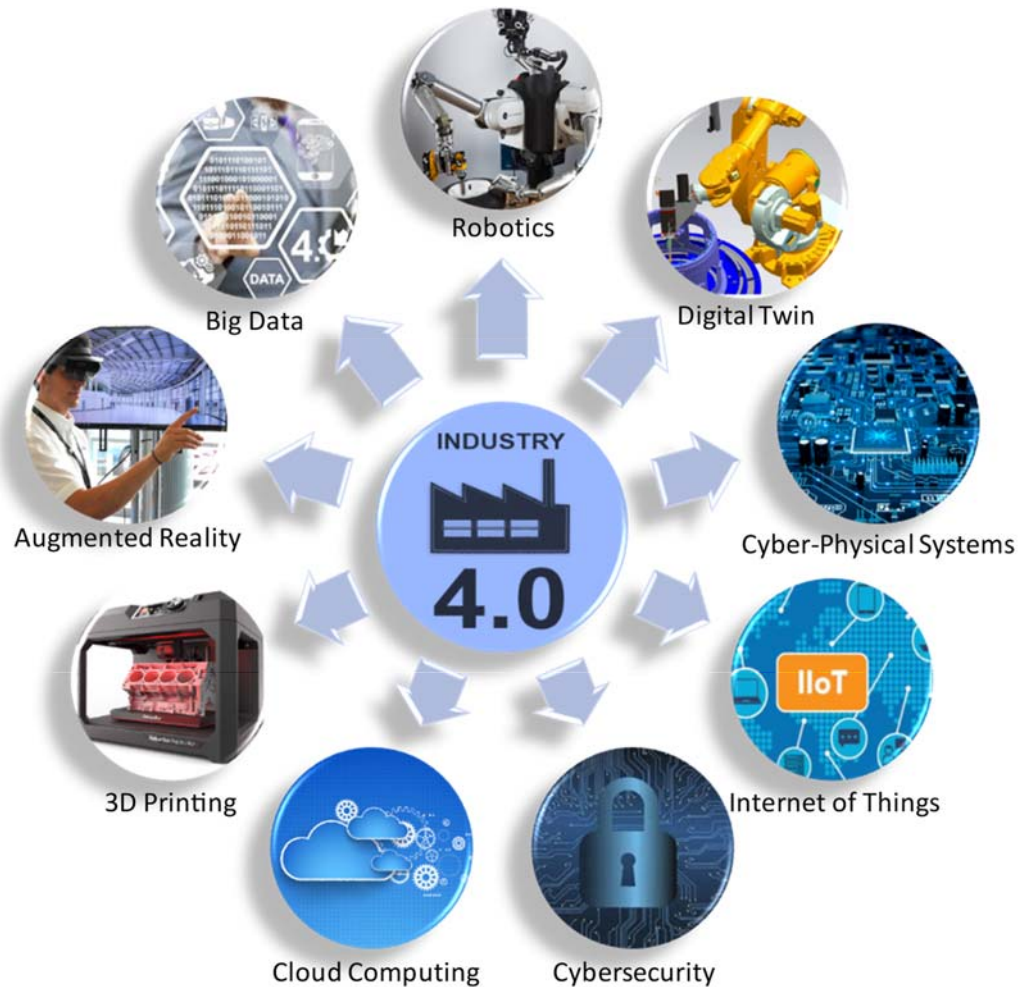Isfahan University of Technology

Industry 4.0 Autumn / Winter School 2022/23

Course Syllabus

An autumn / winter school course on Industry 4.0
Jointly taught by IUT, ZHAW, …

1   General information

Industry 4.0 is a novel paradigm for industrial production in which digitization plays a fundamental role. Implemented examples are mainly characterized by closely linked machines and their virtual representations via data networks and IT applications. In future factories, cyber-physical systems are used to create a virtual representation of the real world and take decentralized decisions. Today's static central control (the automation pyramid) will change to a network of decentralized production units capable of adapting their behaviour to changing production conditions and batch sizes. The next step towards future production will be, that the factory itself will become an intelligent entity. Robots and machines know their abilities and can react flexible to varying process requirements. Products know their production process and interact with people and machines on the shop floor to optimize their way across production. Artificial Intelligence enables processes in the Smart Factory to be stable and fast. Customers, manufacturers and suppliers are digitally linked to each other and the individual product with lot size one in automated high-tech production becomes possible.

This course provides a comprehensive overview of the role of digitization, big data, cyber-physical manufacturing systems, robots, human robot collaboration, artificial intelligence and all relevant Industry 4.0 technologies. In particular, we focus on applications and case studies in order to make the audience understand the new technologies and demonstrate the benefits of Industry 4.0. We also include contributions from researchers and industry to the opportunities and challenges of Industry 4.0. One of the greatest challenges in upgrading to Industry 4.0 is education, without young academics the transition to Industry 4.0 won't be sustainable.

2   Qualification

This course starts with a simple introduction to the most important topics of Industry 4.0. It does not require detailed knowledge of Industry 4.0 technologies, but an excellent knowledge of operational processes and relationships in enterprises. On the first day, the most important core technologies, and their importance for the implementation of Industry 4.0 are explained. In the afternoon session there will be a remote live presentation of the Smart Factory. From a management perspective, the basics and innovations of digitalization in companies are deepened on the second day. The knowledge gained on both days enables the participants to get an overview about Industry 4.0 and the underlying Business strategies.

3   Learning objectives

This course provides participants with an introduction to Industry 4.0, its building blocks, its applications, and advantages compared to conventional production techniques. Learners get a first insight into how intelligent processes, big data, and artificial intelligence can be used to build up the production of the future and to implement new business models.

4   Learning outcomes

Knowledge and understanding
1. Knowledge of basics, drivers and enablers of Industry 4.0
2. Knowledge of modern methods and techniques of planning, dimensioning, design and optimization of Industry 4.0 production systems
3. Knowledge and understanding of value chains in Industry
4. Knowledge and understanding of the Smart Factory paradigm

Applying knowledge and understanding
5. Development of practical skills in dealing with methods and techniques of production system planning and optimization through the application of theoretical learning content in the context of case studies and practical sessions
6. Practical lesson by remote video conferences to the "Learning Factory Industry 4.0" @ZHAW

Making judgements
7. Ability for timely and goal-oriented planning and implementation of technical projects
8. Ability for individual working, structuring and documentation of innovative problem solutions using modern technologies for information acquisition and processing.

Communication skills
9. Ability to structure, prepare and present scientific and technical documentation
10. Ability to describe project activities and to discuss them amongst each other and with lecturers (weekly face-to-face discussion forum and online forum)

Learning skills
11. Ability to autonomously extend the knowledge acquired during the study course by reading and understanding scientific and technical documentation
12. Ability to enlarge knowledge through self-study and consultation of scientific and technical texts

5   Learning content and teaching

The course consists of 2 days with 4 lectures each. Additionally, we will have a practical session where we present mainly the implementation and functionalities of Industry 4.0 principles in the Learning Factory of IUT/ZHAW. A discussion forum will allow participants to ask questions and discuss specific topics amongst each other and with the lecturers.

6   Discussion forum

There will be two discussion forums at the end of each day, and participants can ask their questions to presenters.

7   Recommended readings

Recommended Readings will be published on the course's website at IUT.

8   Teaching language

This autumn / winter school is held in English.

9   Course schedule

The following table is the course schedule.
Any new information will be posted in the Course Updates & News on the course website at IUT

Schedule	Contents
Day 1 **8:30 to 8:45** **Prof. Dr. Peiman Mosaddegh**	**Introduction of Institutions / Lectures and general scope of the winter school**

Day 1
8:45 to 10:00
Prof. Dr.-Ing. Hans Wernher van de Venn
	Introduction to Industry 4.0
	• Definition of Industry 4.0
	    What is it all about and why do we have to change industrial production
	    Videos from Bosch, Siemens, ABB, Automotive Industry (VW, Audi, Mercedes)
	• Developments in USA, Europe, China and other countries
	• Comparison of Industry 4.0 Factory and today's Factory
	    The 10 most important things that will change with Industry 4.0
	• Difference between conventional automation and Industry 4.0
	Practical session: Basics and overview of the IUT/ZHAW learning factory.

Day 1 **10:00 to 10:30** **Discussion led by Prof. Dr. Peiman Mosaddegh**	**Break & Discussion forum** Challenges and chances of a new industrial paradigm Lecturers are available in different break-out sessions for questions

Schedule	Contents
Day 1 **10:30 to 12:00** **Prof. Dr.-Ing. Hans Wernher van de Venn**	**Basic principles and technologies of a Smart Factory** • Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services • Big Data • Cyber-Physical Systems • Value chains in manufacturing companies • Customization of products • Digital Twins • Cloud Computing / Cloud Manufacturing • Security issues within Industry 4.0 networks
Day 1 **12:00 to 13:30**	**Lunch break**
Day 1 **13:30 to 15:00** **Prof. Dr.-Ing. Hans Wernher van de Venn**	**The Smart Product** • The Smart Product as basic element in implementing Industry 4.0 • What is a Smart Product? • How to make a product intelligent? • Work piece tagging • QR codes and RFID • Communication between product and environment • Multi-agent systems in production • Applications for smart products (examples of existing or future applications in the field of manufacturing)

Schedule	Contents
Day 1 **15:00 to 17:00** **Prof. Dr.-Ing. Hans Wernher van de Venn et al.**	**Practical Session:** Remote presentation of the Industry 4.0 / 5.0 The Smart Factory Lab of IUT & ZHAW • Mass customization & Hyper customization, how to… • The Digital Twin, how to… • Dynamic production process based on virtual costs optimizing production time, how to… • Predictive Maintenance, how to, example from the smart factory • Human Robot Collaboration, how to… • Asset Administration Shell, how to…
Day 1 **17:00 to 18** **Discussion led by Prof. Dr. Peiman Mosaddegh**	**Late day discussion forum:** What can we learn from the application of Industry 4.0 Lecturers are available in different break-out sessions for questions

Day 2 of autumn / winter school on Industry 4.0

Schedule	Contents
Day 2 **8:30 to 10:00** **Prof. Dr.-Ing. Hans Wernher van de Venn**	**Interoperability: RAMI 4.0, Asset Administration Shell and Communication systems and standards for Industry 4.0** • Interoperability and integration levels of Industry 4.0 • The Industry 4.0 Reference Architecture Model RAMI4.0 • Basics on Service oriented Architecture • OPC-UA as future standard in Industry 4.0 • The Asset Administration Shell as basic layer for Industry 4.0 • ECLASS, the worldwide "Industry 4.0 language"
Day 2 **10:00 to 10:30** **Discussion led by Prof. Dr. Peiman Mosaddegh**	**Break & Discussion forum** Interoperability and the Asset Administration Shell as a key for vendor independent plug&produce devices Lecturers are available in different break-out sessions for questions
Day 2 **10:30 to 12:00** **Prof. Dr.-Ing. Hans Wernher van de Venn**	**Machine Learning and Artificial Intelligence in Production** • Basics of Machine Learning in production • Vision systems and parts recognition • AI and big Data • Predictive Maintenance • AI in Robotics / Cobots
Day 2 **12:00 to 13:30**	**Lunch break**

Schedule	Contents
Day 2 **13:30 to 15:00** **Prof. Dr.-Ing. Hans Wernher van de Venn**	**Digital strategies and new Business models** • Digital Transformation the Basic Terms • Digital Transformation Examples • Digital Transformation Building Blocks • Impact of Digital Transformation in Industry • Introduction to new Business Models • Big Companies and Digital Business Models • The real Revolution of Industry 4.0 • Drivers for Digital Business Models in Industry • How to build a Business Model? • The Business Model Canvas
Day 2 **15:00 to 17:00** **Prof. Dr. Peiman Mosaddegh** **Prof. Dr.-Ing. Hans Wernher van de Venn**	**Case studies of new Business Models** • Big Companies and Digital Business Models (W. van de Venn) • The Schunk eGrip Business Case (W. van de Venn) • The HILTI Business Case (W. van de Venn) • The automotive industry in Iran (P. Mosaddegh) **Q&A and discussion:** What is the right digital strategy for different industries in Iran?