Session Chair: Imre Horváth

14:20 – 14:40	Raul Florentin Drenţa **Advancing Engineering Education Through Competency-Based Learning: Insights, Challenges, and Future Directions**
14:40 – 15:00	Edit Lázár **Innovation in the Teaching of the Structure Generating Matrix (SGM) in Higher Education**
15:00 – 15:20	Codruța Bendea **Innovative Teaching Methods in Energy Engineering at University of Oradea**
15:20 – 15:40	István Balajti – Boglárka Burján-Mosoni, Imre Kocsis **Characterization of Challenge-Based Pedagogy – Brain Maintanence for Efficient Cyber-Physical Systems Education**
15:40 – 16:00	Imre Kocsis – István Balajti, Boglárka Burján-Mosoni **A Framework for the Development of the Engineering Soft Skills in Undergraduate Education**

14:20 – 14:40	**Raul Florentin Drenţa** – Assistant Lecturer – Tehnical University of Cluj Napoca, North University Center of Baia Mare, Department of Engineering and Technology Management

Advancing Engineering Education Through Competency-Based Learning: Insights, Challenges, and Future Directions

This comprehensive study offers an in-depth synthesis of the latest research on competency-based education (CBE) in engineering, exploring its transformative potential for reshaping both academic and professional landscapes. By critically examining a wide spectrum of methodologies and outcomes, the article underscores how CBE addresses the growing need for workforce-ready engineers equipped with practical skills and industry alignment. The analysis integrates insights from over two decades of global studies, highlighting significant benefits such as enhanced problem-solving abilities, collaborative skills, and adaptability to rapidly changing technological environments. Moreover, the findings reveal how CBE fosters innovation and lifelong learning, positioning it as a pivotal framework for tackling the challenges posed by Industry 4.0 and the transition to sustainable practices.

This article also identifies key challenges, including resource allocation, faculty preparedness, and resistance to curriculum changes, offering actionable strategies to overcome these barriers. The synthesis emphasizes the critical role of partnerships between academia and industry in closing the skill gap and advancing educational outcomes. Additionally, it explores emerging trends, such as the integration of digital technologies and personalized learning pathways as accelerators for effective CBE implementation.

Through its comprehensive approach, this research not only provides a roadmap for institutions seeking to adopt or enhance CBE frameworks but also sets the stage for future scholarly inquiry into scalable and innovative models. The findings contribute to global efforts aimed at creating an adaptable and competent engineering workforce ready to address the complex challenges of the 21st century.

14:40 – 15:00	**Edit Lázár** - Assistant Lecturer, Budapest Busniess University, Faculty of Finance and Accountancy, Department of Applied Quantitative Methodology

Innovation in the Teaching of the Structure Generating Matrix (SGM) in Higher Education

In everyday life, you use databases more and more often on the Internet. The most of them is based on a kind of relational database management program.

University students must be prepared to use them. It would be expected to have a certain systems approach of them. They must also understand how it works, along with a little of its theoretical background, for example the data model. This is also important for them because if they get to know the model in a small environment, they will understand how large-scale corporates work as management and decision-making systems, and even data warehouses and part of Big Data, work. Why is it important that data is stored in a database and not in a spreadsheet program and used from there? The best way to do this for students to create a smaller data model themselves. At Budapest Business University (BBU) Faculty of Finance and Accountancy (FFA), we also teach, among other things, the synthetic branch of data modeling, through the Structure Generating Matrix (SGM) method. We focus on the basics of this method in education.

In this article, I would like to share the newly introduced web-based initial platform in education, its use and experiences. Supporting it with data on how the students received it, how useful it proved to be, supporting all this in statistics through scores and grades.

I included data from more than 500 students in the analysis, including a breakdown by country in the case of foreigners. I was curious about how the input status of the students, such as whether or not they had a high school diploma in mathematics and/or computer science, is reflected and what background connection there may be between their understanding of the SGM model. In the article, I also compare Hungarian and foreign students. I examine whether there is a connection between gender and SGM scores.

At the end of the article, I present what opportunities there are for innovation, for example in what directions it would be worth developing, and what other factors could have influenced the obtained results.

15:00 – 15:20	**Codruța Bendea** – Associate Professor, University of Oradea - Faculty of Energy Engineering and Industrial Management, Deparment Energy Engineering

Innovative Teaching Methods in Energy Engineering at University of Oradea

The field of energy engineering is at the forefront of addressing global challenges such as climate change, energy security, and sustainable development. To prepare students to excel in this dynamic field, it is imperative to adopt innovative teaching methods that foster active learning, critical thinking, creativity, and global collaboration. This paper explores how cutting-edge educational strategies, including active learning, blended learning, virtual and augmented reality, digital tools, gamification, and international collaboration, can transform energy engineering education at the University of Oradea. It is just recently that our Department of Energy Engineering started to implement these strategies. We focus on how to increase our students interest and motivation by using game designed elements like optimizing the energy mix for a city or region (Power Grid, GigaWatt, Pampero, and Keep Cool board games were bought by the end of 2024 are about to be used starting from the Spring semester 2025) or simulating energy market dynamics and energy transition – online simulations - Energy market game (offered by Stanford University), Transition mission (offered by Siemens Energy), Renewable Energy Communities RECxploration, Energy manager, or ELECTRIFYtoday. Another important direction to be developed within our department is integrating sustainability into the curricula of the three bachelor study programs (Power Systems Engineering, Energy Engineering and Information Technologies, and Renewable Energy) and the two Master's programs that our department is offering. Our students learn how to sustainably produce energy and, of course, use it sustainably, addressing environmental impacts and resources management, so SDG7 Affordable and Clean Energy is addressed very often, but the rest of the SDGs are less or not at all addressed. Therefore, the main challenge for us is to make our students aware of all 17 SDGs. Topics such as life-cycle analysis, carbon footprint reduction, and circular economy principles can be integrated into existing subjects. Besides the theoretical approach, we are going to use several board games: SDG Architect, The Sustainability Lens, Global Goal Compendium, and CO2 Second Chance. Our department made some small steps towards using virtual and augmented reality. Starting from January 2025 we have two pairs of glasses that will allow our students to get an immersive learning experience by walking inside a nuclear reactor, a power plant or a hydraulic turbine. As a conclusion, the Energy Engineering Department just started this magnificent journey but specialized staff training activities for these innovative teaching techniques are still needed.

15:20 – 15:40	**István Balajti** – Associate Professor, University od Debrecen, Faculty of Engineering, Department of Electrical Engineering and Mechatronics

Characterization of Challenge-Based Pedagogy – Brain Maintanence for Efficient Cyber-Physical Systems Education

"There are two types of people living on Earth, the Engineers and Everyone else. We Engineers like Everyone else types people but they are not Engineers." The importance of Cyber-Physical Systems (CPS) frequently called Industry 4.0 (I4.0), or Internet of Things (IoT), grows permanently. Artificial intelligence (AI) supported CPS is spreading rapidly in our world and it is called Smart Cyber-Physical Systems (S-CPS). The Extended Cyber-Physical Systems (E-CPS) or Next Generation Cyber-Physical Systems (NG-CPS) are expanding to address more complex problems such as the impact of intellectualization on human roles and the social embedding of heterogeneous systems.
The industrial metaverse for smart manufacturing and its novel characteristics require new types of advanced engineering education at the university level, while the addition of new skills requires rigorous preparatory work. The development and validation of effective knowledge transfer methods that meet the I4.0 educational needs is frequently called Education 4.0 (E4.0). The characteristics of Challenge-Based Pedagogy (CBP)-Brain Maintenance awarded by Nobel Beer developed in the Faculty of Engineering indicate promising performances. It focused on engineering thinking reinforcement What? Why?? and How? while challenging weekly tasks are shaking the students by using their minds efficiently. The key question here is this: "How should challenges be connected, and their results enlarge each other efficiency?" Why make the report and solutions of received weekly tasks from the BOSS motivate students to become The BOSS in the near future after graduation?

15:40 – 16:00	**Imre Kocsis** – Professor, University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies

A Framework for the Development of the Engineering Soft Skills in Undergraduate Education

The authors developed and applied a method to improve the engineering soft skills of senior undergraduate students in the context of advanced engineering topics such as Cyber-Physical Systems, Cyber Security, Measurement Data Collection, Measurement Technology, Mechatronic Devices. The results, based on individual and group interviews, show that the gap between the existing and required soft skills of senior engineering students is quite large, and the participants expressed the need for intensive development of these skills not only in the final stage of the training. A main conclusion drawn from the interviews introduced in this paper is that the efficiency of personality development concentrated in the last semesters of education is not effective enough due to the lack of experience of students in this field. To improve the method, the timeframe was extended to the earlier stages of education, and some basic skills were identified and a method for their development was established. A case study presents the elements of the new methodology in basic subjects such as engineering mathematics.