Description of course	
Code	
Name	**Modern Power Supply Systems For Transport And Transport Infrastructure**
Version	2025/26
A. Place of the course in system of studies	
Level of education	Second cycle programme
Form and mode of studies	full-time study (onsite / remote classes)
Field of studies	Transport
Profile	General academic profile
Specialisation	Main field
Place of teaching of course	Division of Information and Mechatronic Systems in Transport
Place of realization of course	Warsaw University of Technology, Faculty of Transport
Coordinator	Phd Marcin Koniak
B. General characteristic of the course	
Block of courses	
Group of courses	
Level of course	
Language of course	English
Nominal semester	
Preliminary requirements	no
Limit of students	
C. Effects of education and manner of teaching	
Purpose of course	This course aims to equip students with comprehensive knowledge and practical skills in designing, implementing, and analyzing modern power supply systems for transport infrastructure. It focuses on energy efficiency, reliability, and sustainability across rail, road, and urban transit networks, incorporating renewable energy integration and smart grid technologies. By completing this course, students will: • Identify and analyze power supply architectures for railways, electric vehicle networks, and transport hubs. • Analyze energy efficiency and sustainability metrics in transport power systems using simulation tools (e.g., MATLAB, PowerFactory, Python, other specialized software). • Develop solutions for grid stability, renewable energy integration, and emergency power backup in transport infrastructure. • Analyze the energy and charging systems of transport vehicles for its various means • Enhance employability through hands-on projects in railway electrification, EV charging networks and energy management. • Strengthen collaborative problem-solving skills via laboratory exercises in power system diagnostics and optimization. The curriculum integrates theoretical principles with real-world applications, preparing graduates for engineering roles in sustainable transport infrastructure, smart grid development, and energy management systems.
Effects of education	See Table 1
	Lecture: 1,5

Form of didactic studies and number of hours per week	Exercise type of course	-
	Laboratory	1,5
	Project type of course	1,5
Contents of education	1. Transportation Power System Fundamentals • Classification of transportation power systems: AC vs. DC, overhead vs. third-rail. • Key components: transformers, rectifiers, converters, and energy storage. • Power quality metrics: voltage stability, harmonics, and efficiency losses. 2. Modern Power Grid Architecture • Design principles for rail/road power networks: redundancy, scalability, and fault tolerance. • Smart Grid Integration: IoT-enabled monitoring and control systems. • Integration of renewable energy (solar, regenerative braking) into transportation infrastructure. • EV charging systems 3. Modeling the behavior of the energy system. • mathematical methods of demand modeling • methods of component failure prediction modeling • -Spectral analysis of power quality disturbances (e.g. voltage sags, swells). 4. Simulation of transport energy networks • Tools: dedicated software. • Network modeling: • Scenario testing: • Peak demand management, renewable instability and recovery from network failures. 5. Characterization of energy sources and systems • Classical fossil fuel-based energy sources • Renewable energy sources • Impact of energy sources on the system and continuity of supply • Charging system safety 6. Applications in transport infrastructure Railway: • Optimization of AC/DC traction power, reuse of regenerative braking energy. Road: • Electric vehicle charging networks: deployment of fast charging stations and impact on the network. Ports/airports: • Shore power systems and integration of hydrogen fuel cells. 7. Practical implementation Software: dedicated software. Labs: • Power loss analysis in simulated DC traction substation. • Design of microgrid for distribution center with solar integration. • Mitigation of harmonic distortions in AC rail systems.	

	8. Final project Task: Design of resilient power source for transport hub (e.g. metro station + electric vehicle depot). Deliverables: • Simulation model verifying network stability under peak loads. • Cost-benefit analysis of renewable energy integration. • Technical documentation and project defense. Focus: Interdisciplinary problem solving, scalability and compliance with ISO 50001 energy management standards.
Methods of education	• Lectures enriched with multimedia presentations and live sketching. • Computer labs using dedicated software • Team-based project work with supervisor consultation. • Case study analysis of real-world power supply transport systems • Individual and group discussions to promote critical thinking.
Methods of evaluation	• Midterm Test (20%) – Theoretical understanding of Power systems fundamentals and architecture • Lab Reports (30%) – Practical exercises on modelling, and analysis. • Final Project (30%) – Team-based design and simulation with oral presentation. • Final Test(20%) – Written exam evaluating integration of knowledge and practical understanding.
Methods of verification of the effects of education	• Written assessments (midterm + final) for theoretical knowledge. • Lab reports and project documentation for practical skills. • Oral presentation and Q&A for soft skills and applied comprehension. • Instructor observation during labs for collaboration and engagement.
Exam	No
Literature:	**Required Reading:** • Electric Railway Traction: Power, Energy and Control – K. T. Erickson, A. P. Hedges • Power System Stability and Control – Prabha Kundur • Smart Grid: Integrating Renewable, Distributed & Efficient Energy – Fereidoon P. Sioshansi • Power Quality in Modern Power Systems – Antonio Moreno-Muñoz **Recommended Reading:** • Electric Vehicle Integration into Modern Power Networks – Rodrigo García-Valle • Microgrids: Design and Applications – Antonio Carlos Zambroni de Souza • Renewable Energy Systems: Modeling, Optimization and Control – Ahmad Taher Azar • Computational Methods for Electric Power Systems – Mariesa L. Crow
www	
D. Student's activity	
Number of ECTS points	6
Number of hours of a student's job for the achievement of the education effect (description):	Participation in lectures 15 h Participation in laboratory/computer classes 30 h Involvement in project work, self work 20 h Literature study and preparation for tests 40 h Development of lab reports 30 h Final exam preparation 30 h
Number of credits ECTS on the course with the direct participation of academic teacher	3

Number of credits ECTS on practical activities on the course	3
E. Additional information	
Notes	As long as it does not cause changes in the relationship of a given subject with the directional effects in the content of education, changes may be introduced on an ongoing basis, taking into account the latest scientific achievements.
Date of last edition	

Table 1. General academic profile

Effect:	Field effects	Verification:	Area effect
Knowledge			
Understanding grid architecture principles (redundancy, scalability) and component integration (transformers, converters) enables engineers to build resilient power networks.	W01	Lecture tests	Tr2A_W05
Advanced of mathematical modeling for demand forecasting and failure prediction allows proactive maintenance.	W02	Lecture tests	Tr2A_W08
Knowledge of energy source characterization (fossil fuels vs. renewables) and charging system safety protocols ensures reliable, eco-friendly supply continuity.	W03	Lecture tests	Tr2A_W05
Expertise in application-specific optimizations—like reusing regenerative braking energy in railways or deploying fast-charging EV stations—drives technological advancements.	W04	Lecture tests Lab reports	Tr2A_W10
Skills			
Simulation skills (using dedicated software) support scenario testing for peak demand, renewable instability, and failure recovery.	U01	Lab reports Project report	Tr2A_U15
He can use information from literature and use Internet databases	U02	Lab reports Project report	Tr2A_U01
Can estimate selected characteristics and interpret the results.	U04	Lab reports Project report	Tr2A_U06

I can cooperate with other people during teamwork and take the lead in a team.	U05	Lab reports Project report	Tr2A_U20
Social competences			
Understands the need for continuous training and refreshing the acquired knowledge, in particular in the field of stochastic processes	KS01	Lab reports Project report	Tr2A_K01
Can think and act in a creative and enterprising way.	KS02	Lab reports Project report	Tr2A_K04