GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Automatic guidance and controll systems in transportation, PG_00064992		
Field of study	Transport and Logistics		
Date of commencement of studies	February 2027	Academic year of realisation of subject	2027/2028
Education level	second-cycle studies	Subject group	Specialty subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Institute of Naval Architecture -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Mohammad Ghaemi	
	Teachers	prof. dr hab. inż. Wiesław Tarełko dr hab. Anna Witkowska	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	30.0	0.0	45

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	45	11.0	44.0	100

Subject objectives

The main objectives of the course:

- providing students with basic knowledge about modern automation, guidance, navigation and control systems of transport systems

- preparing students to design a selected system of automation, guidance, navigation or control of transport systems

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W12] identifies and interprets the main developmental trends and significant new achievements in the field of engineering and technical sciences and disciplines relevant to the course of study	The student draws a basic block diagram of a transport automation, guidance or control system. The student selects components that perform a specified function within a transport automation, guidance or control system. The student designs a guidance or control arrangement for a transport system.	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge
	[K7_U13] evaluates the feasibility and potential for utilizing new technical and technological achievements in accomplishing tasks characteristic for the field of study	The student provides examples of sensor and actuator applications in automation, guidance and control systems used in transport. The student describes the operating principles of the individual components of transport automation, guidance and control systems. The student defines transport guidance and control systems and classifies them according to selected criteria.	[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
	[K7_U03] identifies and formulates task specifications in the scope of transport systems and processes design, including non-standard problems and taking into consideration their non-technical aspects	The student has knowledge of triangulation and trilateration used to determine a transport vehicle’s position in space. The student has knowledge of electromagnetic and mechanical wave theory used to determine the bearing to a transport vehicle and its distances from reference points.	[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment

Subject contents	Course content – lecture Benefits of Automation in Transport: The Example of a Car Levels of Driving Automation Automated Transport Systems and the “Intelligence” of Transport Vehicles Technological Solutions in Transport Why Are Intelligent Transport Systems (ITS) Needed? The Concept of “Guidance” and Its Meaning The Concept of “Navigation” and Its Meaning Map Projections of the Earth’s Surface Guidance, Navigation and Control (GNC) Systems in Transport Vehicle Guidance Technologies Lasers and Their Applications in Guidance Systems Operating Principles of Wave-Based Guidance Systems Basic Techniques for Measuring Distances Between an Object and Reference Points Mathematical Interpretation of Trilateration Global Navigation Satellite Systems (GNSS) Detection and Ranging Using Radar, LiDAR and Sonar Operating Principles of an Inertial Navigation System (INS) Main Components of Inertial Navigation Systems Determining a Vehicle’s Direction of Motion Using INS Operating Principles of Accelerometers and Gyroscopes Advantages of Inertial Navigation Systems (INS) Systems for Measuring a Vehicle’s Own Motion Vision-Based Imaging Integration of Cameras, LiDAR and Radar in Autonomous Vehicles Road Illumination in Autonomous Vehicles

	Laser Distance Sensors for Transport Vehicles Laser Guidance Systems for Transport Vehicles Monitoring System Architecture for Vessel Docking and Mooring Ultrasonic Distance Sensors for Transport Vehicles Aircraft Guidance During Landing GNC Systems in Autonomous Road Vehicles “Intelligent” Operations of Autonomous Vessels Characteristics of the GBAS–RTK (Real-Time Kinematic) System in the Port of Gdynia
Prerequisites and co-requisites	

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
pytania kontrolne	66.0%	51.0%
ocena projektu pod względem spełnienia wszystkich wymaganych elementów	100.0%	49.0%

Recommended reading

Basic literature	Bierlaire M. et al. (Eds.): Integrated Transport and Land Use Modeling for Sustainable Cities. Routledge, New York, 2014. Hensher D., Button K. (Eds.): Handbook of Transport Modelling. Pergamon, Amsterdam New York Tokyo, 2005. Daganzo C.: Fundamentals of Transportation and Traffic Operations. Pergamon Press, New York, 1997
Supplementary literature	Vision-Based Estimation for Guidance, Navigation, and Control. M. K. Kaiser; N. R. Gans; W. E. Dixon, Published in: IEEE Transactions on Aerospace and Electronic Systems (Volume: 46, Issue: 3, July 2010), pp. 1064 - 1077
eResources addresses	

Example issues/ example questions/ tasks being completed	**Topics for Analysis and Discussion:** Automation and autonomy in transport: differences, stages of development and the human role in vehicle control. Benefits and limitations of intelligent transport systems (ITS), with examples from road and maritime transport. The roles of guidance, navigation and control in GNC systems used across different modes of transport. Capabilities and limitations of GNSS, INS, radar, LiDAR, sonar and cameras for positioning and monitoring the surrounding environment. Integration of data from multiple sensors in autonomous vehicles: its importance for accuracy, reliability and operational safety. **Sample Examination / Test Questions:** How does automation differ from autonomy in transport, and how does the driver's role change across the levels of driving automation? What functions do the guidance, navigation and control subsystems perform within a GNC system? What are the principles of the ToF and TDoA measurement methods, and how can their results be used to determine an object's position? How do radar, LiDAR and sonar work, and what are the main differences between their applications in transport? What are the main components of an INS, how does it determine an object's motion, and what role does Kalman filtering play in integrating navigation data? **Sample Practical Tasks:** **Distance Measurement Using ToF:** Calculate the distance from a sensor to an obstacle using a given echo return time and wave propagation speed, accounting for the signal's round trip to the obstacle and back. **Position Determination Using Trilateration:** Determine an object's coordinates in a plane using its distances from three reference points with known coordinates, and present the solution graphically. **Analysis of Inertial Data:** Determine changes in an object's velocity and orientation using simplified acceleration and angular velocity data and specified initial conditions. **Sensor Selection for an Autonomous Vehicle:** Propose a set of sensors for vehicle localisation and obstacle detection, justify the selection and provide a diagram showing how the sensor data are integrated. **Docking and Mooring Monitoring:** Develop a diagram of a vessel's measurement system, indicating sensor locations and methods for determining the distance to the quay, approach speed and vessel orientation.
Practical activites within the subject	Not applicable

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