GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Vehicle design, PG_00064834						
Field of study	Mechanical Engineering						
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	assessment			
Conducting unit	Division of Mechanical Vehicles and Military Technology -> Institute of Mechanics and Machine Design -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Wojciech Owczarzak				
	Teachers						

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	15.0	0.0	15.0	0.0	60
	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	60	7.0	33.0	100

Subject objectives	The aim of the course is to prepare students to analyse, select and design selected assemblies of motor vehicles, with particular emphasis on the powertrain, vehicle traction characteristics, clutches, gearboxes, final drives, differential mechanisms, drive shafts, wheel hubs, and the fundamentals of vehicle motion mechanics and tyre-road interaction.The course develops students ability to combine knowledge of machine design, vehicle motion theory, engineering calculations and structural case analysis in order to make justified design decisions concerning vehicle safety, durability, energy efficiency, comfort and driving performance.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W13] explains the main principles of individual and teamwork organization, including various forms of entrepreneurship utilizing knowledge from the field of engineering and technical sciences and disciplines relevant to the course of study	The student is prepared to responsibly formulate and justify design decisions, taking into account user safety, durability of assemblies, reduction of energy losses, driving comfort, and the impact of design solutions on vehicle operation.	[SW1] Assessment of factual knowledge
	[K7_K12] is ready for fullfiling social commitement and initation of actions for public interest including entrepreneurial thinking and acting	The student explains the principles of organising individual and team work while carrying out a design task related to a selected assembly of a motor vehicle; plans the scope of calculations, division of tasks, selection of input data, and method of presenting the results.	[SK3] Assessment of ability to organize work
	[K7_U04] creatively designs or modifies devices, processes or systems specific to Mechanics and Mechanical Engineering, using computer-aided design systems in the form of technical documentation, taking into account aspects of economic analysis, using appropriate tools and techniques	The student has structured knowledge of the design, functions and selection principles of the basic assemblies of a motor vehicle, including the powertrain, clutch, gearbox, final drive, differential mechanism, drive shafts, wheel hubs, and the fundamentals of vehicle motion mechanics and vehicle motion resistance.	[SU2] Assessment of ability to analyse information
	[K7_W03] demonstrates a well-structured and theoretically grounded knowledge of the key issues in Mechanical Engineering to enable the design and diagnosis of mechanical systems, processes and devices	The student selects and calculates selected parameters of the vehicle powertrain, prepares the traction characteristic, determines or justifies the gear ratios of the gearbox and final drive, analyses the operation of the clutch, differential mechanism and drive shafts, and presents the results in the form of design documentation.	[SW1] Assessment of factual knowledge

Subject contents

Course content – lecture

1. Introduction to motor vehicle design: vehicle structure, functional, operational and safety requirements, and the role of powertrain, running gear, braking and steering systems.
2. Fundamentals of vehicle motion theory: vehicle as a dynamic object, modelling simplifications, drivervehicleenvironment system, steerability, stability and influence of disturbances on the vehicle path.
3. Mechanics of the pneumatic tyre: wheel radii, tyre deformation, deformation slip, lateral slip, adhesion, rolling resistance and its impact on energy consumption.
4. Powertrain systems: tasks, structure and design variants of powertrains and their influence on vehicle mass, efficiency, traction, durability and serviceability.
5. Automotive clutches: functions, dry and wet friction clutches, hydrodynamic clutches, torsional vibration damping, clutch control and basics of clutch release system calculations.
6. Gearboxes: functions, classification, design of mechanical, hydromechanical, stepped, continuously variable, manual and automatic gearboxes, synchronizers and gear-shifting mechanisms.
7. Gear ratio selection: driving force characteristics, starting condition, maximum speed, economical driving, engine speed drop after gear shifting and driving comfort.
8. Final drives: types of final drives, gear ratio, hub reduction gears, drive pinion shaft bearing arrangements and influence of design on efficiency, noise, durability and ground clearance.
9. Differential mechanisms: design, operating principle, bevel, cylindrical, limited-slip and Torsen differentials, and electronically controlled torque distribution.
10. Propeller shafts, joints, drive shafts and hubs: functions, design requirements, compensation of angular and length changes, and basics of drive shaft calculations.
11. Analysis of design and calculation case studies: component selection, interpretation of results, assessment of design limitations and justification of design decisions.

Course content – exercises

1. Determination of basic vehicle motion parameters, motion resistance and forces acting on a pneumatic tyre.
2. Preparation of the vehicle traction characteristic based on engine data, the dynamic rolling radius of the wheel, gear ratios and powertrain efficiency.
3. Selection of gearbox and final drive ratios, taking into account the starting condition, maximum speed, economical driving and engine speed drop after gear shifting.
4. Calculations of the friction clutch and clutch control mechanism: displacement of components, pedal force, mechanism ratios and verification of basic design requirements.
5. Calculations and analysis of the final drive and differential mechanism depending on the adopted vehicle powertrain layout.
6. Calculations of drive shafts for selected load cases: maximum driving force, braking and lateral loads.
7. Analysis of technical documentation and comparison of real design solutions used in passenger cars, commercial vehicles and special-purpose vehicles.

Course content – project

Example project variants:

Design of a single-plate friction clutch for a selected motor vehicle.

Design of a differential mechanism and final drive for a vehicle, including the assessment of basic load cases.

Design of drive shafts for a selected motor vehicle.

Prerequisites and co-requisites

Knowledge of the fundamentals of machine design, mechanics, strength of materials, basics of engineering drawing, and basic motor vehicle construction. The student is required to be able to perform basic engineering calculations, interpret structural diagrams, and use technical documentation.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Term project	100.0%	30.0%
Tests during the semester	60.0%	30.0%
Written assessment of the lecture component	60.0%	40.0%

Recommended reading	Basic literature	1.Jaśkiewicz Z., Projektowanie układów napędowych pojazdów samochodowych, WKŁ, Warszawa, 1982 2.Kurmaz L.W. Projektowanie węzłów i części maszyn, WPŚ, Kielce , 2006 3.Studziński K, Samochód. Teoria, konstrukcja i obliczenia, WKŁ, Warszawa, 1980 4.Gabrylewicz M.: Podwozia i nadwozia pojazdów samochodowych 1, WKŁ, 2010 5.Czarnigowski J., Podstawy Konstrukcji Maszyn, Wykład 8: Przekładnie zębate część 1
	Supplementary literature	There are no requirements.
	eResources addresses	
Example issues/ example questions/ tasks being completed	Preparation of the vehicle traction characteristic for the assumed engine, tyre, vehicle mass and powertrain ratio parameters. Selection of gearbox ratios, taking into account the starting condition, maximum speed and economical driving. Calculation of basic parameters of the friction clutch and its release mechanism. Analysis of the design and operating principle of the final drive in conventional and integrated powertrain layouts. Design of a differential mechanism and assessment of the influence of LSD/Torsen differentials on torque distribution. Strength calculations of the drive shaft for specified load cases. Selection of joints and analysis of compensation for changes in length and operating angle of the drive shaft. Comparison of FWD, RWD, AWD and mid-engine powertrain layouts in terms of traction, mass, efficiency and safety. Assessment of the influence of rolling resistance, wheel slip and adhesion on vehicle performance and energy consumption.	
Practical activites within the subject	Not applicable	

Document generated electronically. Does not require a seal or signature.