COURSE DESCRIPTION CARD - SYLLABUS

Course name

Vehicle chassis systems and components design

Course

Field of study

Mechatronics

Area of study (specialization)

Mechatronic design of machines and vehicles

Level of study

Second-cycle studies

Form of study

full-time

Year/Semester

1/2

Profile of study

general academic

Course offered in

English

Requirements

elective

Number of hours

Lecture

30

Laboratory classes

Other (e.g. online)

Tutorials

Projects/seminars

15

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

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Responsible for the course/lecturer:

Prerequisites

Knowledge: knowledge of the basics of machine design, knowledge of technical drawing and technical (kinematic, force) diagrams, knowledge of general mechanics and material strength.

Skills: defining loads on mechanical systems, performing analytical calculations in the field of mechanics and strength of materials, the ability to use a spreadsheet (MS Excel, Google Sheets or others).

Social competences: Ability to identify problems and solve computational and construction dilemmas. Self-reliance

Course objective

The main goal of the course is to provide students with knowledge about the structure and role of individual sub-systems of motor vehicles and the ability to conduct the design process of these sub-systems and their elements.

Course-related learning outcomes

Knowledge

One has a knowledge of the classification, construction, and operation as well as technical characteristics of modern mechatronic machines and devices. One also has knowledge of the life cycle of electronic products.

One has a knowledge of computer analysis of construction, including advanced operations in the CAD environment, regarding 3D visualization and analysis of the cooperation of mechanical components.

Skills

One can design complex mechatronic devices and systems, using modeling and simulations. One also can plan and carry out experiments, including measurements and computer simulations, interpret the obtained results and draw conclusions.

One can use computer systems to design and operate mechatronic devices. One also can implement control systems in the real-time operating system. One can use the basic methods of image processing and analysis. One can as well prepare software documentation.

One can visualize individual mechanical elements and their assemblies in a 3D environment and analyze the cooperation of elements shown in the drawing. One also can develop technical documentation of a mechatronic device. One can also make a preliminary economic analysis of the considered project.

Social competences

One understands the need for lifelong learning and can inspire and organize the learning process of other people.

One can interact and work in a group, assuming different roles in it.

One can set priorities for the implementation of a task set by himself or others.

One can think and act creatively and enterprisingly.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Written exam on the lecture material - selection of short problem and test questions. False answers give negative points for a given question, but the overall score for question is on a scale from 0 to 1. Rating scale - 50% - dst, 60% - dst +, 70% - db, 80% db +, 90% bdb .

Project: assessment based on the results of the evaluation of reports on implemented projects. Each of the projects is assessed on the basis of the degree of implementation of the assigned tasks - completion of the completed project with the completion of at least 50% of the negative sentences in the project. Rating scale - 50% - dst, 60% - dst +, 70% - db, 80% db +, 90% very good. The overall grade for a project course subject is an average grade from all individually completed and submitted project reports. It is necessary to obtain a positive assessment from all 4 projects.

Programme content

LECTURES:

Lecture 1 - Designing vehicle braking systems

Analysis of the requirements for the braking performance according to the type approval and operational requirements in terms of forces and heat dissipation. Consideration of grip and driver restrictions.

Lecture 2 - Design of a hydraulic brake cuircit

Dynamic and kinematic ratio - limits of pump capacity and brake pedal travel, overall evaluation of the hydraulic circuit. Vacuum booster and its selection.

Lecture 3 - Designing a car disc and drum brake

Effectiveness of disc and drum brakes, types of drum brakes (simplex, duplex, servo, duo-servo), braking torque calculations, material limitations, disc brakes - design and friction torque calculations,

Lecture 4 - Design / selection of the braking force corrector characteristics for the rear axle of the car

Chart of unit braking forces, types of braking force correctors - corrector controlled by suspension deflection, inertial corrector,

Lecture 5 - Mechatronic vehicle braking systems

ABS system - structure and components, control algorithms, electronic brake force distribution - structure and components, control algorithms, emergency brake assist systems - structure and components, control algorithms

Lecture 6 - Designing motor vehicle steering systems

Designing the kinematics of the steering system. Design of the steering linkage and selection of the steering gear.

Lecture 7 - Selection of the power steering characteristics of the vehicle

Moment of friction and aligment torques in the steering system. The structure and types of devices supporting steering systems. Desired power steering characteristics and their selection.

Lecture 8 - Design of suspensions - requirements for dynamics and kinematics

Assessment criteria and requirements for suspensions and methods of assessing their fulfillment. Comfort and safety indicators as well as dynamic loads.

Lecture 9 - Analysis of the dynamics of suspensions

Calculations of the natural frequency, calculations of the damping ratio. Calculations of vibration transmission characteristics.

Lecture 10 - Design of elastic elements

Designing steel spring elements for automotive vehicle suspensions - coil springs and leaf springs.

Lecture 11 - Designing systems for the regulation of ground clearance, stiffness and suspension damping

Reasons and goals for controlling damping, stiffness and suspension clearance. Structures of mechatronic control systems for damping, stiffness and clearance of suspensions. Selection of sensors and actuators.

Lecture 12 - Design of powertrain system - traction characteristics

Selection of the required driving forces to overcame the resistance of motion of the vehicle and the requiered performance as well as the variability of the load and operating conditions. The influence of the selection of gears on the obtained traction characteristics, the gradeability and the obtained intensity of acceleration. Adhesion taken into account.

Lecture 13 - Design and selection of vehicle clutches

Design of disc clutches- calculation algorithms for: geometry of the clutch disc, durability of the friction clutch and clutch pressure springs - central and screw. Designing the actuation system - mechanical and hydraulic.

Lecture 14 - Selection of gear ratios in the gearbox

Determination of the number of gears and selection of gears: the smallest, the largest and intermediate. Dynamic characteristics of a motor vehicle in terms of longitudinal dynamics: traction, dynamic and power balance.

Lecture 15 - Designing a gear shift strategy

Reasons and purposes of gear changes in relation to operational loads and required functional characteristics. Structures of the control systems of gear changes in automatic transmissions. Selection of the strategy of changing the gear ratios to the individual and situational requirements.

PROJECTS:

Classes 1 and 2 - Design of the brake system - functional calculations for the actuation system and brakes.

Classes 3 and 4 - Design of the steering system - functional calculations for the steering linkeage system and steering mechanism

Classes 5 and 6 - Design of the suspension system - functional loads in terms of dynamics and statics requirements for the full range of operational load variability.

Classes 7 and 8 - Calculations of traction characteristics and evaluation of the performance of the designed vehicle.

Teaching methods

Lecture with multimedia presentation.

Project in the form of tasks to be performed on the basis of the knowledge presented in lectures and on the basis of literature with the possibility of consultation.

Bibliography

Basic

1. Reimpell J, Betzler J.: Podwozia samochodów - podstawy konstrukcji. WKiŁ, 2001

2. Reński A., Budowa samochodów. Układy hamulcowe i kierownicze oraz zawieszenia. Skrypt PW, Warszawa 2004

3. Stańczyk T.L., Lomako D.: Komputerowe obliczenia zespołów samochodów i ciągników, WPŚ, Kielce, 2004

4. Genta G., Morello L.: The Automotive Chassis, Volume 1: Component Design, Springer, 2009

5. Genta G., Morello L.: The Automotive Chassis, Volume 2: System Design, Springer, 2009

6. Jaśkiewicz Zb., Wąsiewski A., Układy napędowe pojazdów samochodowych: obliczenia projektowe, OWPW, Warszawa, 2002

Additional

1. Heißing B. Ersoy M. (Eds.): Chassis Handbook. Fundamentals, Driving Dynamics, Components, Mechatronics, Perspectives. Vieweg+Teubner Verlag | Springer, 2011

2. Zając M., Układy przeniesienia napędu samochodów ciężarowych i autobusów, WKiŁ 2008

3. Micknass W., Popiol R., Sprenger A., Sprzęgła, skrzynki biegów, wały i półosie napędowe, WKiŁ 2012

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	45	2,0
Student's own work (literature studies, preparation for project classes, reports preparation) [1]	55	2,0

[1] delete or add other activities as appropriate