COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Multiphysics Simulations					
2.2 Course convenor			Assoc. Prof. Ph. D. Olivia Florea Prof. Ph. D. eng. Horia ABĂITANCEI					
2.3 Seminar/ laboratory/ project convenor			Assoc. Prof. Ph. D. Olivia Florea Prof. Ph. D. eng. Horia ABĂITANCEI					
2.4 Study year	1	2.5 Semester	1	2.6 Evaluation type	E	2.7 Course status	Content[3)]	CPC
							Attendance type[4)]	AC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/1/1**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/14/14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	60
Additional documentation in libraries, specialized electronic platforms, and field research	50
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	2
Tutorial	2
Examinations	3
Other activities.....	2

3.7 Total number of hours of student activity	119
3.8 Total number per semester	175
3.9 Number of credits[5)]	7

4. Prerequisites (if applicable)

4.1 curriculum-related	• Knowledge of Mathematical Analysis, Algad, Special Mathematics, Vehicle Dynamics, Fluid Mechanics, Hydraulics
4.2 competences-related	• Operating with fundamental concepts of engineering sciences

5. Conditions (if applicable)

5.1 for course development	• Computer room with MATLAB and video projector
5.2 for seminar/ laboratory/ project development	• Computer room with MATLAB and video projector

6. Specific competences and learning outcomes

Professional competences	C.3 Competencies for carrying out tests and practical determinations L.O.3.1 To perform experimental, environmental and operational tests on models, prototypes or on systems and equipment to test their resistance and capabilities in normal and extreme conditions; L.O.3.2 To interpret and analyze data collected during testing, to formulate conclusions, new perspectives or solutions. L.O.3.3 To record the data that was specifically identified during the previous tests, to check if the results of the test produce specific results; CP.4 Competences to carry out scientific research. L.O.4.5 To carry out research on the present and future developments and currents in design, as well as on the related target characteristics of the market; L.O.4.6 To anticipate changes in automotive technology, to supervise and investigate recent technological trends and developments; L.O.4.7 To manage research data; L.O.4.8 To operate scientific research and laboratory equipment; L.O.4.9 To synthesize information, critically interpret and summarize new and complex information from various sources; CP.5 Software design and development capacity L.O.5.1 to develop software for motor vehicles and related systems; L.O.5.2 understand and apply the principles of programming and software development technologies in the automotive industry; L.O.5.3 to evaluate and choose suitable platforms, programming languages and software technologies for projects in the automotive industry; L.O.5.4 to develop software applications to improve the functionality, performance and safety of motor vehicles; L.O.5.5 to test and debug software to ensure the proper and safe operation of vehicle systems; L.O.5.6 to integrate software systems in the global architecture of motor vehicles, taking into account security and compatibility aspects; L.O.5.7 manage automotive software development projects, including planning, budgeting and monitoring progress.
	CP.5 Software design and development capacity Learning outcomes. L.O.5.1 develop software for automotive vehicles and related systems; L.O.5.2 understand and apply the principles of programming and software development technologies in the automotive industry; L.O.5.3 evaluate and choose platforms, programming languages and software technologies suitable for automotive industry projects; L.O.5.4 develop software applications to improve the functionalities, performance and safety of automotive vehicles; L.O.5.5 test and debug software to ensure the correct and safe operation of automotive systems; L.O.5.6 integrate software systems into the overall automotive architecture, taking into account security and compatibility aspects; L.O.5.7 manage automotive software development projects, including planning, budgeting and monitoring progress.

Transversal competences	**Ct1. Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence** L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments; L.O. 1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.3 to show initiative, to be proactive, L.O.1.4 to apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.5 identify problems and make decisions to solve them; L.O.1.6 to comply with the rules, regulations and guidelines related to a certain field or sector and to apply them in his day-to-day activity; L.O.1.7 to plan activities, manage the calendar and resources to complete tasks in a timely manner. **Ct2. Communication and teamwork skills** L.O.2.1 to carry out their work in a team; L.O. 2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities; L.O.2.10 to create and maintain networks, promoting ideas, products and services.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Modeling and simulation play a crucial role in the engineering design process. Modern simulation tools allow the creation of complete system models that take into account all interactions, thus creating multi-physics models. These models accelerate the design and testing process, thus saving human and material resources.
7.2 Specific objectives	• Understanding the principles and potential for automated design using advanced integrated development environments Matlab • Understanding and acquiring the advanced knowledge necessary to develop applications for dynamic simulation of dynamic systems based on Matlab

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Dynamical systems in Matlab	Interactive course	2	
2. Programming in Matlab	Interactive course	2	
3. Kinematics problems solved in Matlab	Interactive course	2	
4. Dynamics problems solved in Matlab	Interactive course	2	
5. Graphical representations in Matlab	Interactive course	2	
6. Animations in Matlab	Interactive course	2	
7. Fractals in Matlab	Interactive course	2	

Bibliography

1. Stormy Attaway, Matlab: A Practical Introduction to Programming and problem Solving, Elsevier, 2009
2. Nicoleta Breaz, Marian Crăciun, Păstorel Gaşpar, Maria Miroiu, Iuliana Paraschiv-Munteanu, MODELAREA MATEMATICĂ PRIN MATLAB, 2011
3. B. Rofffel and B. Betlem, Process Dynamics and Control, Modeling for Control and Prediction, John Wiley & Sons, Ltd 2006
4. Luyben, W.L., Process Modeling Simulation, and Control for chemical engineers, McGraw-Hill, 1973.
5. Imre-Lucaci Arpad, Ana-Maria Cormoş, MATLAB, exemple şi aplica ii în ingineria chimică, Ed. Presa Universitară Clujeană, Cluj-Napoca, 2008.
6. Brian D. Hahn and Daniel T. Valentine Essential MATLAB for Engineers and Scientists, Third Edition, Elsevier, 2006.

8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
1. Dynamical systems in Matlab	Individual work	2	
2. Programming in Matlab	Individual work	2	
3. Kinematics problems solved in Matlab	Individual work	2	
4. Dynamics problems solved in Matlab	Individual work	2	
5. Graphical representations in Matlab	Individual work	2	
6. Animations in Matlab	Individual work	2	
7. Fractals in Matlab	Individual work	2	

Bibliography

7. Stormy Attaway, Matlab: A Practical Introduction to Programming and problem Solving, Elsevier, 2009
8. Nicoleta Breaz, Marian Crăciun, Păstorel Gaşpar, Maria Miroiu, Iuliana Paraschiv-Munteanu, MODELAREA MATEMATICĂ PRIN MATLAB, 2011
9. B. Rofffel and B. Betlem, Process Dynamics and Control, Modeling for Control and Prediction, John Wiley & Sons, Ltd 2006
10. Luyben, W.L., Process Modeling Simulation, and Control for chemical engineers, McGraw-Hill, 1973.
11. Imre-Lucaci Arpad, Ana-Maria Cormoş, MATLAB, exemple şi aplica ii în ingineria chimică, Ed. Presa Universitară Clujeană, Cluj-Napoca, 2008.
12. Brian D. Hahn and Daniel T. Valentine Essential MATLAB for Engineers and Scientists, Third Edition, Elsevier, 2006.

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Theoretical and practical approaches demonstrate the latest programming ideas for automotive design. The curriculum is consistent with similar fields addressed to universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	The ability to operate with the acquired knowledge;	Written exam	50%
10.5 Seminar/ laboratory/ project	Ability to apply in practice;	Written exam	50%
10.6 Minimal performance standard			
• Dynamic simulation of a mechanical system in Matlab			

This course outline was certified in the Department Board meeting on 20/092024. and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA,  **Dean**	**Prof. dr. ing. Mihai DUGULEANĂ,**  **Head of Department**
Prof. Ph. D. Olivia Florea,  ..... Prof. Ph. D. eng. Horia ABĂITANCEI, ... **Course holder**	Prof. Ph. D. Olivia Florea,  ..... Prof. Ph. D. eng. Horia ABĂITANCEI, ... **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			CAD and Graphics programming					
2.2 Course convenor			Prof. Ph. D. eng. Florin GÎRBACIA					
2.3 Seminar/ laboratory/ project convenor			Prof. Ph. D. eng. Florin GÎRBACIA					
2.4 Study year	1	2.5 Semester	1	2.6 Evaluation type	E	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/1/1**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/14/14
Time allocation					hours
Study of textbooks, course support, bibliography and notes					15
Additional documentation in libraries, specialized electronic platforms, and field research					25
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays					45
Tutorial					4
Examinations					2
Other activities.....					3

3.7 Total number of hours of student activity	94
3.8 Total number per semester	150
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	• Knowledge of Mathematical Algebra, Elementary CAD notions Cunoașterea algebricii matematice, noțiuni elementare CAD
4.2 competences-related	• Operating with fundamental concepts of engineering sciences.

5. Conditions (if applicable)

5.1 for course development	• projector • lecture notes • recommended bibliography
5.2 for seminar/ laboratory/ project development	• projector • laboratory equipped with computers • virtual and augmented reality equipments • lecture notes

	• recommended bibliography

6. Specific competences and learning outcomes

Professional competences	Cp1. Competences in the design of systems, equipment and vehicle components L.O.1.1 the ability to study, interpret and capitalize on technical resources specific to the motor vehicle manufacturing industry; L.O.1.2 the use of advanced concepts, techniques and principles regarding the design of modern systems and equipment intended for motor vehicles; L.O.1.3 applying mathematical methods and using calculation and simulation programs to perform technical analyzes and design solutions for specific problems; L.O.1.4 designing prototypes of vehicle components and systems by applying advanced engineering principles; Cp2. Software design and development capability L.O.2.1 to develop software for motor vehicles and related systems; L.O.2.2 understand and apply the principles of programming and software development technologies in the automotive industry; L.O.2.3 to evaluate and choose suitable platforms, programming languages and software technologies for projects in the automotive industry; L.O.2.4 to develop software applications to improve the functionality, performance and safety of motor vehicles; L.O.2.5 to test and debug software to ensure the proper and safe operation of vehicle systems; Cp3. Skills in using CAD-CAM-CAE systems L.O.3.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model;

Transversal competences	Ct1. Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments; L.O. 1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.3 to show initiative, to be proactive, L.O.1.4 to apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.5 identify problems and make decisions to solve them; L.O.1.6 to comply with the rules, regulations and guidelines related to a certain field or sector and to apply them in his day-to-day activity; L.O.1.7 to plan activities, manage the calendar and resources to complete tasks in a timely manner. Ct2. Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O. 2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities; L.O.2.10 to create and maintain networks, promoting ideas, products and services.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Enhance the theoretical knowledge of CAD modeling and identifying their specific solutions for automotive design; • Training and skills development of advanced 3D graphics programming; • Develop specific programming skills in CAD / CAE languages ; • Enhance the techniques of computer aided design of parts / assemblies on which the virtual prototype of the product is achieved throughout the life cycle; • Training and skills development of students on the use of specialized equipment currently used in CAD and 3D graphics programming.
7.2 Specific objectives	• Develop the capacity to p implement projects in automotive design; • Develop skills on three-dimensional modelling of parts and assemblies; • Develop skills in using adequate CAD programs to accurate and fast solving of graphics representations. • Develop skills in 3D graphics programming. • Develop skills in specific programming CAD / CAE languages.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introduction. The aim of the course. Framing 3D modeling and programming in assisted	Interactive lecture	2 hours	

engineering. Current automotive design requirements. Product development using CAD / CAE and 3D graphics.			
3D graphics-aided design: defining basic elements and algorithms.	Interactive lecture	2 hours	
Geometric modeling – Curve entities; analytic and synthetic. Surface entities; Ruled, tabulated, Coons, Bezier, and B-spline surfaces. Advance Surface modeling.	Interactive lecture	2 hours	
Methods of creating solid models: Boundary Representation (B-rep), Euler operator, Euler/Poincare formula. Constructive Solid Geometry (CSG), primitive solids, Boolean operations. Parametric Modeling, feature-based modeling.	Interactive lecture	2 hours	
Basics of assembly, Top-Down and Bottom-Up design, degrees of freedom, mating components	Interactive lecture	2 hours	
Architecture CAD software. CAD development kernels. Typical functionality of professional CAD software. Commercial CAD software - features and performance.	Interactive lecture	2 hours	
Intelligent CAD systems (KBD). Knowledge representation. Description of the Intelligent CAD systems.	Interactive lecture	2 hours	
CAD applications programming using Visual Basic. Syntax elements. Common programming techniques.	Interactive lecture	4 hours	
3D graphics programming using OpenGL. Algorithms for 3D graphics programming. Modeling of primitives using OpenGL. Generic surface modeling. 3D transformations. 3D viewing. Advanced lighting techniques. Visualization techniques: perspective view, rendering, lighting, image control.	Interactive lecture	4 hours	
Computer animation. Methods for obtaining frames. Method "keyframe" (keyframes). Simulation method. Techniques for obtaining frames. Creating animations using OpenGL and VRML languages.	Interactive lecture	2 hours	
Demonstration applications of CAD systems and advanced programming algorithms and visualization of 3D graphics in automotive design.	Interactive lecture	4 hours	
Bibliography 1. Gîrbacia Florin, Computer Aided Design: course notes, Editura Universității Transilvania din Brașov, 2020. ISBN 978-606-19-1332-9. 2. Gîrbacia, F. Computer Aided Design and Graphics Programming. Editura Universită ii Transilvania, Braşov, 2016. 3. Talabă, D., Bazele CAD. Proiectare asistată de calculator. Editura Universită ii Transilvania, Braşov, 2000. 4. Gîrbacia, F., Talabă, D., Tehnologiile realității virtuale:lucrări practice, Ed. Universită ii Transilvania Braşov, 2012.			

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6. C. Anghel, G. Şimon, Grafică Tehnică Asistată de Calculator, Editura Risoprint, Cluj-Napoca, 2008.
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9. Lee, Kunwoo, Principles of CAD/CAM/CAE Systems, Addison/Wesley, 1999.
10. Hearn, D., Baker P., "Computer Graphics with OpenGL", Prenticel Hall, 2003.
11. Foley J. D., Van Dam A., Feiner S. K., Hughes J. F., Computer Graphics - Principles and Practice, Second Edition in C, Pearson Education, 2003.

8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Getting on the use and configuration of CATIA program, specific terms. Sketching techniques. Sketcher CATIA Module. Constraints modeling tools. Profile modeling tools. Operation modeling tools.	Interactive lecture, exercises and examples, individual work	2 hours	
Solid modeling module. CATIA Part Design module. Sketch-Based Modelling Tools Features. Surface-Based Features. Dress-up Features. Transformation Features. Boolean Operations.	Interactive lecture, exercises and examples, individual work	4 hours	
Creating models for assemblies, CATIA Assembly Design module. Product Structure Tool assembly tools. Constraints Tool assembly tools. Features Assembly assembly tools. Applications in vehicle design.	Interactive lecture, exercises and examples, individual work	2 hours	
CATIA CAD applications programming using Visual Basic. Creating script files. Saving and running a script file. Creating GUI.	Interactive lecture, exercises and examples, individual work	6 hours	
OpenGL programming applications for automotive design.	Interactive lecture, exercises and examples, individual work	2 hours	
VRML programming applications for automotive design.	Interactive lecture, exercises and examples, individual work	6 hours	
Developing applications in automotive design.	Interactive lecture, exercises and examples, individual work	6 hours	

Bibliography

1. Gîrbacia Florin, Computer Aided Design: course notes, Editura Universității Transilvania din Brașov, 2020. ISBN 978-606-19-1332-9.
2. Gîrbacia, F. Computer Aided Design and Graphics Programming. Editura Universită ii Transilvania, Braşov, 2016.
3. Gîrbacia, F., Talabă, D., Tehnologiile realității virtuale:lucrări practice, Ed. Universită ii Transilvania Braşov, 2012.
4. Gîrbacia Florin, Duguleană Mihai (2019): Virtual and augmented reality in automotive design and maintenance: course notes, Editura Universitatii Transilvania din Brasov, ISBN 978-606-19-1124-0.

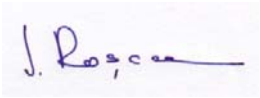
9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Theoretical knowledge underpins the latest approaches in programming and 3D modeling for the field of automotive design. The analytical curriculum is consistent with similar fields addressed at universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	The ability to apply the knowledge of design and assisted graphics	Written exam	50%
10.5 Seminar/ laboratory/ project	The ability to use modern CAD and graphic programming techniques, skills and tools	Solving practical applications	50%
10.6 Minimal performance standard			
◘ Knowledge of the fundamentals of CAD graphics programming ◘ Modeling an interactive virtual 3D environment for engineering applications ◘ Carrying out laboratory work ◘ The grades obtained for the project and exam activity must be at least 5			

This course outline was certified in the Department Board meeting on 20/092024. and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA, **Dean** 	**Prof. dr. ing. Mihai DUGULEANĂ,** **Head of Department** 
Prof. Ph. D. eng. Florin GÎRBACIA, **Course holder** 	Prof. Ph. D. eng. Florin GÎRBACIA,  **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transport Engineering
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design (in English)

2. Data about the course

2.1 Name of course			Dynamics of multibody systems					
2.2 Course convenor			Prof.dr.ing. Antonya Csaba					
2.3 Seminar/ laboratory/ project convenor			Prof.dr.ing. Antonya Csaba					
2.4 Study year	1	2.5 Semester	1	2.6 Evaluation type	E	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	CFC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/1/1**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/14/14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	60
Additional documentation in libraries, specialized electronic platforms, and field research	35
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	22
Tutorial	0
Examinations	2
Other activities.....	0

3.7 Total number of hours of student activity	119
3.8 Total number per semester	175
3.9 Number of credits[5)]	7

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	• Basic knowledge of mechanics

5. Conditions (if applicable)

5.1 for course development	• Classroom, video projector
5.2 for seminar/ laboratory/ project development	• Laboratory with computers

6. Specific competences and learning outcomes

Professional competences	C.2 Competences to carry out scientific research. L.O.2.1 To carry out scientific research, to conceive or create new knowledge by formulating questions in the field by researching, improving or developing concepts, theories, models, techniques, tools, software or operational methods and by using methods and techniques scientific; L.O.2.2 To gather information about current trends and styles regarding vehicles and the need for new products or services; L.O.2.3 To prepare reports that describe the results and processes of scientific or technical research or evaluate its progress. These reports help researchers keep up with recent discoveries; L.O.2.4 To prepare research documents or give presentations to report the results of an ongoing research project, indicating the analysis procedures and methods that led to the respective results, as well as possible interpretations of the results; L.O.2.5 To synthesize information, critically interpret and summarize new and complex information from various sources; C.4 Skills to use CAD-CAM-CAE systems L.O.4.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model; L.O.4.2 using computer-aided engineering programs to perform stress analyzes for engineering projects. C.5 Ability to design and develop software L.O.5.1 to develop software for motor vehicles and related systems; L.O.5.2 understand and apply the principles of programming and software development technologies in the automotive industry; L.O.5.3 to evaluate and choose suitable platforms, programming languages and software technologies for projects in the automotive industry; L.O.5.4 to develop software applications to improve the functionality, performance and safety of motor vehicles; L.O.5.5 to test and debug software to ensure the proper and safe operation of vehicle systems; L.O.5.6 to integrate software systems in the global architecture of motor vehicles, taking into account security and compatibility aspects; L.O.5.7 manage automotive software development projects, including planning, budgeting and monitoring progress. C.6 Skills to use CAD-CAM-CAE systems L.O.6.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model; L.O.6.2 the use of computer-aided manufacturing (CAM) programs to control machines and machine tools in the creation, modification, analysis or optimization processes as part of the manufacturing processes of motor vehicle parts; L.O.6.3 using computer-aided engineering programs to perform stress analyzes for engineering projects.
Transversal competences	Ct.1 Competences for integration into specific activities at the workplace and technical competencies, in conditions of autonomy and professional independence L.O.1.1 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.2 to show initiative, to be proactive, L.O.1.3 to provide advice to colleagues, offering suggestions on the best way forward; L.O.1.4 to be able to work in a team but also independently develop their own ways of doing things, showing the desire to learn, L.O.1.5 to analyze new problems, based on creative, innovative, analytical, and holistic thinking;

	Ct.2 Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O.2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• The objective of this course is to present the theoretical knowledge of the foundations of Multibody Dynamics with applications in Automotive Engineering: analytical foundations for the systematic generation of motion equations, numerical methods for their solution and interpretation of simulation results.
7.2 Specific objectives	• Become familiar with methodology, algorithms and software for kinematic and dynamic simulation of complex mechanical systems, automotive systems (automotive and mechanical subsystems composed of rigid elements) • Given a mechanical system, understand how to generate in a systematic and general fashion the equations that govern the time evolution • Have a basic understanding of the techniques (numerical methods) used to solve the equation of motion for multibody systems • Be able to use software to simulate and interpret the dynamics associated with complex mechanical systems • Laboratory exercises and the project aimed at introducing multibody systems simulation tools: software tools MSC.Adams and/or Matlab-Siscape-Multibody

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introduction. Background, classification of methods, history, modelling fundamentals, computational methods.	The use of classical and multimedia teaching techniques (computer, video projector)	2	
Kinematic analysis of multibody systems (MBS) Analysis of elements in MBS Bodies: classification, representation Connections between bodies: joints, degrees of freedom The degree of freedom of the MBS, loops, topology map Translation and rotation; coordinate transformation Velocity and acceleration Generalized coordinates Formulation of the kinematic model Absolute and relative constraints Constraint equations imposed by joints Driver constraints, motion Kinematic analysis: equations for kinematics Solving nonlinear equations for the kinematic model,	Teaching based on significant examples to provide motivation and explanation of the basic concepts and specific methods, highlighting the relevant ideas	10	

the Newton-Raphson method The Jacobi matrix Equations for computing velocity and acceleration The multi-body algorithm for kinematics			
Dynamic analysis of multibody systems Dynamical model for a system of rigid bodies Euler-Lagrange formulation Mass and mass distribution Principle of Virtual Work, virtual Displacements D'Alembert's Principle Variational equation of motion for a rigid body Newton-Euler Equations Forces and torques acting on a body External forces, load cases Lagrange multiplier theorem Lagrange form of the constrained equations of motion Forces acting on MBS Force-generating elements: springs, dampers Input data defining the dynamic model of the MBS Formulating dynamic model, Newton-Euler equations, Lagrange multipliers Automatic formulation of dynamic equations Numeric integration of the equation of motion Initial Conditions Euler's method Runge-Kutta methods Multi-step methods Numerical solution methods for differential-algebraic equations Newmark's integration formulas Determination of the joint forces Invers dynamics Equilibrium analysis		8	
Optimization of complex multibody systems Adapting the design parameters kinematic / dynamic function moving purposes Adapting motion parameters to a function design goal		4	
Commercial packages like MSC ADAMS/Matlab-Simscape-Multiboody Commercial software can automatically generate and solve for the response of complex MBS Shortcomings of these methods, issues related to kinematics, forward and inverse dynamics, and singularities.		4	
Bibliography Haug, E. J., Computer Aided Kinematics and Dynamics of Mechanical Systems: Basic Methods, Wiley, 1989. Shabana, A. A., Dynamics of Multibody Systems, Cambridge University Press, 2005. Wittenburg, J. Dynamics of Multibody Systems, Springer-Verlag, 2008.			

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Antonya, Cs., Boboc, R.G., Mechanisms: theory and examples. Transilvania University Press, 2023.

8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
1. Kinematic analysis of MBS	Experimental activity on multibody systems developed with Matlab-Simscape-Multibody or MSC ADAMS. Explanations, examples, interactivity, case studies	2	
2. Dynamic analysis of MBS with rigid elements		2	
3. Dynamic analysis of MBS with rigid elements, equilibrium		2	
4. Inverse dynamics		2	
5. Presentation of results and graphical simulation of MBS		2	
6. Optimization of MBS		2	
7. Evaluation.		2	
Project: Theoretical subject: write a report of 4-5 pages about an imposed theoretical topic. MBS simulation in MSC ADAMS or Matlab-Simscape-Multibody (kinematic and/or dynamic). Write a 5-6 pages report about the model with: ◘ Model description ◘ Simulation premises ◘ Initial conditions ◘ Components, degrees of freedom, joints, forces, masses ◘ Building the model ◘ Results, interpretation of results The model will have more than 4 bodies. It can be a kinematic or dynamic simulation, but motivate your decision.		7 x 2	

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ADAMS User Guide MSC Software
Haug, E. J., Computer Aided Kinematics and Dynamics of Mechanical Systems: Basic Methods, Wiley, 1989.
Shabana, A. A., Dynamics of Multibody Systems, Cambridge University Press, 2005.
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Antonya, Cs., Simularea grafică a sistemelor de corpuri, Editura Transilvania University Press, 2004.
Antonya, Cs., Boboc, R.G., Mechanisms: theory and examples. Transilvania University Press, 2023.

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Studying theoretical subjects and applications ensures the formation of skills related to the design and analysis of multibody systems of motor vehicles and understanding the interaction of mechanical systems. These skills are needed in the design and analysis of modern vehicles. Completing the course involves knowing and using software tools for designing modern mechanical systems in an integrated and optimal approach.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Using basic knowledge to explain and interpret algorithms for multibody systems	Oral examination	33%
10.5 Seminar/ laboratory/ project	According to the project subject (theoretical and simulation)	Presentation	67%
10.6 Minimal performance standard			
• Use basic knowledge to explain and interpret algorithms for multibody systems, • Elaboration of a project with an imposed theme, • The grades obtained for the homework and exam must be at least 5.			

This course outline was certified in the Department Board meeting on 20/092024. and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA, **Dean**	Prof.dr.ing. Mihai DUGULEANĂ, **Head of Department**
Prof.dr.ing. Csaba ANTONYA, **Course holder**	Prof.dr.ing. Csaba ANTONYA, **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

[2)] Study level – choose from among: Bachelor / Master / Doctorat;

[3] Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

[4] Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

[5] One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transports
1.4 Field of study[1)]	Master of Automobiles Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Tribology					
2.2 Course convenor			Prof. Ph.D. Eng. Radu Velicu/ Prof. Ph.D. Eng. Daniel Munteanu					
2.3 Laboratory			Prof. Ph.D. Eng. Radu Velicu/ Conf. Ph.D. Eng. Camelia Gabor					
2.4 Study year	I	2.5 Semester	1	2.6 Evaluation type	E	2.7 Course status	Content[3)]	DAP
							Attendance type[4)]	DI

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/2/0**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/28/0

Time allocation	hours
Study of textbooks, course support, bibliography and notes	20
Additional documentation in libraries, specialized electronic platforms, and field research	28
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	30
Tutorial	10
Examinations	6
Other activities	-

3.7 Total number of hours of student activity	94
3.8 Total number per semester	150
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	• Solid mechanics; Strength of Materials, Machines Parts
4.2 competences-related	• Knowledge and abilities to work in one or more standard or high-level programming languages (e.g., Excel, Matlab)

5. Conditions (if applicable)

5.1 for course development	• classroom, projector
5.2 for seminar/ laboratory/ project development	• computer room, dedicated software, testing devices

6. Specific competences and learning outcomes

Professional competences	C.2 Skills in the Design of Vehicle Systems, Equipment, and Components L.O.2.1 Ability to study, interpret, and capitalize on the technical resources specific to the automotive manufacturing industry. L.O.2.2 Development of testing protocols for vehicle components and equipment. CP.3 Skills in Conducting Practical Tests and Measurements L.O.3.1 Perform experimental, environmental, and operational testing on models, prototypes, or systems and equipment to test their strength and capabilities under normal and extreme conditions. L.O.3.2 Interpret and analyze data collected during testing to draw conclusions, identify new perspectives, or propose solutions. L.O.3.3 Record data that was specifically identified during previous trials to verify whether testing produces specific results. L.O.3.4 Collect data and statistics for testing and evaluation to generate pattern statements and forecasts, aiming to uncover useful information in the decision-making process. C.4 Skills in Conducting Scientific Research L.O.4.1 Conduct scientific research, create or develop new knowledge by formulating domain-specific questions, through research, improvement, or development of concepts, theories, models, techniques, tools, software, or operational methods using scientific methods and techniques. L.O.4.2 Manage research data. L.O.4.3 Operate scientific research and laboratory equipment. L.O.4.4 Synthesize information, critically interpret, and summarize new and complex information from various sources. C.6 Skills to use CAD-CAM-CAE systems L.O.6.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model; C.7 Skills in Developing Manufacturing and Assembly Technologies for Vehicles, and Testing and Validation Procedures for Vehicle Components, Systems, and Equipment L.O.7.1 Apply and develop specific design criteria, procedures, and methods for modern vehicle manufacturing, assembly, and maintenance technologies. L.O.7.2 Operate precision measuring equipment. L.O.7.3 Develop testing and validation protocols to allow a variety of analyses for vehicle components and systems. L.O.7.4 Evaluate vehicle system performance using specific testing procedures and equipment. L.O.7.5 Identify potential issues and find optimal solutions. C.8 Ability to Improve Safety and Adhere to Standards for Technical Equipment Safety L.O.8.1 Inspect equipment used during industrial activities, such as manufacturing or construction equipment, to ensure that the equipment complies with safety and environmental legislation. L.O.8.2 Integrate mechanical, electrical, electronic, software, and safety engineering in vehicle design, such as for trucks, vans, and cars. L.O.8.3 Apply basic safety standards and technical standards specific to equipment to prevent risks associated with the use of technical equipment at the workplace.

Transversal competences	CT.1 Skills for Integration into Workplace-Specific Activities and Technical Skills with Autonomy and Professional Independence L.O.1.1 Take responsibility, be accountable for personal decisions, and show readiness to work while honoring commitments. L.O.1.2 Demonstrate determination, making sustained efforts to succeed with clear objectives, and make decisions by choosing among several alternatives.
	L.O.1.3 Show initiative and be proactive. L.O.1.4 Demonstrate self-reflection, quick thinking, and accept constructive criticism and guidance from colleagues or superiors. L.O.1.5 Apply scientific, technological, and engineering knowledge by processing complex information, operating technological installations, tools, or digital equipment. L.O.1.6 Identify problems and make decisions to solve them. L.O.1.7 Comply with standards, regulations, and guidelines related to a specific field or sector and apply them in daily work activities. L.O.1.8 Plan activities, manage schedules and resources to complete tasks on time. CT.2 Communication and Teamwork Skills L.O.2.1 Work effectively in a team. L.O.2.2 Address an audience, deliver a speech, or make a presentation. L.O.2.3 Use simple digital tools and technologies to communicate, interact, and collaborate with others. L.O.2.4 Be capable of training other team members and organizing information, objects, and resources.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• The acquisition by students of fundamental concepts in tribology as a science that addresses phenomena of friction, lubrication, and wear in relation to practical applications. • The purpose of the lab is to introduce students to high-performance equipment for analyzing friction, lubrication, lubricant properties, and wear.
7.2 Specific objectives	• Understanding the phenomena and mechanisms of friction • Understanding the role of lubrication and the necessary properties of lubricants • Understanding the phenomena of boundary, mixed, and hydrodynamic lubrication • Understanding the mechanisms of wear development, conditions of occurrence, and methods of reduction • Developing practical skills for operating specific equipment to measure defining parameters for friction, lubrication, and wear phenomena

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1.Introduction (meaning of friction, lubrication and wear).	Lectures, discussion	2 hrs	
2.Dry friction (surfaces topography of solids, model of contact, friction and wear, stick-slip)	Lectures, discussion	2hrs	
3.Wear (Abrasive, erosive and cavitation wear, fatigue wear (sliding, rolling)	Lectures, discussion	2hrs	
4.Wear (Abrasive, erosive and cavitation wear, fatigue wear (sliding,	Lectures,	2hrs	

rolling)	discussion		
5.Lubricants (dynamic and kinematic viscosity, viscosity-temperature relationship, viscosity-pressure relationship, measurements, classification, types of lubricants and their description - mineral and synthetic oils, greases; additives)	Lectures, Discussion	6hrs	
6.Hydrodynamic lubrication (Conditions for HDL, simplifying assumptions, Reynolds equation, simplifications, bearing parameters from Reynolds eq., application for journal bearings - pressure distribution, load capacity, friction, power loss; Stribeck curve, squeeze films and Reynolds eq.)	Lectures, Discussion	6hrs	
7.Improving the tribological properties of metallic parts by diffusion surface treatments - surface modification by altering surface chemistry (high temperature diffusion treatments: carburizing and carbonitriding; low temperature diffusion treatments: nitriding and nitrocarburizing – principles, technological parameters, mechanical and tribological surface properties before and after treatment).	PPT presentation, discussion	4hrs	
8.Integrating tribological coating systems into the surfaces design process – surfaces modification by adding new material onto the surface (tribological coatings and their properties, deposition technologies and technological parameters – advantages and disadvantages, applications, substrates preparation, duplex processes).	PPT presentation, discussion	4hrs	
9.Micro-nanomechanics/micro-nanotribology (tribological thin films and multilayers, surfaces topography by AFM and STM, micro-scale friction, atomic scale friction, directionality effect on microfriction, micro/nanoindentation – hardness and elastic modulus, micro/nano wear and scratching, boundry lubrication	PPT presentation, discussion,	2hrs	
10.Micro-nanomechanics/micro-nanotribology (tribological thin films and multilayers, surfaces topography by AFM and STM, micro-scale friction, atomic scale friction, directionality effect on microfriction, micro/nanoindentation – hardness and elastic modulus, micro/nano wear and scratching, boundry lubrication	PPT presentation, discussion,	2hrs	

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2. Stachowiak, G.W., Batchelor, A.W. Engineering tribology, Elsevier, 3rd ed. 2005
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8.2 Laboratory	Teaching-learning methods	Number of hours	Remarks
1. Tribometer (description, specifications, destinations, use)	On site presentation	2	Weekly report

2. Ball on disk continuous test for dry, boundary or mixed lubrication (Stribeck curve)	Experimental reading and analyse	2	Weekly report
3. Pin on plate oscillation test for dry, boundary or mixed lubrication		2	Weekly report
4. Block on ring test for boundary or mixed lubrication		2	Weekly report
5. Ball on plate oscillation test for static and dynamic friction, stick – slip test		2	Weekly report
6. General presentation of laboratory equipment for surface testing: ball-on-disk tribometer (CSM Instruments), Compact platform (for micro- and nano-level indentation and scratching).		2	Weekly report
7. Wear tests using the pin-on-disk tribometer. Determination of wear and friction coefficients under various conditions.		2	Weekly report
8. Testing adhesion of tribological thin-films using the scratch-testing method.		2	Weekly report
9. Surfaces topography evaluation at micro and nano levels (mechanic profilometer method and Atomic Force Microscopy method).	General presentation and principle of analysis	2	Weekly report
10. Establishing coatings/thin film thickness and adhesion; Ball-cratering technique and scratch test.		2	Weekly report
11. The indentation method; establishing the elastic modulus and indentation hardness of coatings and thin films.		2	Weekly report
12. Tribology; establishing the dynamic friction coefficient for coatings and thin films using the ball-on-disk tribometer.		2	Weekly report
13. Tribology; establishing the wear rate of coatings and thin films using Ball-on-disk tribometer and using the profilometer method.		2	Weekly report
14. Deposition of tribological purpose thin films on stainless steel.		2	Weekly report

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1. UMT3, Reference manual, 2011
2. UMT3, Application manual, 2012
3. Bhushan, B., Handbook of Micro/nanotribology, Second edition, CRC Press, LLC, 1999.
4. CSM Instruments, Manual of Instrumentation methods, Pesseux, Switzerland, 2011.

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

In corroboration with Industrial Companies interests.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Theory understanding	Grid test, objective evaluation	50%
	Correct use of terminology		
10.5 Seminar/ laboratory/ project	Ability to recognize the phenomena related to friction, lubrication and wear	Practical work/oral presentation, subjective evaluation	50%

	Efficient communication Correctness of graphical representations and numeric calculus Correct Conclusions		
10.6 Minimal performance standard			
The passing grade for both the course and the laboratory is obtained by demonstrating the ability to identify and define the main processes in tribology (friction, lubrication, wear) and knowledge of the main practical methods used in the tribology laboratory.			

This course outline was certified in the Department Board meeting on 20/092024. and approved in the Faculty Board meeting on 30/09/2024.

Prof. Ph.D. Eng. Ioan Călin ROȘCA,  **Dean**	**Prof. Ph.D. Eng. Mihai DUGULEANĂ**  **Head of Department**

Course holder, ***Prof. dr. ing. Radu VELICU***  **Course holder,** **Prof. dr. ing. Daniel MUNTEANU** 	**Holder of laboratory,** ***Prof. dr. ing. Radu VELICU***  **Holder of laboratory,** **Conf. dr. ing. Camelia GABOR** 

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Practice for research and development I					
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor			Prof. Ph. D. eng. Florin GÎRBACIA					
2.4 Study year	1	2.5 Semester	1	2.6 Evaluation type	C	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	**NCPC**

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**12**	out of which: 3.2 lecture	**0**	3.3 seminar/ laboratory/ project	**0/0/12**
3.4 Total number of hours in the curriculum	168	out of which: 3.5 lecture	0	3.6 seminar/ laboratory/ project	168

Time allocation	hours
Study of textbooks, course support, bibliography and notes	20
Additional documentation in libraries, specialized electronic platforms, and field research	20
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	16
Tutorial	0
Examinations	4
Other activities.....	20

3.7 Total number of hours of student activity	60
3.8 Total number per semester	228
3.9 Number of credits[5)]	4

4. Prerequisites (if applicable)

4.1 curriculum-related	• Elementary concepts of automotive engineering, computer-aided design
4.2 competences-related	• Operating with fundamental concepts of engineering sciences.

5. Conditions (if applicable)

5.1 for course development	• projector • lecture notes • Windows operating system, Catia V5, Matlab
5.2 for seminar/ laboratory/ project development	• projector • laboratory equipped with computers • Windows operating system, Catia V5, Matlab

6. Specific competences and learning outcomes

Professional competences	C1. Skills for identifying needs for design L.O.1.1 To identify customer needs, using appropriate questions and active listening to identify customer expectations, wishes and requirements according to products and services; L.O.1.2 To interpret the technical requirements of customers, analyzing, understanding and applying the information provided regarding the technical conditions; L.O.1.3 To define technical design requirements, by specifying the technical properties of the goods, materials, methods, processes, services, systems, software and functionalities, by identifying and addressing the specific needs that must be met according to the client's requirements; L.O.1.4 To ensure the connection with the engineers from the other departments to ensure a common understanding and to discuss the design, development and improvement of the products; L.O.1.5 To make design sketches to contribute to the elaboration and communication of design concepts. C2. Competences in the design of systems, equipment and vehicle components L.O.2.1 the ability to study, interpret and capitalize on technical resources specific to the motor vehicle manufacturing industry; L.O.2.2 the use of advanced concepts, techniques and principles regarding the design of modern systems and equipment intended for motor vehicles; L.O.2.3 applying mathematical methods and using calculation and simulation programs to perform technical analyzes and design solutions for specific problems; L.O.2.4 designing prototypes of vehicle components and systems by applying advanced engineering principles; C4 Competences to carry out scientific research. L.O.4.5 To synthesize information, critically interpret and summarize new and complex information from various sources; L.O.4.6 To interact professionally in research and professional environments; L.O .4.7 To apply systematic research methods and to communicate with the relevant parties to find specific information, evaluating the research results in view of the relevant estimation of the information, as well as the related technical systems and their evolutions; L.O .4.8 To provide proof of in-depth knowledge and complex understanding of the research field, including responsible research, ethical principles and scientific integrity in research matters, respect for private life and GDPR requirements, related to research activities in - a certain discipline.
Transversal competences	Ct1. Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments; L.O. 1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.3 to show initiative, to be proactive, L.O.1.4 to apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.5 identify problems and make decisions to solve them; L.O.1.6 to comply with the rules, regulations and guidelines related to a certain field or sector and to apply them in his day-to-day activity; L.O.1.7 to plan activities, manage the calendar and resources to complete tasks in a timely manner.

	Ct2. Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O. 2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities; L.O.2.10 to create and maintain networks, promoting ideas, products and services.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Apply scientific knowledge to solve automotive engineering problems.
7.2 Specific objectives	• Practical skills for simulating the development processes of automotive products. • Development of programming skills in specific CAD languages. • Theoretical and applicative knowledge related to multibody systems • Practical simulation and analysis skills with MB systems software packages • Theoretical and applied knowledge related to the modeling and simulation of the physical processes • Development of modern software, innovative methods, principles and simulation procedures • Development of methods for evaluating research and development projects • Developing a management strategy using modern principles and methods

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Not the case			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Advanced design and simulation in CATIA V5, using standardized computing, component libraries	Video projector presentations, examples, experiments, case studies related to multibody systems, programming in specific CAD languages, 3D graphic programming	168	
Advanced design elements in CATIA V5 software using appropriate controls			
Development of VRML 3D graphics application for automotive design			
Virtual prototyping using MB systems			
Group projects			

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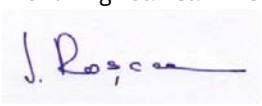
9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Through its content and through the elaboration of the thematic portfolio (the study), the masters acquire competences in accordance with the expectations of the epistemic community and of the producers in the car market. The analytical program is in line with similar fields addressed at universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course			
10.5 Seminar/ laboratory/ project	Modelling of proposed CAD models	Oral presentation	100%
	Completion of MBS simulation		
	Involvement in practical activities		
	Efficiency in verbal communication (presentation)		
10.6 Minimal performance standard			
• Knowledge of CAD fundamentals • Realization of an MBD simulation for engineering applications • Realization of practical project • The marks for project work must be at least 5.			

This course outline was certified in the Department Board meeting on 20/092024. and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA,  **Dean**	**Prof. dr. ing. Mihai DUGULEANĂ,**  **Head of Department**
Prof. Ph. D. eng. Florin GÎRBACIA,  **Course holder**	Prof. Ph. D. eng. Florin GÎRBACIA,  **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

[4] Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

[5] One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transport Engineering
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design (in English)

2. Data about the course

2.1 Name of course			Advance Simulation in Automotive Design					
2.2 Course convenor			Prof.dr.ing. Antonya Csaba					
2.3 Seminar/ laboratory/ project convenor			Prof.dr.ing. Antonya Csaba					
2.4 Study year	1	2.5 Semester	2	2.6 Evaluation type	E	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	CFC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/0/2**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/0/28

Time allocation	hours
Study of textbooks, course support, bibliography and notes	67
Additional documentation in libraries, specialized electronic platforms, and field research	15
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	35
Tutorial	0
Examinations	2
Other activities.....	0

3.7 Total number of hours of student activity	119
3.8 Total number per semester	175
3.9 Number of credits[5)]	7

4. Prerequisites (if applicable)

4.1 curriculum-related	•
4.2 competences-related	• Basic knowledge of mechanics

5. Conditions (if applicable)

5.1 for course development	• Classroom, video projector
5.2 for seminar/ laboratory/ project development	• Laboratory with computers

6. Specific competences and learning outcomes

Professional competences	C.2 Competences to carry out scientific research. L.O.2.1 To carry out scientific research, to conceive or create new knowledge by formulating questions in the field by researching, improving or developing concepts, theories, models, techniques, tools, software or operational methods and by using methods and techniques scientific; L.O.2.2 To gather information about current trends and styles regarding vehicles and the need for new products or services; L.O.2.3 To prepare reports that describe the results and processes of scientific or technical research or evaluate its progress. These reports help researchers keep up with recent discoveries; L.O.2.4 To prepare research documents or give presentations to report the results of an ongoing research project, indicating the analysis procedures and methods that led to the respective results, as well as possible interpretations of the results; L.O.2.5 To synthesize information, critically interpret and summarize new and complex information from various sources; C.4 Skills to use CAD-CAM-CAE systems L.O.4.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model; L.O.4.2 using computer-aided engineering programs to perform stress analyzes for engineering projects. C.5 Ability to design and develop software L.O.5.1 to develop software for motor vehicles and related systems; L.O.5.2 understand and apply the principles of programming and software development technologies in the automotive industry; L.O.5.3 to evaluate and choose suitable platforms, programming languages and software technologies for projects in the automotive industry; L.O.5.4 to develop software applications to improve the functionality, performance and safety of motor vehicles; L.O.5.5 to test and debug software to ensure the proper and safe operation of vehicle systems; L.O.5.6 to integrate software systems in the global architecture of motor vehicles, taking into account security and compatibility aspects; L.O.5.7 manage automotive software development projects, including planning, budgeting and monitoring progress. C.6 Skills to use CAD-CAM-CAE systems L.O.6.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model; L.O.6.2 the use of computer-aided manufacturing (CAM) programs to control machines and machine tools in the creation, modification, analysis or optimization processes as part of the manufacturing processes of motor vehicle parts; L.O.6.3 using computer-aided engineering programs to perform stress analyzes for engineering projects.
Transversal competences	Ct.1 Competences for integration into specific activities at the workplace and technical competencies, in conditions of autonomy and professional independence L.O.1.1 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.2 to show initiative, to be proactive, L.O.1.3 to provide advice to colleagues, offering suggestions on the best way forward; L.O.1.4 to be able to work in a team but also independently develop their own ways of doing things, showing the desire to learn, L.O.1.5 to analyze new problems, based on creative, innovative, analytical, and holistic thinking;

	Ct.2 Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O.2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• The simulation process refers to performing experiments on models of automotive systems to predict how the real system would behave. • Understanding the dynamics of automotive systems and the purpose they serve in designing, analyzing, and controlling them. • Conceptualizing how a system is divided into subsystems and components to allow their synthesis.
7.2 Specific objectives	• Synthesis of mathematical models to represent the automotive systems' dynamic responses for analysis, design, and/or control. • Analysis of the dynamic characteristics of the automotive systems and their responses to inputs. • Methodical system design and synthesis by selecting its parameters to meet the specified criteria. • Control by using sensors and actuators to automate a process or system. • Bond graph representation: structured graphical representation - establishes rules going from the design of models by phenomenological analysis to equation formatting. • Modelling in a non-causal way, allowing focusing on the physical description of the phenomena involved within the automotive systems. • Use of specific software programs for modeling, simulation, and control of integrated systems.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Introduction to: Modeling vs. Simulation Design, analysis, or control of dynamic systems State-Space Modeling Bond Graphs	The use of classical and multimedia teaching techniques (computer, video projector)	4	
2. Bond Graph Modeling Concepts. Basic Bond Graph Elements Basic bond graph elements: sources, transformers/gyrators, junctions Causal bond graphs Examples	Teaching based on significant examples to provide motivation and explanation of the basic concepts and specific methods, highlighting the relevant ideas	12	
3. Bond Graph Synthesis and Equation Derivation Mathematical modeling of automotive systems Algebraic Loops and Derivative Causality The state space representation		12	

Inputs into dynamic systems Laplace Transforms Transfer Function Impedance Bond Graphs Time domain analysis Frequency domain analysis			
Bibliography Mellodge, Patricia: A Practical Approach to Dynamical Systems for Engineers. Woodhead Publishing, 2016 Javier A. Kypuros: System Dynamics and Control with Bond Graph Modeling. CRC Press, 2013 Dean C. Karnopp, Donald L. Margolis, Ronald C. Rosenberg: System Dynamics Modeling, Simulation, and Control of Mechatronic Systems. John Wiley & Sons, 2012 Claudiu Pozna: Teoria sistemelor automate, Matrixrom, 2010 Antonya, Cs., Boboc, R.G., Mechanisms: theory and examples. Transilvania University Press, Brasov, 2023. François E. Cellier, Ernesto Kofman: Continuous System Simulation, Springer, 2006 Wolfgang Borutzky: Bond Graph Modelling of Engineering Systems, Springer, 2011 Antonya, Cs.: Simularea grafică a sistemelor de corpuri. Transilvania University Press, Braşov, 2004			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Project: 1. Theoretical Subject Write a report of 4-5 pages about the topic from the following list: 1. Bond graph modeling concepts 2. Bond graph elements: mechanical – translational 3. Bond graph elements: mechanical – rotation 4. Bond graph elements: electrical circuits 5. Bond graph elements: flow system 6. Bond graph elements: sources, transformers/gyrators, junctions 7. Causal bond graphs 8. Bond graph synthesis and equation derivation 9. The state space representation 10. Laplace transforms, solving for the system response 11. Impedance bond graphs 12. Time domain analysis 13. Frequency domain analysis 2. Practical subject Simulation in AMESIM or Matlab/Simscape model of an automotive application Write a report about the model with: ◘ Model description ◘ Simulation premises	Experimental activity on system dynamics developed with Siemens AMESim or Matlab/Simscape. Explanations, examples, interactivity, case studies	28	

◘ Initial conditions ◘ Components, ◘ Building the model ◘ Results, interpretation of results			

Bibliography

Mellodge, Patricia: A Practical Approach to Dynamical Systems for Engineers. Woodhead Publishing, 2016

Javier A. Kypuros: System Dynamics and Control with Bond Graph Modeling. CRC Press, 2013

Dean C. Karnopp, Donald L. Margolis, Ronald C. Rosenberg: System Dynamics Modeling, Simulation, and Control of Mechatronic Systems. John Wiley & Sons, 2012

Claudiu Pozna: Teoria sistemelor automate, Matrixrom, 2010

Antonya, Cs., Boboc, R.G., Mechanisms: theory and examples. Transilvania University Press, Brasov, 2023.

François E. Cellier, Ernesto Kofman: Continuous System Simulation, Springer, 2006

Wolfgang Borutzky: Bond Graph Modelling of Engineering Systems, Springer, 2011

Antonya, Cs., Simularea grafică a sistemelor de corpuri. Transilvania University Press, Braşov, 2004

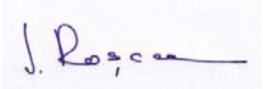
9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Studying theoretical subjects and applications ensures the formation of skills related to the integrated design of vehicle systems and understanding the interaction of mechanical systems with electrical/electronic control systems, respectively with hydraulic, pneumatic, thermal systems, etc. These skills are needed in the design and analysis of modern vehicles. Completing the course involves knowing and using software tools for designing modern mechanical systems in an integrated and optimal approach.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Using basic knowledge to explain and interpret algorithms for multibody systems	Oral examination	33%
10.5 Seminar/ laboratory/ project	According to the project subject (theoretical and simulation)	Presentation	67%
10.6 Minimal performance standard			
• Use basic knowledge to explain and interpret the vehicle's dynamic systems. • Elaboration of a project with an imposed theme, • The grades obtained for the imposed subject, project, and exam must be at least 5.			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA, **Dean** 	Prof.dr.ing. Mihai DUGULEANĂ, Head of Department 

Prof.dr.ing. Csaba ANTONYA, **Course holder**	Prof.dr.ing. Csaba ANTONYA, **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Simulation in product development					
2.2 Course convenor			Prof.dr.ing. BUTNARIU Silviu					
2.3 Seminar/ laboratory/ project convenor			Prof.dr.ing. BUTNARIU Silviu					
2.4 Study year	1	2.5 Semester	2	2.6 Evaluation type	C	2.7 Course status	Content[3)]	DS
							Attendance type[4)]	DI

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**2**	out of which: 3.2 lecture	**1**	3.3 seminar/ laboratory/ project	**0/0/1**
3.4 Total number of hours in the curriculum	28	out of which: 3.5 lecture	14	3.6 seminar/ laboratory/ project	0/0/14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	22
Additional documentation in libraries, specialized electronic platforms, and field research	18
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	28
Tutorial	2
Examinations	2
Other activities.....	

3.7 Total number of hours of student activity	72
3.8 Total number per semester	100
3.9 Number of credits[5)]	4

4. Prerequisites (if applicable)

4.1 curriculum-related	• Engineering disciplines studied in the undergraduate years
4.2 competences-related	• Basic engineering concepts

5. Conditions (if applicable)

5.1 for course development	• classroom, projector
5.2 for seminar/ laboratory/ project development	• computer room.

6. Specific competences and learning outcomes

Professional competences	C.1 Skills for identifying needs for design L.O.1.1 To identify customer needs; L.O.1.2 To interpret the technical requirements of customers, analyzing, understanding and applying the information provided regarding the technical conditions; L.O.1.3 To define technical design requirements, C.6 Skills to use CAD-CAM-CAE systems L.O.6.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model; L.O.6.3 using computer-aided engineering programs to perform stress analyzes for engineering projects. C.7 Competences for the development of vehicle manufacturing and assembly technologies, test and validation procedures for vehicle components, systems and equipment L.O. 7.2 evaluation of advanced vehicle manufacturing technologies and their correlation with the optimal operating parameters of vehicle systems; L.O.7.6 development of test and validation protocols to enable a variety of analyzes of vehicle components and systems; L.O.7.8 identifying problems that may arise and finding optimal solutions; R.Î.7.10 evaluating the possibility that a system or its components can be obtained by applying certain engineering principles. C.8 The ability to improve safety and comply with technical equipment safety standards L.O.8.2 combine mechanical, electrical, electronic, software and safety engineering for vehicle design.
Transversal competences	CT.1 Competences for integration into specific activities at the workplace and technical competences, in conditions of autonomy and professional independence L.O.1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.6 to be able to work in a team but also independently, developing their own ways of doing things, showing the desire to learn, L.O.1.7 to analyze new problems, based on creative, innovative, analytical, holistic thinking; L.O. 1.9 apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.13 to plan activities, manage the calendar and resources to complete tasks in a timely manner. CT.2 Communication and teamwork skills L.O.2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	Theoretical and applied training in the design and development of products in the field of motor vehicles
7.2 Specific objectives	• Understanding product development strategies • Understanding of product design methods and processes • Understanding and practicing simulation in product development

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Trends in the automotive industry. Life cycle assessment	Interactive course, exposure to	2	
Product development in the automotive industry. Introduction		2	

(background, methods, history)	multimedia		
Life cycle of automotive products		2	
Product development process models. Simulation in product development		4	
Project management in product development		2	
How product development simulation adds value to the product development process		2	
Bibliography Rafinjad, D. R. *Innovation, product development and Commercialization*, 2007 Munch, J., a o , *Software process definition and Management,* Springer, 2012 Karniel, A., Reich Y., *Managing the Dynamics of the New Product Development Process*, Springer, 2011.			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Product development processes for public transport systems: case studies of electromobility systems; infrastructure; monitoring; efficiency; innovation process, research activities.	Individual and group work, assisted training	6	
Product Development Simulation Case Studies: Global Customer Demands: Model Supported Design vs Traditional Design; model validation; virtual model verification, applications on automotive engine subassemblies	Individual and group work, assisted training	8	
Bibliography Rafinjad, D. R. *Innovation, product development and Commercialization*, 2007 Munch, J., a o , *Software process definition and Management,* Springer, 2012 Karniel, A., Reich Y., *Managing the Dynamics of the New Product Development Process*, Springer, 2011.			

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The content of the discipline was discussed with the professors of the department and with the representatives of the Schaeffler Romania company

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Ability to identify, formulate and solve engineering problems	Knowledge verification to support the project	50
10.5 Seminar/ laboratory/ project	Correctness of schemes and calculations and conclusions	Project analysis	30
	The originality of the presentation.	Powerpoint presentation	20
10.6 Minimal performance standard			
• Grade 5 on the project • Score 5 on the knowledge test			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA Dean of Faculty of Mechanical Engineering	Prof.dr.ing. Mihai DUGULEANĂ Head of Department
Prof.dr.ing. Silviu BUTNARIU Course holder	dr.ing. Eugen BUTILĂ Holder of laboratory/ project

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Finite element analysis in automotive design (FEA)					
2.2 Course convenor			Prof.dr.ing. BUTNARIU Silviu					
2.3 Seminar/ laboratory/ project convenor			dr.ing. BUTILĂ Eugen					
2.4 Study year	1	2.5 Semester	2	2.6 Evaluation type	E	2.7 Course status	Content[3)]	DAP
							Attendance type[4)]	DI

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/1/1**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/14/14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	30
Additional documentation in libraries, specialized electronic platforms, and field research	25
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	28
Tutorial	8
Examinations	3
Other activities.....	

3.7 Total number of hours of student activity	94
3.8 Total number per semester	150
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	• General concepts of physics, mechanics, strength of materials. Mathematical disciplines and engineering disciplines (machine parts, material resistance, mechanics, mechanisms), studied in the undergraduate years
4.2 competences-related	Knowledge and understanding: • familiarize students with the concepts and terminology of the discipline, with reference to mechanical systems and processes in the field of automotive engineering study. • understanding the reasoning used and how the investigation; • understanding criteria for choice and use of methods of investigation. Explanation and interpretation: • explain the concepts used in finite element analysis and interpretation of analysis results of tension and strain generated in different application situations; Instrumental – Applied

	• to selection of the concepts and proper investigation methods, recognizing how best to resolve the problem subject to study; • proper use of specific calculation processes theory finite element discretization of a correct interpretation of results, proper use of the automatic calculation program for. Attitude • evidence of positive and responsible attitudes towards science based on knowledge of phenomena and connections with engineering practice; • fostering scientific environment centered democratic values and relationships; • making best use of their potential in creative and scientific activities; • engaging in a partnership relationship with other people: colleagues, teachers, etc. participation in their scientific development.

5. Conditions (if applicable)

5.1 for course development	• classroom, projector
5.2 for seminar/ laboratory/ project development	• computer room, dedicated software (ANSYS), machine elements.

6. Specific competences and learning outcomes

Professional competences	C.2 Competences to design systems, equipment and vehicle components L.O.2.3 applying mathematical methods and using calculation and simulation programs to perform technical analyzes and design solutions for specific problems; L.O.2.5 designing prototypes of vehicle components and systems by applying advanced engineering principles; L.O.2.6 preparation of functional models, prototypes in order to test concepts and reproduction possibilities; creating prototypes for pre-production test evaluation; L.O.2.7 development of test protocols for vehicle components and equipment; C.4 Competences to carry out scientific research. L.O 4.3 To prepare reports that describe the results and processes of scientific or technical research or evaluate its progress. L.O.4.4 To prepare research documents or give presentations to report the results of an ongoing research project, indicating the analysis procedures and methods that led to the respective results, as well as possible interpretations of the results; L.O.4.9 To synthesize information, critically interpret and summarize new and complex information from various sources; C.6 Skills to use CAD-CAM-CAE systems L.O.6.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model; L.O.6.3 using computer-aided engineering programs to perform stress analyzes for engineering projects.

Transversal competences	CT.1 Competences for integration into specific activities at the workplace and technical competences, in conditions of autonomy and professional independence L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments; L.O.1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.13 to plan activities, manage the calendar and resources to complete tasks in a timely manner. CT.2 Communication and teamwork skills L.O.2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	The study of the Finite Element Method discipline has as its general objective the acquisition of knowledge and the acquisition of the skills necessary for professional development in the environment of industrial codes and, in particular, to form the skills necessary for the design and computer-assisted manufacturing activities of specific engineering milestones
7.2 Specific objectives	In this course, the fundamental aspects of the finite element method are first presented, then the student becomes familiar with the use of basic tools for finite element modelling and analysis, applied in the real situation of some engineering problems. The educational purpose of the course aims at the following objectives: • Knowledge and appropriate use of the concepts with which the discipline operates: finite element, model with finite elements, elementary stiffness matrix, global stiffness matrix, boundary conditions, processing, post-processing, etc.; • Understanding the principles of modelling resistance structures and their elements, as well as developing the skills of correct application of this knowledge; • Carrying out pertinent analyses regarding the schematization level accepted when developing a model with finite elements in structural mechanics problems; • The correct interpretation of the results and the formulation of conclusions based on the results obtained following the analysis on models with finite elements;

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. The finite element method: The principle of the finite element method, the steps to solve a problem using the finite element method, shape functions, general considerations on the choice of elemental elements, meshing domain analysis for continuous structures, obtaining finite element numerical model.	Interactive course, exposure to multimedia, heuristic conversation, explanation, demonstration	4	
2. One-dimensional problems		2	
3. Multidimensional problems		2	
4. Calculation methods of engineering structures. Using finite element method in engineering. Physical and Engineering Opportunities limits.		2	
5. Basis of the theory of elasticity: tension, displacement fields		4	

and strain states;			
6. Laws of behavior / criteria limits of elasticity: Tresca criterion, Von Mises criterion.		4	
7. Mechanical Fundamentals of finite element method. Balance equations. Laws of behaviour. Approximation by finite elements. The finite element method in elasticity, led by displacement calculation, deformation tensor, vector efforts, the element stiffness matrix.		2	
8. Types of finite elements and criteria of their choice. Practical problems using the finite element method. Influence of mesh, test case.		4	
9. Case study for a bar subjected to bending.		2	
10. Steps for the finite element analysis and the flowchart for solving process. Interpretation of finite element analysis results.		2	
Bibliography Butnariu, S., Mogan, Gh., Analiza cu elemente finite în ingineria mecanică. Aplicatii practice in ANSYS, Ed. Universită ii Transilvania, ISBN 978-606-19-0474-7 (print), 2014			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
1. Description the possibilities and the performances calculation used programs.	Learning through problem / explanation, demonstration, case study, conducting guided and independent applications.	2	14 case studies – tutorials from references
2. Analysed the structure geometry modelling: Defining mesh parameters. Choice of finite element. Discretization.		3	
3. Physical and mechanical modelling: Defining material. Defining and declaring links. Defining external actions - forces and moments - and load situations.		3	
4. Finite element analysis: static calculation, calculation of dynamic		3	
5. Finite element analysis results. Interpretation and exploitation.		1	
6. Assessment of laboratory activity and project evaluation		2	
7. Project – finite element analysis of an element / assembly	Solving a case study	14	
Bibliography Butnariu, S., Mogan, Gh., Analiza cu elemente finite în ingineria mecanică. Aplicatii practice in ANSYS, Ed. Universității Transilvania, ISBN 978-606-19-0474-7 (print), 2014			

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Finite element analysis software applications offer a wide range of solutions in industry, for example in civil construction infrastructure: power plants, bridges, roads, railways, structures, and water systems. Benefits include: greater confidence in the structural integrity of the design when considering multiple innovative construction methods and materials, rapid evaluation of trade studies, configuration changes, concept drawings, side-by-side evaluation of the overall structure, with details key within the structure, as well as the ability to cope with all types of loading environments.

A large proportion of representative employers recognize that modeling and simulation, including finite element analysis (FEA) and computer-aided design (CAD), are valuable tools in vehicle development to optimize design and minimize risk. Using simulation tools including ADAMS, MATLAB, as well as finite element analysis, these companies provide rapid design coupled with corrective action.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Ability to apply knowledge of mathematics, science and engineering. Ability to identify, formulate and solve engineering problems	Testing theoretical and practical knowledge by carrying out a complex project - case study	50
10.5 Seminar/ laboratory/ project	Ability to complete, follow and complete case studies solvable through MEF based on tutorials.	Studying and solving laboratory work	15
	Ability to use modern engineering techniques, skills and tools required for engineering practices; case study.	Practical test - solving exercises	35
10.6 Minimal performance standard			
• Minimum requirements for grade 5: for all evaluation activities, at least half of the points awarded, respectively minimum grade 5, must be obtained. The minimum performance standards are given by understanding the introductory concepts taught in each topic, making the connection between concepts, the correct approach to the applications and calculation dexterity			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA Dean of Faculty of Mechanical Engineering	Prof.dr.ing. Mihai DUGULEANĂ Head of Department
Prof.dr.ing. Silviu BUTNARIU Course holder	dr.ing. Eugen BUTILĂ Holder of laboratory/ project

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Virtual and augmented reality in automotive design and maintenance					
2.2 Course convenor			Prof. Ph. D. eng. Florin GÎRBACIA					
2.3 Seminar/ laboratory/ project convenor			Prof. Ph. D. eng. Florin GÎRBACIA					
2.4 Study year	1	2.5 Semester	2	2.6 Evaluation type	E	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**3**	out of which: 3.2 lecture	**1**	3.3 seminar/ laboratory/ project	**0/1/1**
3.4 Total number of hours in the curriculum	42	out of which: 3.5 lecture	14	3.6 seminar/ laboratory/ project	0/14/14
Time allocation					hours
Study of textbooks, course support, bibliography and notes					15
Additional documentation in libraries, specialized electronic platforms, and field research					35
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays					52
Tutorial					2
Examinations					2
Other activities.....					2

3.7 Total number of hours of student activity	108
3.8 Total number per semester	150
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	• Knowledge of 3D Modelling, 3D Graphics Programming
4.2 competences-related	• Operating with fundamental concepts of engineering sciences.

5. Conditions (if applicable)

5.1 for course development	• projector • lecture notes • recommended bibliography
5.2 for seminar/ laboratory/ project development	• projector • laboratory equipped with computers • virtual and augmented reality equipments • lecture notes • recommended bibliography

6. Specific competences and learning outcomes

Professional competences	Cp1 Competences in the design of systems, equipment and vehicle components L.O.1.1 the ability to study, interpret and capitalize on technical resources specific to the motor vehicle manufacturing industry; L.O.1.2 the use of advanced concepts, techniques and principles regarding the design of modern systems and equipment intended for motor vehicles; L.O.1.3 applying mathematical methods and using calculation and simulation programs to perform technical analyzes and design solutions for specific problems; L.O.1.4 designing prototypes of vehicle components and systems by applying advanced engineering principles; Cp2. Competences to carry out scientific research. L.O.2.1 To carry out scientific research, to conceive or create new knowledge by formulating questions in the field by researching, improving or developing concepts, theories, models, techniques, tools, software or operational methods and by using methods and techniques scientific; L.O.2.2 To gather information about current trends and styles regarding vehicles and the need for new products or services; L.O.2.3 To prepare reports that describe the results and processes of scientific or technical research or evaluate its progress. These reports help researchers keep up with recent discoveries; L.O.2.4 To prepare research documents or give presentations to report the results of an ongoing research project, indicating the analysis procedures and methods that led to the respective results, as well as possible interpretations of the results; L.O.2.5 To carry out research on the present and future developments and currents in design, as well as on the related target characteristics of the market; L.O.2.6 To manage research data; L.O.2.7 To operate scientific research and laboratory equipment; L.O.2.8 To synthesize information, critically interpret and summarize new and complex information from various sources; L.O.2.9 To interact professionally in research and professional environments; L.O.2.10 To apply systematic research methods and to communicate with the relevant parties to find specific information, evaluating the research results in view of the relevant estimation of the information, as well as the related technical systems and their evolutions; L.O.2.11 To provide proof of in-depth knowledge and complex understanding of the research field, including responsible research, ethical principles and scientific integrity in research matters, respect for private life and RGPD requirements, related to research activities in - a certain discipline. Cp3. Software design and development capability L.O.3.1 to develop software for motor vehicles and related systems; L.O.3.2 understand and apply the principles of programming and software development technologies in the automotive industry; L.O.3.3 to evaluate and choose suitable platforms, programming languages and software technologies for projects in the automotive industry; L.O.3.4 to develop software applications to improve the functionality, performance and safety of motor vehicles; L.O.3.5 to test and debug software to ensure the proper and safe operation of vehicle systems; Cp4. Skills in using CAD-CAM-CAE systems L.O.4.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model;

Transversal competences	Ct1. Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments; L.O. 1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.3 to show initiative, to be proactive, L.O.1.4 to apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.5 identify problems and make decisions to solve them; L.O.1.6 to comply with the rules, regulations and guidelines related to a certain field or sector and to apply them in his day-to-day activity; L.O.1.7 to plan activities, manage the calendar and resources to complete tasks in a timely manner. Ct2. Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O. 2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities; L.O.2.10 to create and maintain networks, promoting ideas, products and services.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Understanding the principles and potential for automotive design of Virtual Reality (VR) and Augmented Reality (AR) techniques and technologies. • Understand and gain basic knowledge required to develop applications for 3D simulation of automotive based on VR technology.
7.2 Specific objectives	• Learning of knowledge for creating interactive 3D virtual environments required in automotive design; • Learning knowledge for development of RV / RA software; • Acquisition of practical skills for automotive design applications through the use of RV / RA technologies and programming environments.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introduction. The aim of the course. Introduction to human-computer interaction. Terminology, definitions and characteristics of virtual reality. Terminology, definitions and characteristics of augmented reality. Available technologies for virtual reality and augmented. History of virtual and augmented reality.	Interactive lecture	2 hours	
Software systems and standards for virtual and	Interactive lecture	2 hours	

augmented reality: Unity, InstantReality, ARCore			
Virtual and augmented reality hardware: technology and stereoscopic 3D visualization systems, haptic and audio systems	Interactive lecture	2 hours	
Virtual and augmented reality hardware: 3D input devices for virtual reality: tracking systems, voice commands, gloves, brain-computer interfaces.	Interactive lecture	2 hours	
3D interaction techniques for virtual and augmented reality.	Interactive lecture	2 hours	
Designing RV/RA user interfaces and applications	Interactive lecture	4 hours	

Bibliography

1. Gîrbacia Florin, Duguleană Mihai (2019): Virtual and augmented reality in automotive design and maintenance: course notes, Editura Universitatii Transilvania din Brasov, ISBN 978-606-19-1124-0.
2. Gîrbacia F. (2016): Tehnologii de Realitate Virtuală și Augmentată Aplicate în Inginerie. Note de curs", Editura Universitatii Tranilvania din Brasov, ISBN 978-606-19-0784-7.
3. Talabă, D., Amditis, A. Product Engineering, Tools and Methods Based on Virtual Reality. Editura Springer, 2007.
4. Gîrbacia, F. Talabă, D., Tehnologiile realității virtuale:lucrări practice, Editura Universității Transilvania Braşov, 2012.
5. Girbacia, F. Cercetari teoretice si experimentale privind dezvoltarea de interfete multimodale de realitate virtuala pentru aplicatii de proiectare asistata de calculator,Teza de doctorat,Universitatea Transilvania Brasov, 2007.
6. Vince J., Realitate Virtuala, Editura Tehnica, Bucuresti, 2000.
7. Doug A. Bowman, Ernst Kruijff, Joseph J. LaViola, Ivan Poupyrev, "3D User Interfaces: Theory and Practice", Addison-Wesley/Pearson Education, 2005,ISBN 0-201-75867-9.
8. Burdea, G. Virtual Reality Technology, Ed. John Wiley&Sons, 2003.

Thalman, D. Stepping into Virtual Reality, Ed. Springer, 2008.

8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Geometric modeling of 3D virtual environments for automotive design applications.	Interactive lecture, exercises and examples, individual work	2 hours	
Techniques and principles for developing virtual reality applications using Unity	Interactive lecture, exercises and examples, individual work	4 hours	
Techniques and principles for developing applications using the, Unity, Instant Reality and ArCore SDK Augmented Reality libraries	Interactive lecture, exercises and examples, individual work	4 hours	
Development of 3D stereoscopic passive / active visualization automotive design applications.	Interactive lecture, exercises and examples, individual work	4 hours	
Navigation and interaction in virtual three-dimensional VRML scenes using 3D mouse and joystick	Interactive lecture, exercises and examples, individual work	2 hours	
Designing a with 1 DOF haptic device for an automotive part design haptic prototyping	Individual work	6 hours	
Development of a Augmented Reality Application	Individual work	6 hours	

for automotive maintenance interactive instructions			

Bibliography

1. Gîrbacia, F. Computer Aided Design and Graphics Programming. Editura Universită ii Transilvania, Braşov, 2016.
2. Gîrbacia Florin, Duguleană Mihai (2019): Virtual and augmented reality in automotive design and maintenance: course notes, Editura Universitatii Transilvania din Brasov, ISBN 978-606-19-1124-0.
3. Gîrbacia, F., Talabă, D., Tehnologiile realității virtuale:lucrări practice, Ed. Universit ii Transilvania Braşov, 2012.
4. Gîrbacia F. (2016): Tehnologii de Realitate Virtuală și Augmentată Aplicate în Inginerie. Note de curs", Editura Universitatii Tranilvania din Brasov, ISBN 978-606-19-0784-7.

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Cunoştin ele teoretice și practice fundamentează cele mai noi abordări ale tehnologiilor de Realitate Virtuală și Augmentată pentru domeniul proiectării autovehiculelor. Programa analitică este în concordan ă cu domeniile similare abordate la universități din țară și din străinătate.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Ability to configure virtual reality systems for engineering	Written exam	40%
10.5 Seminar/ laboratory/ project	Ability to use modern virtual reality techniques and technologies	Solving practical applications	60%
10.6 Minimal performance standard			
• Knowledge of the fundamentals of VR/RA technologies • Development of an RV/RA application for automotive engineering • The grades obtained for the project and exam activity must be at least 5			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA,  **Dean**	**Prof. dr. ing. Mihai DUGULEANĂ,**  **Head of Department**

Prof. Ph. D. eng. Florin GÎRBACIA, ... **Course holder**	Prof. Ph. D. eng. Florin GÎRBACIA, ... **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Practice for research and development I					
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor			Prof. Ph. D. eng. Florin GÎRBACIA					
2.4 Study year	1	2.5 Semester	2	2.6 Evaluation type	C	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	**NCPC**

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**12**	out of which: 3.2 lecture	**0**	3.3 seminar/ laboratory/ project	**0/0/12**
3.4 Total number of hours in the curriculum	168	out of which: 3.5 lecture	0	3.6 seminar/ laboratory/ project	168

Time allocation	hours
Study of textbooks, course support, bibliography and notes	20
Additional documentation in libraries, specialized electronic platforms, and field research	20
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	16
Tutorial	0
Examinations	4
Other activities.....	20

3.7 Total number of hours of student activity	60
3.8 Total number per semester	228
3.9 Number of credits[5)]	4

4. Prerequisites (if applicable)

4.1 curriculum-related	• Elementary concepts of automotive engineering, computer-aided design
4.2 competences-related	• Operating with fundamental concepts of engineering sciences.

5. Conditions (if applicable)

5.1 for course development	• projector
5.2 for seminar/ laboratory/ project development	• projector • laboratory equipped with computers • Windows operating system, Unity 3D, Ansys

6. Specific competences and learning outcomes

Professional competences	C1. Skills for identifying needs for design L.O.1.1 To identify customer needs, using appropriate questions and active listening to identify customer expectations, wishes and requirements according to products and services; L.O.1.2 To interpret the technical requirements of customers, analyzing, understanding and applying the information provided regarding the technical conditions; L.O.1.3 To define technical design requirements, by specifying the technical properties of the goods, materials, methods, processes, services, systems, software and functionalities, by identifying and addressing the specific needs that must be met according to the client's requirements; L.O.1.4 To ensure the connection with the engineers from the other departments to ensure a common understanding and to discuss the design, development and improvement of the products; L.O.1.5 To make design sketches to contribute to the development and communication of design concepts. C4 The ability to improve safety and comply with technical equipment safety standards L.O.4.7 To manage research data; L.O.4.8 To operate scientific research and laboratory equipment; L.O.4.9 To synthesize information, critically interpret and summarize new and complex information from various sources; L.O.4.10 To interact professionally in research and professional environments; C.6 Skills to use CAD-CAM-CAE systems L.O.6.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model; L.O.6.2 the use of computer-aided manufacturing (CAM) programs to control machines and machine tools in the creation, modification, analysis or optimization processes as part of the manufacturing processes of motor vehicle parts; L.O.6.3 using computer-aided engineering programs to perform stress analyzes for engineering projects. C.8 The ability to improve safety and comply with technical equipment safety standards L.O.8.1 inspect equipment used during industrial activities, such as manufacturing or construction equipment, to ensure that the equipment complies with safety and environmental legislation. L.O.8.2 combine mechanical, electrical, electronic, software, and safety engineering to design motor vehicles such as trucks, vans, and automobiles. L.O.8.3 to apply the basic security standards and technical standards specific to equipment to prevent risks related to the use of technical equipment at work.
Transversal competences	Ct1. Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments; L.O. 1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.3 to show initiative, to be proactive, L.O.1.4 to apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.5 identify problems and make decisions to solve them; L.O.1.6 to comply with the rules, regulations and guidelines related to a certain field or sector and to apply them in his day-to-day activity; L.O.1.7 to plan activities, manage the calendar and resources to complete tasks in a timely manner.

	Ct2. Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O. 2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities; L.O.2.10 to create and maintain networks, promoting ideas, products and services.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Apply scientific knowledge to solve automotive engineering problems.
7.2 Specific objectives	• Practical skills for operating and use the RV hard-software systems. • Practical skills for simulating the development processes of automotive products. • Practical skills of advanced simulation in the design of vehicles • Theoretical and applied knowledge related to the modeling and simulation of the physical processes • Development of modern software, innovative methods, principles and simulation procedures • Development of methods for evaluating research and development projects • Developing a management strategy using modern principles and methods

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Not the case			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Development of a passive / active 3D stereoscopic visualization application related to automotive design	Video projector presentations, examples, experiments, case studies related to multibody systems, programming in specific CAD languages, 3D graphic programming	168	
Developed RV / RA application for maintenance of autovehicles			
Performing a finite element analysis in Ansys of a vehicle component			
Group projects			

Bibliography

1. Gîrbacia Florin –„Tehnologii de realitate virtuală pentru proiectarea asistată de calculator”, Editura Universitatii Transilvania, 2019. ISBN 978-606-19-1123-3
2. Gîrbacia Florin, Duguleană Mihai – „Virtual and augmented reality in automotive design and maintenance: course notes”, Editura Universitatii Transilvania din Brasov, 2019. ISBN 978-606-19-1124-0
3. Gîrbacia, F. Computer Aided Design and Graphics Programming. Editura Universită ii Transilvania, Braşov, 2016.

4. Gîrbacia, F., Talabă, D., Tehnologiile realității virtuale:lucrări practice, Ed. Universit ii Transilvania Braşov, 2012.
5. Gîrbacia F. (2016): Tehnologii de Realitate Virtuală și Augmentată Aplicate în Inginerie. Note de curs", Editura Universitatii Tranilvania din Brasov, ISBN 978-606-19-0784-7.
6. Butnariu, S., Mogan, Gh., Analiza cu elemente finite în ingineria mecanică. Aplicatii practice in ANSYS, Ed. Universită ii Transilvania, ISBN 978-606-19-0474-7 (print), 2014

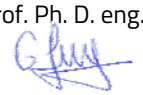
9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Through its content and through the elaboration of the thematic portfolio (the study), the masters acquire competences in accordance with the expectations of the epistemic community and of the producers in the car market. The analytical program is in line with similar fields addressed at universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course			
10.5 Seminar/ laboratory/ project	RV application development	Oral presentation	100%
	FEM simulation completion		
	Involvement in practical activities		
	Efficiency in verbal communication (presentation)		
10.6 Minimal performance standard			
• Knowledge of CAD fundamentals • Realization of an MBD simulation for engineering applications • Realization of practical project • The marks for project work must be at least 5.			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA,  **Dean**	**Prof. dr. ing. Mihai DUGULEANĂ,**  **Head of Department**
Prof. Ph. D. eng. Florin GÎRBACIA,  **Course holder**	Prof. Ph. D. eng. Florin GÎRBACIA,  **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

A. COURSE OUTLINE

1. Program data

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Motor vehicles and transport
1.4 Master's field of study [1)]	Automotive Engineering
1.5 Cycle of studies[2)]	Masters
B. 1.6 Curriculum/Qualification	Virtual Engineering in Automotive Design / Master's Degree

2. Discipline data

2.1 Name of the discipline	Advanced mechanical transmissions in automotive engineering							
2.2 Course Activity Holder				Conf.dr.ing. Dragoș Sorin Dima				
2.3 Owner of project activities				Conf.. dr.ing. Dragoș Sorin Dima				
2.4 Year of study	1	2.5 Semester	2	2.6 Type of assessment	C	2.7 Discipline regime	Content3)	DAP
							Obligation4[)]	DO

3. Total estimated time (hours per semester of teaching activities)

3.1 Number of hours per week	**2**	of which: 3.2 course	**1**	3.3 Seminar/ Laboratory/ Project	**0/0/1**
3.4 Total hours of the curriculum	28	of which: 3.5 course	14	3.6 Seminar/ Laboratory/ Project	0/0/14

Time Pool Distribution	hours
Study by textbook, course material, bibliography and notes	8
Additional documentation in the library, on specialized electronic platforms and in the field	7
Preparation of seminars/laboratories/projects, assignments, papers, portfolios and essays	28
Tutoriat	2
Examination	2
Other activities.....	

3.7 Total hours of student activity	47
3.8 Total hours per semester	75
3.9 Number of credits5)	3

4. Preconditions (where applicable)

4.1 curriculum - related	General concepts of physics, mechanics, strength of materials. Mathematical disciplines and engineering disciplines (machine parts, material resistance, mechanics, mechanisms), studied in the undergraduate years
4.2 Competences	Knowledge and understanding: ◘ familiarize students with the concepts and terminology of the discipline, with reference to mechanical systems and processes in the field of automotive engineering study. ◘ understanding the reasoning used and how the investigation; ◘ understanding criteria for choice and use of methods of investigation. Explanation and interpretation: ◘ explain the concepts used in finite element analysis and interpretation of analysis results of tension and strain generated in different application situations;

	Instrumental – Applied ◘ to selection of the concepts and proper investigation methods, recognizing how best to resolve the problem subject to study; ◘ proper use of specific calculation processes theory finite element discretization of a correct interpretation of results, proper use of the automatic calculation program for. Attitude ◘ evidence of positive and responsible attitudes towards science based on knowledge of phenomena and connections with engineering practice; ◘ fostering scientific environment centered democratic values and relationships; ◘ making best use of their potential in creative and scientific activities; ◘ engaging in a partnership relationship with other people: colleagues, teachers, etc. participation in their scientific development.

5. Conditions (where applicable)

5.1 for course development	classroom, projector
5.2 for seminar/ laboratory/ project	computer room, dedicated software (ANSYS), machine elements.

6. Specific competences and learning outcomes

	CP2. Skills in the design of systems, equipment and components of motor vehicles L.O.2.1 the ability to study, interpret and capitalize on the technical resources specific to the automotive manufacturing industry; L.O.2.2 the use of advanced concepts, techniques and principles for the design of modern automotive systems and equipment; L.O.2.3 the application of mathematical methods and the use of calculation and simulation programs to perform technical analyses and design solutions for specific problems; L.O.2.5 Prototype design of automotive components and systems by applying advanced engineering principles; **CP4 Competences to carry out scientific research** L.O.4.1 To conduct scientific research, to conceive or create new knowledge by formulating questions in the field by researching, improving or developing concepts, theories, models, techniques, tools, software or operational methods and by using scientific methods and techniques; L.O.4.2 Gather information about current vehicle trends and styles and the need for new products or services; L.O.4.3 Prepare reports describing the results and processes of scientific or technical research or assessing its progress. These reports help researchers keep up with recent findings; L.O.4.4 Develop research papers or give presentations to report the results of a research project, indicating the analysis procedures and methods that led to those results, as well as possible interpretations of the results; L.O.4.5 Conduct research on present and future developments and trends in design, as well as related target market characteristics; L.O.4.6 Anticipate changes in automotive technology, supervise and investigate recent technological trends and developments; L.O.4.7 Manage research data;

6. Specific competences accumulated (according to the competence grid of the curriculum)	L.O.4.9 Synthesize information, interpret and critically summarize new and complex information from various sources; L.O.4.10 Interact professionally in research and professional environments; L.O.4.11 Apply systematic research methods and communicate with relevant parties to find specific information, evaluating research results with a view to relevant estimation of the information, as well as related technical systems and their developments; L.O.4.12 Demonstrate in-depth knowledge and complex understanding of the field of research, including responsible research, ethical principles and scientific integrity in research, respect for privacy and GDPR requirements, related to research activities in a particular discipline. **CP.6 Competences for the use of CAD-CAM-CAE systems** L.O.6.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimisation of an industrial design; **CP.7 Competences for the development of motor vehicle manufacturing and assembly technologies, test and validation procedures for motor vehicle components, systems and equipment** L.O.7.2 Evaluation of advanced technologies for the manufacture of motor vehicles and their correlation with the optimal operating parameters of motor vehicle systems; L.O.7.3 applying and developing specific criteria, procedures and methods for the design of modern manufacturing, assembly and maintenance technologies for motor vehicles;
Transversal competences	**CT.1 Integration skills in specific activities at the workplace and technical skills, in conditions of autonomy and professional independence** L.O.1.1 to take responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments; L.O.1.2 to show determination, making sustained efforts for success by pursuing clear objectives, to make decisions by choosing from several alternative possibilities; L.O.1.3 show initiative, be proactive, L.O.1.4 to show self-reflection, quick thinking and to accept criticism and new guidance received from colleagues or superiors; L.O.1.5 provide advice to co-workers, providing suggestions on the best way forward; L.O.1.6 to be able to work in a team but also independently by developing their own ways of doing things, showing a willingness to learn, L.O.1.7 to analyse new problems that have arisen, based on creative, innovative, analytical, holistic thinking; L.O.1.8 to ensure customer orientation; R.Î.1.9 to apply scientific, technological and engineering knowledge, processing complex information; L.O.1.10 to identify problems and make decisions to solve them; L.O.1.11 to apply principles, policies and regulations aimed at environmental sustainability, including the reduction of waste, energy and water consumption, the reuse and recycling of products, as well as involvement in the collaborative economy; L.O.1.12 to comply with the rules, regulations and guidelines relating to a particular field or sector and to apply them in its day-to-day work; L.O.1.13 plan activities, manage the calendar and resources to complete tasks in a timely manner.

	CT.2 Communication and teamwork skills L.O.2.1 to carry out their work in a team; R.Î.2.2 to address an audience, to give a speech, to make a presentation; L.O.2.3 moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, to coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities;

7. Objectives of the discipline (resulting from the specific skills accumulated)

7.1 General objective of the discipline	Theoretical and applicative training in the construction and operation of motor vehicle transmissions. In-depth theoretical and applied training in the design and development of automotive transmissions. Theoretical and applicative training in understanding the physical processes of mechanical transmissions controlled by mechatronic systems.
7.2 Specific objectives	Introduction of master's students to the fundamental concepts of modern transmissions for motor vehicles. Understanding the structures and functionalities of automatic transmissions. Understanding the methods and algorithms of designing automatic transmissions. Theoretical and applied knowledge related to all stages of product development (conception, design, manufacture, operation). Practical skills in approaching automotive product development processes. Development of automatic transmission design skills. Improve your CAD modeling and calculation skills with software packages. Practical skills for studying the behavior of mechanical systems controlled by mechatronic devices.

8. Content

8.1 Course	Teaching methods	Number of hours	Observations
Motor vehicle transmissions (operating principles, terminology, classification, development trends).	Lecture, discussions	2	
Kinematics and dynamics of planetary mechanisms.		2	
Automatic planetary transmissions.		2	
Mechanical friction transmissions with continuously variable gear ratio (CVT).		2	
Hydromechanical transmissions (with hydrodynamic and hydrostatic variators).		2	
Controlled torque distribution systems. All-wheel drive.		2	
Hybrid powertrains.		2	
Bibliography Preda I. Transmisii mecanice avansate în ingineria automobilului. http://elearning.unitbv.ro Fischer, R., Küçükay, F., Jürgens, G., Najork, R. and Pollak, B. The Automotive Transmission Book. Powertrain: Springer,			

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Macarie,T.N. Transmisii continue pentru autovehicule. Ed. Universită ii din Piteşti, 1999.
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Ciolan,Gh. Preda,I. Pereş,Gh. Cutii de viteze pentru automobile. Editura Didactică şi Pedagogică, Bucureşti, 1998.

8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Observations
Calculation of transmission ratios and torque moments for a planetary transmission with chosen kinematic scheme	Individual and group work, assisted training		
Presentation of the project requirements; Initial documentation		2	
Finalization of the topic; Understanding how it works		2	
Making the kinematic scheme		2	
Calculation of transmission reports		2	
Calculation of torques and yields		2	
Making the PPT presentation		2	
Presentation and grading of the project		2	
Bibliography Preda I. Transmisii mecanice avansate în ingineria automobilului. http://elearning.unitbv.ro			

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The content of the discipline was discussed with the professors of the department and with representatives of the company Shaeffler Romania.

10. Assessment

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight of the final grade
10.4 Course		Written knowledge testing	50%
10.5 Seminar/ laboratory/ project	Correctness of schemes and calculations.	Analysis of the presentation file.	30%
	The originality of the presentation.	Powerpoint presentation	20%
10.6 Minimum performance standard			
Grade 5 for the project Grade 5 on the knowledge test			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Dean, **Prof.dr.ing. Ioan Călin ROȘCA**	**Head of Department ,** **Prof.dr.ing. Mihai DUGULEANA**
Course holder, **Conf.dr.ing. Dragoș Sorin DIMA**	**Project coordinator** **Conf.dr.ing. Dragoș Sorin DIMA**

Note:

Field of study - choose one of the following variants: Bachelor's/Master's/Doctorate (to be filled in according to the Nomenclature of fields and specializations/university study programs in force);

The study cycle - one of the following variants is chosen: Bachelor's/ Master's/ Doctorate;

Discipline regime (content) - one of the variants is chosen**: DF** (fundamental discipline)/ **DD** (discipline in the field)/ **DS** (specialized discipline)/ **DC** (complementary discipline) - for the bachelor's level; **DAP** (deepening discipline)/ **DSI** (synthesis discipline)/ **DCA** (advanced knowledge discipline) - for the master's level;

Discipline regime (compulsory) - one of the variants is chosen: **DI** (compulsory subject)/ **DO** (optional subject)/ **DFac** (optional subject);

One credit is equivalent to 25 hours of study (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotives and Transportation
1.4 Field of study[1)]	Master
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotives Design

2. Data about the course

2.1 Name of course			Experimental Systems for testing the Automotives Elements					
2.2 Course convenor			Prof.dr.ing. Lates Mihai Tiberiu					
2.3 Seminar/ laboratory/ project convenor			Prof.dr.ing. Lates Mihai Tiberiu					
2.4 Study year	2	2.5 Semester	3	2.6 Evaluation type	C	2.7 Course status	Content[3)]	AC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**2**	out of which: 3.2 lecture	**1**	3.3 seminar/ laboratory/ project	**1**
3.4 Total number of hours in the curriculum	28	out of which: 3.5 lecture	14	3.6 seminar/ laboratory/ project	14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	44
Additional documentation in libraries, specialized electronic platforms, and field research	24
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	14
Tutorial	-
Examinations	3
Other activities.....	-

3.7 Total number of hours of student activity	82
3.8 Total number per semester	110
3.9 Number of credits[5)]	4

4. Prerequisites (if applicable)

4.1 curriculum-related	• Tribology, Advanced Mechanical Transmissions in Automotives Engineerings.
4.2 competences-related	• Theoretical and practical knowledge in the field of tribological and automotives mechanical transmissions testing.

5. Conditions (if applicable)

5.1 for course development	• Classroom with blackboard and video projector • Recommended references
5.2 for seminar/ laboratory/ project development	• Laboratory with test rig • Recommended references

6. Specific competences and learning outcomes

CP.1 Skills for identifying needs for design

Learning outcomes. The graduate of the master's study program is able to:

R.Î.1.1 To identify customer needs, using appropriate questions and active listening to identify customer expectations, wishes and requirements according to products and services;

R.Î.1.2 To interpret the technical requirements of the clients, analyzing, understanding and applying the information provided regarding the technical conditions;

CP.3 Competencies for performing practical tests and determinations

Learning outcomes. The graduate of the master's study program is able to:

R.Î.3.1 To perform experimental, environmental and operational tests on models, prototypes or on systems and equipment to test their resistance and capabilities in normal and extreme conditions;

R.Î.3.2 Interpret and analyze data collected during testing to formulate conclusions, new insights or solutions.

R.Î.3.3 To record data that has been specifically identified during previous trials, to verify that trial results produce specific results;

R.Î.3.4 To collect data and statistics for testing and evaluation in order to generate statements and predictions of patterns, with the aim of discovering useful information in the decision process;

R.Î.3.5 To simulate and test mechatronic units using appropriate equipment;

R.Î.3.6 To compare the performance of alternative vehicles based on selected factors;

R.Î.3.7 To evaluate the ecological footprint of vehicles and to use several methods of analyzing greenhouse gas emissions;

R.Î.3.8 To test mechatronic units using appropriate equipment, collecting and analyzing data. To monitor and evaluate the performance of the system and take measures, if necessary.

CP.4 Competences to carry out scientific research.

Learning outcomes. The graduate of the master's study program is able to:

R.Î.4.1 To carry out scientific research, to conceive or create new knowledge by formulating questions in the field by researching, improving or developing concepts, theories, models, techniques, tools, software or operational methods and by using scientific methods and techniques;

R.Î.4.2 To gather information about current vehicle trends and styles and the need for new products or services;

R.Î.4.3 To prepare reports that describe the results and processes of scientific or technical research or evaluate its progress. These reports help researchers keep up with recent discoveries;

R.Î.4.4 To prepare research documents or give presentations to report the results of an ongoing research project, indicating the analysis procedures and methods that led to the respective results, as well as possible interpretations of the results;

R.Î.4.5 To carry out research on the present and future developments and currents in design, as well as on the related target characteristics of the market;

R.Î.4.6 Anticipate changes in automotive technology, monitor and investigate recent technological trends and developments;

R.Î.4.7 To manage research data;

R.Î.4.8 To operate scientific research and laboratory equipment;

R.Î.4.9 Synthesize information, critically interpret and summarize new and complex information from various sources;

R.Î.4.10 To interact professionally in research and professional environments;

R.Î.4.11 Apply systematic research methods and communicate with relevant parties to find information specifice, evaluând rezultatele cercetarilor în vedeea estimarii relevante a informatiilor, precum si a sistemelor tehnice conexe si a evolutiilor acestora;

R.Î.4.12 Să dea dovada de cunoastere aprofundata si întelegere complexa a domeniului de cercetare, inclusiv a

Transversal competences	**CT.1 Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence** Learning outcomes. The graduate of the master's study program is able to: R.Î.1.1 to take responsibility, to accept responsibility for one's own decisions, showing willingness to work, respecting one's commitments; R.Î.1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; R.Î.1.3 to show initiative, to be proactive. **CT.2 Communication and teamwork skills** Learning outcomes. The graduate of the master's study program is able to: R.Î.2.1 to carry out their work in a team; R.Î.2.2 to address an audience, give a speech, make a presentation; R.Î.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Theoretical and applied training in experimental tests and associated mechanical and mechatronic systems.
7.2 Specific objectives	• Theoretical and applied training on the structure, programming and operation of test stands. • Training in the development of experiments.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Test planning. The parameters. Control. Values. Precision. Equipment. Saving data.	Lecture based on video projector	1 hour	
2. Analysis of experimental data. Errors. Uncertainty analysis. Statistical analysis. Graphic formats.	Lecture based on video projector	1hour	
3. Measurement of forces. Forces. Moments. Tensions and efforts.	Lecture based on video projector	2 hours	
4. Measurement of displacements. Travels. Speeds. Vibrations.	Lecture based on video projector	2 hours	
5. Definition of tests. Testing of mechanical transmissions (gears, chain drives, belt drives). Bearing testing. Tribological testing.	Lecture based on video projector	7 hours	
6. Acquisition of data. Drafting the report and presentation.	Lecture based on video projector	1 hour	
Bibliography 1. J. P. Holman. Experimental methods for engineers. Boston, McGraw-Hill Publishing House, 2001.			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks

1. Run-in tests	Practical tests	2 hours	
2. Chain/skid friction testing	Practical tests	2 hours	
3. Testing chain drives	Practical tests	2 hours	
4. Bearing testing	Practical tests	2 hours	
5. Testing of bearing assemblies	Practical tests	2 hours	
6. Chain/skid wear testing (oscillating motion)	Practical tests	2 hours	
7. Chain/skid Stribeck curve testing	Practical tests	2 hours	
Bibliography 1. J. P. Holman. Experimental methods for engineers. Boston, McGraw-Hill Publishing House, 2001.			

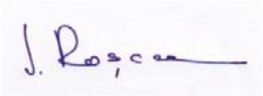
9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Theoretical knowledge underpins the latest approaches in the field of experimental systems in automotive mechanics, and practical examples are based on mechanical engineering problems. The analytical program is in line with the new requirements of the companies producing automotive components (eg Schaeffler Group).

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Correct use of specific testing principles and selection of appropriate test solutions for given problems	Written exam	50%
10.5 Seminar/ laboratory/ project	Correct use of test stands for given problems	Oral exam	50%
10.6 Minimal performance standard			
Correct use of testing principles for given problems			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof. dr. eng. Ioan Călin ROSCA  **Dean**	**Prof. dr. eng. Mihai DUGULEANA**  **Head of Department**
Prof.dr.ing. Mihai Tiberiu LATES **Course holder** 	**Prof.dr.ing. Mihai Tiberiu LATES** **Holder of seminar/ laboratory/ project** 

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

[2] Study level – choose from among: Bachelor / Master / Doctorat;

[3] Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

[4] Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

[5] One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Faculty of Mechanical Engineering
1.3 Department	Automotive and Transport Engineering
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Virtual Instrumentation					
2.2 Course convenor			Prof. Dr Petru A. COTFAS					
2.3 Seminar/ laboratory/ project convenor			Prof. Dr Petru A. COTFAS					
2.4 Study year	II	2.5 Semester	1	2.6 Evaluation type	E	2.7 Course status	Content[3)]	SC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**2**	out of which: 3.2 lecture	**1**	3.3 seminar/ laboratory/ project	**0/1/0**
3.4 Total number of hours in the curriculum	28	out of which: 3.5 lecture	14	3.6 seminar/ laboratory/ project	0/14/0

Time allocation	hours
Study of textbooks, course support, bibliography and notes	42
Additional documentation in libraries, specialized electronic platforms, and field research	34
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	28
Tutorial	14
Examinations	4
Other activities.....	

3.7 Total number of hours of student activity	122
3.8 Total number per semester	150
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	• Basic knowledge of computer programming
4.2 competences-related	• Using of computers

5. Conditions (if applicable)

5.1 for course development	• Classroom with multimedia systems.
5.2 for seminar/ laboratory/ project development	• Classroom with necessary systems and PCs.

6. Specific competences and learning outcomes

Professional competences	CP.2 Competences to design systems, equipment and vehicle components L.O.2.1 the ability to study, interpret and capitalize on technical resources specific to the motor vehicle manufacturing industry; L.O.2.3 applying mathematical methods and using calculation and simulation programs to perform technical analyzes and design solutions for specific problems; CP.3 Competencies for performing tests and practical determinations L.O.3.1 To perform experimental, environmental and operational tests on models, prototypes or on systems and equipment to test their resistance and capabilities in normal and extreme conditions; L.O.3.2 To interpret and analyze data collected during testing, to formulate conclusions, new perspectives or solutions. L.O.3.5 To simulate and test mechatronic units using appropriate equipment; CP.4 Competences to carry out scientific research. L.O.4.8 To operate scientific research and laboratory equipment; CP.5 Ability to design and develop software L.O.5.1 to develop software for motor vehicles and related systems; L.O.5.2 understand and apply the principles of programming and software development technologies in the automotive industry; L.O.5.3 to evaluate and choose suitable platforms, programming languages and software technologies for projects in the automotive industry; L.O.5.4 to develop software applications to improve the functionality, performance and safety of motor vehicles; CP.6 Competences to use CAD-CAM-CAE systems. L.O.6.3 using computer-aided engineering programs to perform stress analyzes for engineering projects.
Transversal competences	CT.1 Competences for integration into specific activities at the workplace and technical competences, in conditions of autonomy and professional independence L.O.1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; CT.2 Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O.2.2 to address an audience, give a speech, make a presentation;

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Explaining the concepts related to the virtual instrumentation from the perspective of using them in designing and managing the electric, electronic and mechatronic systems of automobiles.
7.2 Specific objectives	• Understanding the specific concepts of virtual instrumentation and using graphical programming architectures in solving specific engineering problems; • Gaining practical skills of working with software packages for virtual instrumentation dedicated to the management and control of the mechatronic systems in auto-vehicles. • Gaining the theoretic and applied knowledge about the structure and testing for electric, electronic and mechatronic systems of automobiles.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introduction of the Virtual Instrumentation and	Lecture with cu slides	2 hours	

Graphical System Design concepts. Graphical Programming Language - LabVIEW	improved by conversation, didactic demonstration. Learning through demonstrations by simulation and hardware using.		
Modular Programming. Programming Structures.		2 hours	
Advanced Programming Architectures		2 hours	
Data acquisition in LabVIEW. Measurements and data logging in auto-vehicles		4 hours	
Drivers and communication interfaces with mechatronic systems in auto-vehicles.		2 hours	
Virtual Instrumentation applications. Combining the LabVIEW software with CAD software.		2 hours	

Bibliography

1. P.A. Cotfas, Instrumentație Virtuală, notițe de curs, 2024-2025;
2. P. Adrian Cotfas, D. Tudor Cotfas, and H. Hedesiu, Eds., "LabVIEW - Virtual Instrumentation in Education and Industry", IntechOpen, Jun. 12, 2024. doi: 10.5772/intechopen.102279.
3. H.A. Modran, D. Ursutiu, Instrumentatie virtuala : indrumar de laborator [Resursa electronica], Editura Universitatii Transilvania din Brasov, 2022;
4. J. Essick Hands-On Introduction to LabVIEW for Scientists and Engineers, Oxford University Press Inc, 2018;
5. P. A. Cotfas, D. T. Cotfas, D. Ursutiu, C. Samoila "NI ELVIS Computer-Based Instrumentation", National Technology & Science Press – USA, ISBN 978-1-934891-11-7, IDS Number: 745SR, ISSN: 1582-2214, 2011;
6. P.A. Cotfas "Prelucrarea semnalelor. Aplicatii in LabVIEW", Ed. Lux Libris, ISBN 978-973-131-071-8, Brasov, 2010;
7. ***LabVIEW Manual (LabVIEW Help);
8. Ghionea, I., Initiere in mediul de programare grafica LabVIEW, www.catia.ro/articole.html , Accesat octombrie 2011;

8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Laboratory introduction. LabVIEW introduction	Conversation	Duration: 2 hours	
Applications based on programming structures	Conversation + individual experiment	Duration: 2 hours	
State-Machine and Producer-Consumer architectures in automotive applications	Conversation + individual experiment	Duration: 2 hours	
Virtual Instruments for monitoring and control using sensors and actuators	Conversation + individual experiment	Duration: 4 hours	
Electric and electronic instruments control based on LabVIEW drivers	Conversation + individual experiment	Duration: 2 hours	
Working with LabVIEW projects. Testing the mechatronic systems in auto-vehicles.	Conversation + individual experiment	Duration: 2 hours	

Bibliography

1. P.A. Cotfas, Instrumentație Virtuală, notițe de curs, 2024-2025;
2. P. Adrian Cotfas, D. Tudor Cotfas, and H. Hedesiu, Eds., "LabVIEW - Virtual Instrumentation in Education and Industry", IntechOpen, Jun. 12, 2024. doi: 10.5772/intechopen.102279.
3. H.A. Modran, D. Ursutiu, Instrumentatie virtuala : indrumar de laborator [Resursa electronica], Editura Universitatii Transilvania din Brasov, 2022;
4. J. Essick Hands-On Introduction to LabVIEW for Scientists and Engineers, Oxford University Press Inc, 2018;
5. P. A. Cotfas, D. T. Cotfas, D. Ursutiu, C. Samoila "NI ELVIS Computer-Based Instrumentation", National Technology & Science Press – USA, ISBN 978-1-934891-11-7, IDS Number: 745SR, ISSN: 1582-2214, 2011;
6. P.A. Cotfas "Prelucrarea semnalelor. Aplicatii in LabVIEW", Ed. Lux Libris, ISBN 978-973-131-071-8, Brasov, 2010;

7. ***LabVIEW Manual (LabVIEW Help);
8. Ghionea, I., Initiere in mediul de programare grafica LabVIEW, www.catia.ro/articole.html , Accesat octombrie 2011;

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The content of the course assures acquiring knowledge and the necessary skills in the use of modern technologies in the field of virtual instrumentation and the ability to use programming techniques using the LabVIEW graphic programming language with applications in the automotive field.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Correct explanation of creating a virtual instrument, implementing an architecture or method using the theoretic knowledge taught.	Written evaluation on subjective or objective items Written evaluation on subjective or objective items	70%
	Comparative analysis of certain architectures or programming methods.		
	Correct usage of specific language		
	Clarity, coherence and concision in presentation		
	Coverage of requested topics		
	Correct explanation of creating a virtual instrument, implementing an architecture or method using the theoretic knowledge taught.		
10.5 Seminar/ laboratory/ project	Implementation of architecture or programing method for creating a virtual instrument for information acquisition or processing.	Computer testing and also checking the completion of works during laboratory.	30%
10.6 Minimal performance standard			
• Theoretic trial: getting a minimum score of 4 points from the 9 allocated to the theoretical subjects; a point by default. • Laboratory: Using modular programing in LabVIEW and accomplishing data acquisition and graphic display of results in the application panel.			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof. Dr. Ing. Ioan Călin Roșca,  **Dean of Faculty of Mechanical Engineering**	**Prof. univ. dr. ing. DUGULEANĂ Mihai**  **Head of Department**
Prof. Dr. Petru A. COTFAS,  **Course holder**	**Prof. Dr. Petru A. COTFAS,**  **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Practice for research and development I					
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor			Prof. Ph. D. eng. Florin GÎRBACIA					
2.4 Study year	2	2.5 Semester	3	2.6 Evaluation type	C	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	**NCPC**

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**12**	out of which: 3.2 lecture	**0**	3.3 seminar/ laboratory/ project	**0/0/12**
3.4 Total number of hours in the curriculum	168	out of which: 3.5 lecture	0	3.6 seminar/ laboratory/ project	168

Time allocation	hours
Study of textbooks, course support, bibliography and notes	20
Additional documentation in libraries, specialized electronic platforms, and field research	20
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	16
Tutorial	0
Examinations	4
Other activities.....	20

3.7 Total number of hours of student activity	60
3.8 Total number per semester	228
3.9 Number of credits[5)]	4

4. Prerequisites (if applicable)

4.1 curriculum-related	• Elementary concepts of automotive engineering, computer-aided design
4.2 competences-related	• Operating with fundamental concepts of engineering sciences.

5. Conditions (if applicable)

5.1 for course development	• projector
5.2 for seminar/ laboratory/ project development	• projector • laboratory equipped with computers • Windows operating system, Matlab

6. Specific competences and learning outcomes

Professional competences	C1. Skills for identifying needs for design L.O.1.1 To identify customer needs, using appropriate questions and active listening to identify customer expectations, wishes and requirements according to products and services; L.O.1.2 To interpret the technical requirements of customers, analyzing, understanding and applying the information provided regarding the technical conditions; L.O.1.3 To define technical design requirements, by specifying the technical properties of the goods, materials, methods, processes, services, systems, software and functionalities, by identifying and addressing the specific needs that must be met according to the client's requirements; L.O.1.4 To ensure the connection with the engineers from the other departments to ensure a common understanding and to discuss the design, development and improvement of the products; L.O.1.5 To make design sketches to contribute to the development and communication of design concepts. C4 The ability to improve safety and comply with technical equipment safety standards L.O.4.1 combine mechanical, electrical, electronic, software, and safety engineering to design motor vehicles such as trucks, vans, and automobiles. C.7 Competences for the development of vehicle manufacturing and assembly technologies, test and validation procedures for vehicle components, systems and equipment The learning outcomes for the graduate of the master's study program are: L.O.7.1 application of advanced concepts and procedures for manufacturing and assembly technologies; L.O.7.2 evaluation of advanced vehicle manufacturing technologies and their correlation with the optimal operating parameters of vehicle systems; L.O.7.3 the application and development of specific criteria, procedures and methods for the design of modern manufacturing, assembly and maintenance technologies for motor vehicles; L.O.7.4 operation of precision measuring equipment; L.O.7.5 the ability to draw up the technical documentation related to the manufactured products and equipment; C.8 The ability to improve safety and comply with technical equipment safety standards L.O.8.1 inspect equipment used during industrial activities, such as manufacturing or construction equipment, to ensure that the equipment complies with safety and environmental legislation. L.O.8.3 to apply the basic security standards and technical standards specific to equipment to prevent risks related to the use of technical equipment at work.
Transversal competences	Ct1. Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments; L.O. 1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.3 to show initiative, to be proactive, L.O.1.4 to apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.5 identify problems and make decisions to solve them; L.O.1.6 to comply with the rules, regulations and guidelines related to a certain field or sector and to apply them in his day-to-day activity; L.O.1.7 to plan activities, manage the calendar and resources to complete tasks in a timely manner.

	Ct2. Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O. 2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities; L.O.2.10 to create and maintain networks, promoting ideas, products and services.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Apply scientific knowledge to solve automotive engineering problems.
7.2 Specific objectives	• Practical skills for simulating the development processes of automotive products. • Practical skills for working with integrated software packages for controlling mechatronic systems of vehicles • Practical skills of advanced simulation in the design of vehicles • Development of modern software, innovative methods, principles and simulation procedures • Development of methods for evaluating research and development projects • Developing a management strategy using modern principles and methods

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Not the case			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Clutch model in Simulink	Presentations, examples, experiments, research on the dynamic simulation of the vehicle systems, virtual collision modeling and testing, the sensory and control systems of the vehicles, virtual instrumentation	168	
The suspension system in Simulink			
Servo electro-hydraulic control in Simulink			
Development of a C ++ application for dynamic simulation of a vehicle			
Group projects			

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1. Gîrbacia, F. Computer Aided Design and Graphics Programming. Editura Universită ii Transilvania, Braşov, 2016.
2. https://www.mathworks.com/examples/simulink/category/automotive-applications
3. https://www.computoolable.nl

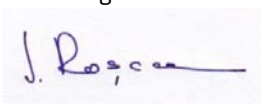
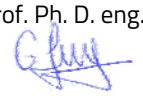
9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Through its content and through the elaboration of the thematic portfolio (the study), the masters acquire competences in accordance with the expectations of the epistemic community and of the producers in the car market. The analytical program is in line with similar fields addressed at universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course			
10.5 Seminar/ laboratory/ project	Completion of simulations in Simulink	Oral presentation	100%
	Development of the C ++ program		
	Involvement in practical activities		
	Efficiency in verbal communication (presentation)		
	Completion of simulations in Simulink		
10.6 Minimal performance standard			
• Knowledge of Simulink and C++ fundamentals • Realization of a Simulink simulation for engineering applications • Realization of practical project • The marks for project work must be at least 5.			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA,  **Dean**	**Prof. dr. ing. Mihai DUGULEANĂ,**  **Head of Department**
Prof. Ph. D. eng. Florin GÎRBACIA,  **Course holder**	Prof. Ph. D. eng. Florin GÎRBACIA,  **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Dynamic simulation of vehicle systems in Matlab and C ++					
2.2 Course convenor			Assoc. Prof. Ph. D. Olivia Florea Prof. Ph. D. eng. Florin GÎRBACIA					
2.3 Seminar/ laboratory/ project convenor			Assoc. Prof. Ph. D. Olivia Florea Prof. Ph. D. eng. Florin GÎRBACIA					
2.4 Study year	2	2.5 Semester	3	2.6 Evaluation type	E	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	EC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/0/2**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/0/28

Time allocation	hours
Study of textbooks, course support, bibliography and notes	20
Additional documentation in libraries, specialized electronic platforms, and field research	16
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	2
Tutorial	2
Examinations	2
Other activities.....	2

3.7 Total number of hours of student activity	44
3.8 Total number per semester	100
3.9 Number of credits[5)]	4

4. Prerequisites (if applicable)

4.1 curriculum-related	• Knowledge of the vehicle dynamics
4.2 competences-related	• Operating with fundamental concepts of engineering sciences. • MATLAB Fundamentals

5. Conditions (if applicable)

5.1 for course development	• projector • lecture notes • recommended bibliography
5.2 for seminar/ laboratory/ project development	• projector • laboratory equipped with computers • lecture notes • recommended bibliography

6. Specific competences and learning outcomes

Professional competences	Cp1. Competencies for performing practical tests and determinations L.O.1.1 To perform experimental, environmental, and operational tests on models, prototypes or systems and equipment to test their resistance and capabilities in normal and extreme conditions; L.O. 1.2 Interpret and analyze data collected during testing to formulate conclusions, new insights, or solutions. L.O.1.3 To record data that has been specifically identified during previous trials, to verify that trial results produce specific results; L.O.1.4 To collect data and statistics to test and evaluate to generate statements and predictions of patterns, to discover useful information in the decision process; L.O.1.5 To compare the performance of alternative vehicles based on selected factors; Cp2. Software design and development capability L.O.2.1. to develop software for motor vehicles and related systems; L.O. 2.2 understand and apply the principles of programming and software development technologies in the automotive industry; L.O.2.3 to evaluate and choose suitable platforms, programming languages and software technologies for projects in the automotive industry; L.O.2.4 to develop software applications to improve the functionality, performance and safety of motor vehicles; L.O.2.5 to test and troubleshoot software to ensure the proper and safe operation of vehicle systems;
Transversal competences	Ct1. Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments; L.O. 1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.3 to show initiative, to be proactive, L.O.1.4 to apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.5 identify problems and make decisions to solve them; L.O.1.6 to comply with the rules, regulations and guidelines related to a certain field or sector and to apply them in his day-to-day activity; L.O.1.7 to plan activities, manage the calendar and resources to complete tasks in a timely manner. Ct2. Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O. 2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities; L.O.2.10 to create and maintain networks, promoting ideas, products and services.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Understanding the principles and potential for using advanced Matlab and C++ Integrated Development Environments for automotive design. • Understand and gain advanced knowledge required to develop applications for dynamic simulation of vehicle systems based on Matlab and C++. • Understanding how to apply basic modeling techniques and tools to develop Simulink block diagrams
7.2 Specific objectives	• Learning of knowledge for creating dynamic simulation of vehicle systems required in automotive design; • Learning knowledge for the development of Matlab and C++ software applications; • Acquirement of practical skills for automotive design applications through the use of Matlab and C++ programming environments. • Creating Simulink models and simulating system dynamics • Modeling continuous-time, discrete-time, and hybrid systems • Building hierarchy into a Simulink model

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Introduction. The purpose of the course. Introduction to C++. Terminology, definitions and features of C++. Technologies available for dynamic simulation of vehicle systems.	Interactive lecture	2	
Basics of the C++ language. Getting Started with Microsoft Visual Studio IDE. Variables, data types, expressions, operators, pointers, networks, functions and structures in C++. Case studies for dynamic simulation.	Interactive lecture	8	
Vehicle dynamics problems solved in C++. Concepts and principles in object-oriented programming: Classes, objects, class hierarchies, Polymorphism. Case studies for dynamic simulation.	Interactive lecture	4	
Introduction to Simulink	Interactive lecture	4	
Simulink: Creating and Simulating a Model. Modeling Programming Constructs. Modeling Discrete Systems. Modeling Continuous Systems	Interactive lecture	6	
Simulink: Solver Selection. Developing Model Hierarchy. Modeling Conditionally Executed Algorithms. Combining Models into Diagrams	Interactive lecture	4	

Bibliography

1. Ruxandra Stanescu, Florin Girbacia, Cristian Postelnicu, Programarea calculatoarelor si limbaje de programare. Indrumar de laborator.,Ed. Universitatii Transilvania din Brasov, ISBN 978-606-19-1596-5, 2023.
2. Talabă, D., Amditis, A. Product Engineering, Tools and Methods Based on Virtual Reality. Editura Springer, 2007.
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virtuala pentru aplicatii de proiectare asistata de calculator,Teza de doctorat,Universitatea Transilvania Brasov, 2007.
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8. Introduction to Simulink, University College of Southeast Norway, http://home.hit.no/~hansha/documents/matlab/training/Introduction%20to%20Simulink/ Introduction%20to%20Simulink.pdf

8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Getting Started with Microsoft Visual Studio C++ IDE	Interactive lecture, exercises and examples, individual work	2	
Development of a C++ application for simulating a vehicle mechanism using procedural programming	Interactive lecture, exercises and examples, individual work	4	
Development of a C++ application for the simulation of a vehicle mechanism using modular programming	Interactive lecture, exercises and examples, individual work	4	
Development of a C++ application for dynamic simulation of a vehicle using OOP	Interactive lecture, exercises and examples, individual work	4	
Engine Model in Simulink	Individual work	2	
Anti-Lock Braking System in Simulink	Individual work	2	
Clutch Engagement Model in Simulink	Individual work	2	
Suspension System in Simulink	Individual work	2	
Hydraulic Systems in Simulink	Individual work	2	
Automatic Transmission Control in Simulink	Individual work	2	
Electrohydraulic Servo Control in Simulink	Individual work	2	

Bibliography
1. Ruxandra Stanescu, Florin Girbacia, Cristian Postelnicu, Programarea calculatoarelor si limbaje de programare. Indrumar de laborator,Ed. Universitatii Transilvania din Brasov, ISBN 978-606-19-1596-5, 2023.
2. Gîrbacia, F. Computer Aided Design and Graphics Programming. Editura Universită ii Transilvania, Braşov, 2016.
3. https://www.mathworks.com/examples/simulink/category/automotive-applications
https://www.computoolable.nl

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Theoretical and practical approaches demonstrate the latest programming IDE for automotive design. The curriculum is consistent with similar fields addressed to universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Ability to operate with assimilated knowledge	Written exam	50%

10.5 Seminar/ laboratory/ project	Ability to apply in practice the assimilated knowledge	Project	50%
10.6 Minimal performance standard			
Development of a project that uses principles and methods specific to the field of mechanical engineering: • Knowledge of the fundamental elements of Matlab and C++, solving dynamic simulation task. • Implement a dynamic vehicle system model in Simulink. • The grades obtained for the project and exam must be at least 5			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA,  **Dean**	**Prof. dr. ing. Mihai DUGULEANĂ,**  **Head of Department**
Prof. Ph. D. Olivia Florea,  ..... Prof. Ph. D. eng. Florin GÎRBACIA,  ..... **Course holder**	Prof. Ph. D. Olivia Florea,  ..... Prof. Ph. D. eng. Florin GÎRBACIA,  ..... **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Modelling and virtual collision testing					
2.2 Course convenor			Prof. Ph. D. Eng. Nicolae ISPAS					
2.3 Seminar/ laboratory/ project convenor			Lecturer Ph. D. Eng. Ionut Alexandru RADU					
2.4 Study year	2	2.5 Semester	3	2.6 Evaluation type	E	2.7 Course status	Content[3)]	DC
							Attendance type[4)]	EC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/1/1**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/14/14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	42
Additional documentation in libraries, specialized electronic platforms, and field research	32
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	14
Tutorial	2
Examinations	4
Other activities.....	4

3.7 Total number of hours of student activity	94
3.8 Total number per semester	150
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	• strength of materials, materials technology, computer assisted design, finite element analysis, passive vehicle safety, vehicle calculation and construction, vehicle dynamics
4.2 competences-related	• Operating with fundamental concepts of engineering sciences, Matlab, SIMULINK, advanced using computer skils

5. Conditions (if applicable)

5.1 for course development	• projector • lecture notes • recommended bibliography
5.2 for seminar/ laboratory/ project development	• projector • laboratory equipped with computers

	• lecture notes • recommended bibliography

6. Specific competences and learning outcomes

Professional competences	C.3 Competencies for carrying out tests and practical determinations L.O.3.1 To perform experimental, environmental and operational tests on models, prototypes or on systems and equipment to test their resistance and capabilities in normal and extreme conditions; L.O.3.2 To interpret and analyze data collected during testing, to formulate conclusions, new perspectives or solutions. L.O.3.3 To record the data that was specifically identified during the previous tests, to check if the results of the test produce specific results; L.O.3.4 To collect data and statistics in order to test and evaluate in order to generate statements and predictions of patterns, with the aim of discovering useful information in the decision process; L.O.3.5 To simulate and test mechatronic units using appropriate equipment; L.O.3.8 To test mechatronic units using appropriate equipment, collecting and analyzing data. To monitor and evaluate the performance of the system and take measures, if necessary. CP.4 Competences to carry out scientific research. L.O.4.2 To gather information about current trends and styles regarding vehicles and the need for new products or services; L.O.4.3 To prepare reports that describe the results and processes of scientific or technical research or evaluate its progress. These reports help researchers keep up with recent discoveries; L.O.4.4 To prepare research documents or give presentations to report the results of an ongoing research project, indicating the analysis procedures and methods that led to the respective results, as well as possible interpretations of the results; L.O.4.7 To manage research data; L.O.4.8 To operate scientific research and laboratory equipment; L.O.4.9 To synthesize information, critically interpret and summarize new and complex information from various sources; C.5 Ability to design and develop software L.O.5.5 to test and debug software to ensure the proper and safe operation of vehicle systems; C.6 Skills to use CAD-CAM-CAE systems L.O.6.1 the use of computer-aided design (CAD) systems to contribute to the creation, modification, analysis and optimization of an industrial drawing or model; L.O.6.3 using computer-aided engineering programs to perform stress analyzes for engineering projects. C.8 The ability to improve safety and comply with technical equipment safety standards L.O.8.1 inspect equipment used during industrial activities, such as manufacturing or construction equipment, to ensure that the equipment complies with safety and environmental legislation. L.O.8.2 combine mechanical, electrical, electronic, software and safety engineering to design motor vehicles such as trucks, vans and cars. L.O.8.3 to apply the basic security standards and technical standards specific to equipment to prevent risks related to the use of technical equipment at work.
Transversal competences	Ct1. Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments;

	L.O. 1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.3 to show initiative, to be proactive, L.O.1.4 to apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.5 identify problems and make decisions to solve them; L.O.1.6 to comply with the rules, regulations and guidelines related to a certain field or sector and to apply them in his day-to-day activity; L.O.1.7 to plan activities, manage the calendar and resources to complete tasks in a timely manner. Ct2. Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O. 2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities; L.O.2.10 to create and maintain networks, promoting ideas, products and services.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Understanding the principles and potential for using advanced PC-CrashIntegrated Development Environments for automotive design. • Understand and gain advanced knowledge required to develop applications for dynamic simulation of vehicle systems based on Matlab and C++. • Understanding how to apply basic modeling techniques and tools to develop Simulink block diagrams
7.2 Specific objectives	• Learning of knowledge for creating dynamic simulation of vehicle systems required in automotive design; • Learning knowledge for the development of PC-Crash software applications; • Acquirement of practical skills for automotive design applications through the use of PC-Crash programming environments. • Creating Simulink models and simulating system dynamics • Modeling continuous-time, discrete-time, and hybrid systems • Building hierarchy into a Simulink model

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Physical-mathematical models used to study vehicle collisions. Legislation Used to Evaluate Car Performance in Collisions	Exposure, plans, figures, schemes, video elements	6 hours	
Implementation of software and physical-mathematical models used by car collision analysis. Package software used to analyze and model collisions involving vehicles. Software used to	Exposure, plans, figures, schemes, video elements	4 hours	

analyze and model collisions involving vehicles			
Modeling vehicle-to-vehicle accidents	Exposure, plans, figures, schemes, video elements	6 hours	
Elements of Biomechanics. Models of occupants and pedestrians. Multibody systems.	Exposure, plans, figures, schemes, video elements	4 hours	
Simulation of vehicle-pedestrian accidents	Exposure, plans, figures, schemes, video elements	2 hours	
FE analysis for virtual modeling of plastic deformation of some elements in the vehicle structure.		4 hours	
Virtual tests for deformable parts of vehicle body.	Exposure, plans, figures, schemes, video elements	2 hours	

Bibliografie

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2. Beleș, H., Șoica, A., Siguranța activă și pasivă a autovehiculelor, Editura Universității din Oradea, Oradea 2011, ISBN 978-606-10-0651-9.
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8. Nahum, A.M., Melvin, J.W., Accidental Injury, ed. Springer – Verlag, 1996.
9. PC-CRASH 12.0 – Manual de Utilizare, DSD- Dr. Steffan Datentechnik, Austria, 2018.
10. ***Standarde internaționale pentru manechine antropometrice destinate încercărilor de coliziune la impact lateral. ISO/TR 9790-1-6.
11. ***Standarde internaționale privind omologarea și testarea la coliziune a autovehiculelor (R 29 – ECE ONU, R – ECE ONU, R 42 – ECE ONU, R 96 – ECE ONU, NHTSA 214).

8.2 ~~Seminar~~/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Vehicle to vehicle accident modeling	Using PC-Crash 15.0 software	8	
Vehicle - pedestrian accident modeling	Using PC-Crash 15.0 software	4	
Modeling occupant / pedestrian behavior using multibody systems	Using PC-Crash 15.0 software	4	
Calculation of injury criteria for occupants on various body segments.	PC_Crash, MathCad	2	
Determination of the deformations and overall stiffness of the structure by virtual modeling of the collision tests	PC_Crash, MathCad	4	

Determination by FEA of the deformations of some elements of the car's resistance structure	PC_Crash, MathCad	4	
Student final evaluation	PC_Crash, MathCad	2	
Vehicle to vehicle accident modeling	Using PC-Crash 15.0 software	8	
Vehicle - pedestrian accident modeling	Using PC-Crash 15.0 software	4	
Modeling occupant / pedestrian behavior using multibody systems	Using PC-Crash 15.0 software	4	
Calculation of injury criteria for occupants on various body segments.	PC_Crash, MathCad	2	
Determination of the deformations and overall stiffness of the structure by virtual modeling of the collision tests	PC_Crash, MathCad	4	
Determination by FEA of the deformations of some elements of the car's resistance structure	PC_Crash, MathCad	4	
Student final evaluation	PC_Crash, MathCad	2	

Bibliography

Șoica, A., Siguranța pasivă a autovehiculelor, Editura Universității Transilvania din Brașov, Brașov 2010, ISBN 978-973-598-739-8.

2. Beleș, H., Șoica, A., Siguranța activă și pasivă a autovehiculelor, Editura Universității din Oradea, Oradea 2011, ISBN 978-606-10-0651-9.

3. Ispas, N., Șoica, A., Beleș, H., Expertiza si dinamica accidentelor rutiere, Editura Universității din Oradea, Oradea 2011, ISBN 978-606-10-0652-6.

4. Șoica, A., Chiru, A., Ispas, N., Huminic, A., Caroserii și sisteme pentru siguranță pasivă I, Editura Universității Transilvania din Brașov, Brașov 2005, ISBN 973 – 635 – 460 – 1.

5. Șoica, A., Caroserii și sisteme pentru siguranța pasiva II, Editura Universității Transilvania din Brașov, Brașov 2008, ISBN 978 – 973 – 598 – 354 – 3.

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7. Șoica, A., s.a., Caroserii și sisteme pentru siguranța pasivă, Reprografia Universității Transilvania din Brașov – 2003.

8. Nahum, A.M., Melvin, J.W., Accidental Injury, ed. Springer – Verlag, 1996.

9. PC-CRASH 12.0 – Manual de Utilizare, DSD- Dr. Steffan Datentechnik, Austria, 2018.

10. ***Standarde internaționale pentru manechine antropometrice destinate încercărilor de coliziune la impact lateral. ISO/TR 9790-1-6.

11. ***Standarde internaționale privind omologarea și testarea la coliziune a autovehiculelor (R 29 – ECE ONU, R 26 –ECE ONU, R 42 – ECE ONU, R 96 – ECE ONU, NHTSA 214).

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

- The requirements of the Romanian Motor Vehicle Engineers Society (SIAR);
- Society of Automotive Engineers (SAE USA) requirements;
- EVU Association Europe;
- SC SCHAEFER - Romania SA;
- SC DACIA GROUP RENAULT SA;
- SC FORD Romania SA;
- SC AUTOLIV Romania SA.

Theoretical and practical approaches demonstrate the latest programming IDE for automotive design. The curriculum is consistent with similar fields addressed to universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Ability to operate with assimilated knowledge	Written exam	50%
10.5 Seminar/ laboratory/ project	Ability to apply in practice the assimilated knowledge	Project	50%
10.6 Minimal performance standard			
Development of a project that uses principles and methods specific to the field of mechanical engineering: • Knowledge of the fundamental elements of PC_Crash solving dynamic simulation task. • Implement a dynamic vehicle system model in Simulink. • The grades obtained for the project and exam must be at least 5			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof.dL.Ong. Ioan Călin ROȘCA,  **Dean**	**Prof. dr. ing. Mihai DUGULEANĂ,**  **Head of Department**
Prof. Ph. D. Eng. Nicolae ISPAS  ..... **Course holder**	Lecturer Ph. D. Eng. Ionut Alexandru RADU ..... **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

[5)] One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transport Engineering
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Sensory and control systems of vehicles					
2.2 Course convenor			Lecturer PhD Eng. Postelnicu Cristian-Cezar					
2.3 Seminar/ laboratory/ project convenor			Lecturer PhD Eng. Postelnicu Cristian-Cezar					
2.4 Study year	2	2.5 Semester	3	2.6 Evaluation type	C	2.7 Course status	Content[3)]	SC
							Attendance type[4)]	EC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**4**	out of which: 3.2 lecture	**2**	3.3 seminar/ laboratory/ project	**0/2/0**
3.4 Total number of hours in the curriculum	56	out of which: 3.5 lecture	28	3.6 seminar/ laboratory/ project	0/14/0

Time allocation	hours
Study of textbooks, course support, bibliography and notes	40
Additional documentation in libraries, specialized electronic platforms, and field research	28
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	20
Tutorial	4
Examinations	2
Other activities.....	0

3.7 Total number of hours of student activity	94
3.8 Total number per semester	150
3.9 Number of credits[5)]	6

4. Prerequisites (if applicable)

4.1 curriculum-related	• Applied electronics
4.2 competences-related	•

5. Conditions (if applicable)

5.1 for course development	• Lecture room with multimedia equipment and minimum 25 places
5.2 for seminar/ laboratory/ project development	• Lecture room with multimedia equipment, electronic components and materials, and minimum 25 places

6. Specific competences and learning outcomes

Professional competences	CP. 2. Competences in the design of systems, equipment and vehicle components R.I.2.2 the use of advanced concepts, techniques and principles regarding the design of modern systems and equipment for motor vehicles CP. 3. R.I.3.8 To test mechatronic units using appropriate equipment, collecting and analyzing data. To monitor and evaluate the performance of the system and take measures, if necessary. CP. 4 Competences to carry out scientific research R.I.4.8 To operate scientific research and laboratory equipment CP. 5 Software design and development capability R.I.5.2. understand and apply the principles of programming and software development technologies in the automotive industry R.I.5.3 to evaluate and choose suitable platforms, programming languages and software technologies for projects in the automotive industry CP. 8 The ability to improve safety and comply with technical equipment safety standards R.I.8.2 combine mechanical, electrical, electronic, software and safety engineering to design motor vehicles such as trucks, vans and cars
Transversal competences	CT.1 Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence R.I.1.9 apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment CT.2 Communication and teamwork skills R.I.2.1 to carry out their work in a team

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Acquiring knowledge and forming basic skills in designing and maintaining auto control systems.
7.2 Specific objectives	• Knowledge of the types of control systems in vehicles; • Understanding the role of control systems in vehicles and their operating principles; • Knowledge of the structure of the control systems and the functional role of the components; • Acquiring practical and practical skills in the field of electrical measurements.

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
1. Introduction to computerized systems in motor vehicles: - Typical structure of control systems; - The specifics of automotive control systems; - Functions of control systems; - Requirements and performance of control systems in motor vehicles.	Presentation; Conversation (Use of teaching materials presented with video projector) Demonstration (use of representative real devices)	4	
2. Sensors used in motor vehicles: Design, operation and destination of sensors: - Pressure; - Acceleration (accelerometers); - Oxygen (lambda);		10	

- Speed; - Position / Distance - Rotation (gyroscopes); - temperature; - Humidity; - Light.			
3. Data communication in motor vehicles: - Types of networks used in motor vehicles; - CAN network; - LIN network - The FlexRay Network.		8	
4. Control systems in motor vehicles: - Traction control system; - Dynamics control system; - Safety and comfort control system - Communication and navigation system; - Control system for information and entertainment; - The diagnosis system.		6	
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8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
1. Study of pressure sensors used in motor vehicles	Demonstration, experiment, direct action, problem-solving	2	
2. Study of acceleration sensors used in motor vehicles		2	
3. Study of temperature and position sensors used in motor vehicles		4	
4. Study of DC motors and step-by-step		2	
5. Study of non-critical control systems (windscreen, doors, lighting, mirrors, etc.)		4	
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9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

The curriculum responds to the current requirements regarding the skills that automotive industry specialists must have.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Written	Written exam	
	Knowledge of concepts; - The ability to apply the accumulated knowledge; - The language appropriate to the subject; - Attitude towards learning	The subjects cover the key chapters of the course: sensors, actuators, communications, and automotive control systems.	70%
10.5 Seminar/ laboratory/ project	Laboratory defend		
	- Degree of involvement while conducting the experiments; - Rhythm of activity; keeping the calendar; - Attitude towards laboratory activities; - Ability to understand phenomena	- Direct and systematic observation; - Record progress - Laboratory defend	30%
10.6 Minimal performance standard			
The final average is calculated only if the student gets a minimum of 5 points at the laboratory defend and minimum 5 points for the written exam.			

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof. PhD Eng.Ioan Calin ROSCA **Dean** 	**Prof. PhD Eng. Mihai DUGULEANA** **Head of Department** 
Lecturer PhD Eng. Cristian-Cezar POSTELNICU **Course holder** 	**Lecturer PhD Eng. Cristian-Cezar POSTELNICU** **Holder of laboratory** 

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transportation
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			Practice for research and development I					
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor			Prof. Ph. D. eng. Florin GÎRBACIA					
2.4 Study year	2	2.5 Semester	3	2.6 Evaluation type	C	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	**NCPC**

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**12**	out of which: 3.2 lecture	**0**	3.3 seminar/ laboratory/ project	**0/0/12**
3.4 Total number of hours in the curriculum	168	out of which: 3.5 lecture	0	3.6 seminar/ laboratory/ project	168

Time allocation	hours
Study of textbooks, course support, bibliography and notes	20
Additional documentation in libraries, specialized electronic platforms, and field research	20
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	16
Tutorial	0
Examinations	4
Other activities.....	20

3.7 Total number of hours of student activity	60
3.8 Total number per semester	168
3.9 Number of credits[5)]	5

4. Prerequisites (if applicable)

4.1 curriculum-related	• Elementary concepts of automotive engineering, computer-aided design
4.2 competences-related	• Operating with fundamental concepts of engineering sciences.

5. Conditions (if applicable)

5.1 for course development	• projector
5.2 for seminar/ laboratory/ project development	• projector • laboratory equipped with computers • Windows operating system, Matlab

6. Specific competences and learning outcomes

Professional competences	C1. Skills for identifying needs for design L.O.1.1 To identify customer needs, using appropriate questions and active listening to identify customer expectations, wishes and requirements according to products and services; L.O.1.2 To interpret the technical requirements of customers, analyzing, understanding and applying the information provided regarding the technical conditions; L.O.1.3 To define technical design requirements, by specifying the technical properties of the goods, materials, methods, processes, services, systems, software and functionalities, by identifying and addressing the specific needs that must be met according to the client's requirements; L.O.1.4 To ensure the connection with the engineers from the other departments to ensure a common understanding and to discuss the design, development and improvement of the products; L.O.1.5 To make design sketches to contribute to the development and communication of design concepts. C2 Competences in the design of systems, equipment and vehicle components L.O.2.1 To carry out scientific research, to conceive or create new knowledge by formulating questions in the field by researching, improving or developing concepts, theories, models, techniques, tools, software or operational methods and by using methods and techniques scientific; L.O.2.2 To gather information about current trends and styles regarding vehicles and the need for new products or services; L.O.2.3 To prepare reports that describe the results and processes of scientific or technical research or evaluate its progress. These reports help researchers keep up with recent discoveries; L.O.2.4 To prepare research documents or give presentations to report the results of an ongoing research project, indicating the analysis procedures and methods that led to the respective results, as well as possible interpretations of the results; L.O.2.5 To synthesize information, critically interpret and summarize new and complex information from various sources; L.O.2.6 To interact professionally in research and professional environments; L.O.2.7 To apply systematic research methods and to communicate with the relevant parties to find specific information, evaluating the research results in view of the relevant estimation of the information, as well as the related technical systems and their evolutions; L.O.2.8 To provide proof of in-depth knowledge and complex understanding of the research field, including responsible research, ethical principles and scientific integrity in research matters, respect for private life and GDPR requirements, related to research activities in - a certain discipline. C3 Skills in using CAD-CAM -CAE systems L.O.3.1 using computer-aided engineering programs to perform stress analyzes for engineering projects. C4 The ability to improve safety and comply with technical equipment safety standards L.O.4.1 combine mechanical, electrical, electronic, software, and safety engineering to design motor vehicles such as trucks, vans, and automobiles. C.8 The ability to improve safety and comply with technical equipment safety standards L.O.8.1 inspect equipment used during industrial activities, such as manufacturing or construction equipment, to ensure that the equipment complies with safety and environmental legislation. L.O.8.3 to apply the basic security standards and technical standards specific to equipment to prevent risks related to the use of technical equipment at work.
Transversal competences	Ct1. Integration skills in specific workplace activities and technical skills, in conditions of autonomy and professional independence L.O.1.1 to assume responsibility, to accept responsibility for their own decisions, showing willingness to work, respecting their commitments;

	L.O. 1.2 to show determination, making sustained efforts for success pursuing clear objectives, to make decisions choosing from several alternative possibilities; L.O.1.3 to show initiative, to be proactive, L.O.1.4 to apply scientific, technological and engineering knowledge, processing complex information, operating technological installations, tools or digital equipment; L.O.1.5 identify problems and make decisions to solve them; L.O.1.6 to comply with the rules, regulations and guidelines related to a certain field or sector and to apply them in his day-to-day activity; L.O.1.7 to plan activities, manage the calendar and resources to complete tasks in a timely manner. Ct2. Communication and teamwork skills L.O.2.1 to carry out their work in a team; L.O. 2.2 to address an audience, give a speech, make a presentation; L.O.2.3 to moderate discussions between two or more people, including in situations such as workshops, conferences or online events; L.O.2.4 to use simple digital tools and technologies to communicate, interact and collaborate with others. L.O.2.5 to negotiate compromises, showing trust and managing the frustration of team members, to find compromise solutions, resolving conflicts; L.O.2.6 to be able to lead others, coordinate a team; L.O.2.7 be able to train other team members and organize information, objects and resources; L.O.2.8 to motivate others, stimulating action; L.O.2.9 to develop teams, managing time and delegating responsibilities; L.O.2.10 to create and maintain networks, promoting ideas, products and services.

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Apply scientific knowledge to solve automotive engineering problems.
7.2 Specific objectives	• Practical skills for simulating the development processes of automotive products. • Practical skills for working with integrated software packages for controlling mechatronic systems of vehicles • Practical skills of advanced simulation in the design of vehicles • Development of modern software, innovative methods, principles and simulation procedures • Development of methods for evaluating research and development projects • Developing a management strategy using modern principles and methods

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Not the case			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
Clutch model in Simulink	Presentations, examples, experiments, research on the dynamic simulation of the vehicle systems, virtual collision modeling and testing, the sensory and control systems of the vehicles, virtual	168	
The suspension system in Simulink			
Servo electro-hydraulic control in Simulink			
Development of a C ++ application for dynamic simulation of a vehicle			
Group projects			

	instrumentation		

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1. Gîrbacia, F. Computer Aided Design and Graphics Programming. Editura Universită ii Transilvania, Braşov, 2016.
2. https://www.mathworks.com/examples/simulink/category/automotive-applications
3. https://www.computoolable.nl

9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

Through its content and through the elaboration of the thematic portfolio (the study), the masters acquire competences in accordance with the expectations of the epistemic community and of the producers in the car market. The analytical program is in line with similar fields addressed at universities in the country and abroad.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course			
10.5 Seminar/ laboratory/ project	Completion of simulations in Simulink	Oral presentation	100%
	Development of the C ++ program		
	Involvement in practical activities		
	Efficiency in verbal communication (presentation)		
	Completion of simulations in Simulink		
10.6 Minimal performance standard			

- Knowledge of Simulink and C++ fundamentals
- Realization of a Simulink simulation for engineering applications
- Realization of practical project
- The marks for project work must be at least 5.

This course outline was certified in the Department Board meeting on 20/092024 and approved in the Faculty Board meeting on 30/09/2024.

Prof.dr.ing. Ioan Călin ROȘCA,  **Dean**	**Prof. dr. ing. Mihai DUGULEANĂ,**  **Head of Department**

Prof. Ph. D. eng. Florin GÎRBACIA, **Course holder**	Prof. Ph. D. eng. Florin GÎRBACIA, **Holder of seminar/ laboratory/ project**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).

COURSE OUTLINE

1. Data about the study programme

1.1 Higher education institution	Transilvania University of Brasov
1.2 Faculty	Mechanical Engineering
1.3 Department	Automotive and Transport Engineering
1.4 Field of study[1)]	Automotive Engineering
1.5 Study level[2)]	Master
1.6 Study programme/ Qualification	Virtual Engineering in Automotive Design

2. Data about the course

2.1 Name of course			University ethics					
2.2 Course convenor								
2.3 Seminar/ laboratory/ project convenor			Senior lecturer Simona ŞOICA, PhD					
2.4 Study year	II	2.5 Semester	IV	2.6 Evaluation type	C	2.7 Course status	Content[3)]	PC
							Attendance type[4)]	CPC

3. Total estimated time (hours of teaching activities per semester)

3.1 Number of hours per week	**1**	out of which: 3.2 lecture	**0**	3.3 seminar/ laboratory/ project	**1**
3.4 Total number of hours in the curriculum	14	out of which: 3.5 lecture	0	3.6 seminar/ laboratory/ project	14

Time allocation	hours
Study of textbooks, course support, bibliography and notes	10
Additional documentation in libraries, specialized electronic platforms, and field research	12
Preparation of seminars/ laboratories/ projects, homework, papers, portfolios, and essays	12
Tutorial	
Examinations	2
Other activities.....	

3.7 Total number of hours of student activity	36
3.8 Total number per semester	50
3.9 Number of credits[5)]	2

4. Prerequisites (if applicable)

4.1 curriculum-related	
4.2 competences-related	• Communication and academic writing

5. Conditions (if applicable)

5.1 for course development	
5.2 for seminar/ laboratory/ project development	• Room equipped with projector/TV, board and marker.

6. Specific competences and learning outcomes

Professional competences	
Transversal competences	Ct.1 Competences for integration into specific workplace activities, and technical competences, showing autonomy and professional independence Learning Outcomes. The graduate of the master study program is able to: L.O.1.1. assume responsibility for his/her decisions, show willingness to work, meet commitments; L.O.1.2. show determination, make decisions by identifying new opportunities; L.O.1.3. show initiative, be proactive; L.O.1.4. show self-reflection, thinki quickly and accept constructive criticism from colleagues or superiors; L.O.1.5 . analyze new issues as they arise, drawing on creative, innovative, analytical, holistic thinking; L.O.1.6. ensure customer orientation; L.O.1.7. identify problems and make decisions to solve them; L.O.1.8. comply with the rules, regulations and guidelines related to a specific field or sector and apply them in his/her daily work; Ct.2 Communication and teamwork skills Learning Outcomes. The graduate of the master study program is able to: L.O.2.1. carry out his/her work in a team; L.O.2.2. address an audience, deliver visual presentation of data; L.O.2.3. coordinate communication in a group, including situations such as workshops, conferences or online events; L.O.2.4 use simple digital tools and technologies to communicate, interact and collaborate with others. L.O..2.5 be able to lead others and coordinate a team; L.O..2.6. be able to train other team members and organize information, objects and resources

7. Course objectives (resulting from the specific competences to be acquired)

7.1 General course objective	• Ethics in scientific research
7.2 Specific objectives	• Adapt and apply scientific writing rules in line with international standards. • Managing professional writing

8. Content

8.1 Course	Teaching methods	Number of hours	Remarks
Bibliography			
8.2 Seminar/ laboratory/ project	Teaching-learning methods	Number of hours	Remarks
8.2.1. Scientific discourse; Importance of ethics in scientific research.	Problematization. Applications	1	
8.2.2. Elaboration of academic and scientific work: Documentation, Research. Scientific databases	Problematization. Applications	2	
8.2.3. Elaboration of academic and scientific work: thesis, hypotheses, research methods	Problematization. Applications	2	
8.2.4. Elaboration of academic and scientific work:	Problematization.	2	

Research methods in engineering	Applications		
8.2.5. Elaboration of academic and scientific work: Organizing texts, writing the abstract;	Problematization. Applications	2	
8.2.6. Elaboration of academic and scientific work: Adapting internationally agreed styles;	Problematization. Applications	2	
8.2.7. Writing technical/scientific texts (technical reports, instructions, procedures, user manuals);	Problematization. Applications	2	
Bibliography Alley, M. (2018) *The craft of scientific writing*. New York: Springer. Bailey, S. (2003) *Academic Writing: A practical guide for students*. London: Routledge. Barrass, R. (2002) *Scientists Must Write: A guide to better writing for scientists, engineers and students*. London: Routledge. Laplante, P.A. (2012) *Technical writing*. Boca Raton: CRC Press Taylor & Francis Group. Marder, M. P. (2011). *Research methods for science*. Cambridge: Cambridge University Press. Thiel, D. V. (2014). *Research methods for engineers*. Cambridge: Cambridge University Press			

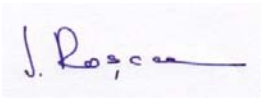
9. Correlation of course content with the demands of the labour market (epistemic communities, professional associations, potential employers in the field of study)

- Academic and scientific rigor and honesty;
- Adapt technical writing skills to the future workplace

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course			
10.5 Seminar/ laboratory/ project	Applying seminar concepts	Written exam	100%
10.6 Minimal performance standard			
• Complying with the rules of scientific writing and obtaining the passing grade			

This course outline was certified in the Department Board meeting on 20/092024. and approved in the Faculty Board meeting on 30/09/2024.

Professor Ioan-Călin ROȘCA, PhD  **Dean**	**Professor Mihai DUGULEANĂ, PhD**  **Head of Department**
	Senior lecturer Simona ȘOICA, PhD  **Holder of seminar**

Note:

1) Field of study – select one of the following options: Bachelor / Master / Doctorat (to be filled in according to the forceful classification list for study programmes);

2) Study level – choose from among: Bachelor / Master / Doctorat;

3) Course status (content) – for the Bachelor level, select one of the following options: **FC** (fundamental course) / **DC** (course in the study domain)/ **SC** (speciality course)/ **CC** (complementary course); for the Master level, select one of the following options: **PC** (proficiency course)/ SC (synthesis course)/ **AC** (advanced course);

4) Course status (attendance type) – select one of the following options: **CPC** (compulsory course)/ **EC** (elective course)/ **NCPC** (non-compulsory course);

5) One credit is the equivalent of 25 study hours (teaching activities and individual study).