Course Title	Vehicle Crashworthiness				
Course Code	AU404				
Course Type	Compulsory				
Level	BSc (Level 1)				
Year / Semester	4th Year / 8th Semester				
Teacher's Name	Dr.-Ing. Loucas Papadakis				
ECTS	6	Lectures / week	3	Laboratories/week	2
Course Purpose	Automotive safety and crashworthiness have recently received great attention with the increase of road traffic and the continuous high number of road accidents and casualties worldwide. New technologies in automotive safety have been adopted by automotive manufacturers aiming for occupants and pedestrian protection. The course purpose is to provide students with up-to-date knowledge in the field of vehicle safety and crashworthiness practiced by modern automotive industries. Upon completion of this course, the students have the skills to determine by means of analytical and numerical methods the crash dynamic and analyse the vehicle behavior during car collisions in terms of their energy absorption and deformation. In this way students will get familiar with the overall vehicle accident analysis reconstruction. The combination of theoretical knowledge and computer laboratory work will enable students to comprehend the use of automotive passive and active safety features and perform finite element computational non-linear analyses for certain vehicle components considering plasticity material models and crash dynamics. Finally, students will get familiar with and apply computer aided methods to perform road accident reconstruction.				
Learning Outcomes	By the end of the course, students must be able to: • Perform analyses of vehicle structures dynamics during crash based on analytical approaches. • Demonstrate methods for vehicle and component design to reduce accident injury levels. • Apply computation methods for analysing main vehicle structure components' behaviour during crash. • Evaluate and explain possible methods and techniques for active and passive safety. • Illustrate the interrelation between occupants and vehicle restraint systems • Investigate and reconstruct vehicle accidents • Generate a structural 3d model to investigate the energy absorption and plasticisation behaviour of ductile materials • Summarize and present the proposed models and critically				

	appraise problematic regions.		
Prerequisites	AU403	Corequisites	None
Course Content	• General Dynamics of Vehicle Impacts: equations of motion; vehicle safety; materials crashworthiness requirements and goals; frontal, side, rear and rollover accidents; legislations and directives; vehicle accident and their consequences; accident investigation and reconstruction. • Current Crashworthiness Design Practices: lumped mass-spring system (LMS); FE-based crashworthiness, crash energy management. • Energy Absorption Design Methods by applying energy absorbing geometrical features on automotive structures. • Energy Absorbing Systems: rings and rings systems; beam bending; axial crushing of circular, square and tapered vehicle structural members; top-hat behaviour under impact loading; inversion tubes and inverbuck tubes; composite tubes. • Vehicle and Occupant Analysis: Restraint and airbag systems; head, neck and chest criteria; criteria for the lower extremities. • Impact biomechanics, injury mechanisms and human tolerance to impact. • Model of the Human Body: lumped mass-spring systems and FE based systems, dummies and their modelling, real human body modelling; multi-body models versus FE models. • Crash Modelling of vehicle structures and accident reconstruction using the commercial software LS-DYNA and PC-Crash Computer laboratory work, where students can apply their gained knowledge and improve skills in computational methods complies the theoretical part of the course. Students perform the computer laboratory work alone or in small groups of two with the lecturer's supervision. Additionally, during the computer laboratory sessions, students implement the principles taught in the lecture sessions on specific practical automotive collision scenarios with the aid of computer tools.		
Teaching Methodology	The taught part of course is delivered to the students by means of lectures, conducted with the help of computer presentations. Lecture notes and presentations are available through the e-learning platform for students to use in combination with the textbooks. Furthermore theoretical principles are explained by means of demonstration examples, videos and analytical solutions of specific car collision problems. Lectures are supplemented with computer laboratory work carried out with the supervision of the lecturer Here a demonstration of practical problems in vehicle crashworthiness takes place. Additionally, during the laboratory sessions, students work on specific vehicle collision cases in the form of		

	short projects/assignments. Students perform the modelling and simulation project work alone or small groups of 2. By the end of each crash modelling task students are requested to present their 3d computational models and discuss their findings.
Bibliography	(a) Textbooks: • J. Kisilowski, J. Zalewski Modeling of Road Traffic Events, Springer, 2022 • C. Lakshmana Rao, V. Narayanamurthy, K. R. Y. Simha, Applied Impact Mechanics, Wiley, 2016 • U. Seifert and M. Gonter, Integrated Automotive Safety Handbook, SAE, 2013 (b) References: • D. C. Fleming and K. E. Jackson, Crashworthy Composite Structures: Aircraft & Vehicle Applications, DESteach Publications, 2021 • D. E. Struble and J. D. Struble, Automotive Accident Reconstruction: Practices and Principles, 2nd edition, CRC Press, 2020 • K.-U. Schmitt, P.F. Niedrer, D.S. Cronin, Trauma Biomechanics: An introduction to Injury Biomechanics, Springer, Zurich, 2014 • Dr. Steffan Datentechnik, PC-CRASH: A Simulation Program for Vehicle Accidents, 2013 • G. Davies, Materials for Automobile Bodies, Butterworth-Heinemann, 2012 For extended **internet literature review** students are advised to use the following *keywords* related to this course: *impact mechanics; crashworthiness; energy absorption; automotive passive and active safety; frontal, side, rear and rollover collisions; automotive safety legislations and directives; vehicle accident investigation and reconstruction; accident restraint and airbag systems; FE analysis of impact, lumped mass-spring systems; FE based systems, crash test dummies; crash tests; multi-body models; biomechanics during vehicle impact; LS-DYNA manual*
Assessment	The assessment consists of following methods for both the theoretical and practical part of the course. Each assessment method is assigned with a weight which is used for the calculation of the final grade. Mid-term exam: 20% Computer Laboratory: 3d models setup, reports and assignment: 20% Final Exam (written): 60%
Language	**English**