Subject Guide –Application of simulation in vehicle safety and biomechanics

Shortened Name	SVSB	**Semester**	2-2022
Class Time (weekly)	Thurs, 9-12	**Lecture hours**	3h x 15w
Subject Code	090125213	**Assignment and self-study**	5h x 15w
ECTS credits	6	**Preparation for exam**	30
KMUTNB Credits	3(3-0-6)	**Total working hours/semester**	150

1 Revision date of this document, reasons for revision

- 22.12.2022

2 Course description

Numerical simulation methods available in the field of vehicle safety including accident reconstruction. Kinematics of vehicle impact; Simulation of side impact and frontal collision; Principle of human body simulation; analysis of occupant and pedestrian post-crash kinematics and injury mechanisms.

3 Lecturer

- Assoc. Prof. Dr. Julaluk Carmai

4 Expected learning outcomes (in accordance with the MAE program ELOs)

Primary ELOs (primary content of class, knowledge is explicitly evaluated (for example, by exams), larger share of overall grade)

- Knowledge and understanding methodology of simulation and design (SELO 1)
- Knowledge and understanding of scientific fundamentals relevant for the understanding of numerical simulation in crashworthiness (SELO 2)
- Skills of using commercial software for simulation in engineering applications (SELO 5)
- Knowledge, understanding and ability to consider the human body in simulation and design (SELO 9)
- Ability to work as team member (GELO4)

Secondary LOs (not primary content of class, but implicitly taught and evaluated by application (for example, by project work or assignments), lower share of overall grade)

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- Ability to define a technical task or problem, to analyze/structure it and formulate a strategy to solve it (GELO 1)
- Awareness of engineering responsibility (GELO2)
- Ability to write a technical report (GLO3)
- Competence in literature research and summary (GELO5)
- Ability to present a project in front of a professional audience (GELO 6)
- Ability to explore information from various resources (GLO8)
- Knowledge of applicable laws, guidelines, regulations (SELO08)

Note: These ELOs correspond to the Program ELOs (referenced in parentheses).

5 Assessment

Each student will be individually assessed based on the performance on written exams and seminar, with the overall grade resulting from the shares in the table below:

Evaluated items	**shares**
Midtern exam in topics 1,2,3	20%
Final exam in topics 4,5,6	20%
Assignments	35%
Course project	25%
Total	**100%**

- Assignments include simulation exercises, literature reviews related to the learned topics.
- Both exams are closed-book and paper-based.

6 Teaching materials

- Power-point presentation of each lecture is given before class.

7 Books and references

- Vehicle crash mechanics, 2002, Mathew Huang, CRC Press LLC
- Vehicular accident investigation and reconstructions, 2000, Donald J. Van Kirk, CRC Press LLC
- Pedestrian and Cyclist Impact, A Biomechanical Perspective, 2009, Ciaran and Danis Wood, Springer.
- Biomechanical Aspect of Passenger Car vs. Child Pedestrian Collision, Dynamics Tests and Numerical simulation, 2012, Zuzana Schejbalova, Lambert Academic Publishing.
- Lecture handouts by Julaluk Carmai.

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8 Course schedule

Week	Date/Month	Activity, Topics	Evalu-ation %	Class Hours
1		Introduction to application of simulation in vehicle safety and biomechanics (Topic 1)		3
2		Simulation tools for crashworthiness design I (Topic 2)		3
3		Simulation tools for crashworthiness design II (Topic 2)		3
4		Human body model I (Topic 3)		3
5		Crash simulation laboratory using finite element technique I		3
6		Human body model II (Topic 3) Assignment presentation		3
7		Crash simulation laboratory using finite element technique II, Project preparation		3
7		Fundamental Principles for Vehicle/Occupant Systems Analysis I (Topic 4)		1
8		Midterm exam (topic 1,2,3)	20%	3
9		Crash simulation laboratory using finite element technique III, Project progress		3
10		Fundamental Principles for Vehicle/Occupant Systems Analysis II (Topic 4)		3
11		Assignment presentation		3
12		Introduction to Impact biomechanics I (Topic 5)		1 2
13		Introduction to Impact biomechanics II (Topic 5)		3
14	15/11	Accident resonstruction (Topic 6)		3
15	22/11	Accident reconstruction workshop		3
16	29/11	Final exam (topics 4,5,6)	20%	3
17	02/12	Final project presentation	25%	2
		Sum	100%	45

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9 Content details

Lecture no.	Topics	Lesson (L) Contents
1	Introduction to application of simulation in vehicle safety and biomechanics	• Overview of vehicle safety • Vehicle crash kinematics. • The role of computer simulation in vehicle safety • Brieft overview of simulation tools available in the vehicle safety field
2	Simulation tools for crashworthiness design	• Basic physics/dynamics of crash • Lump Mass Spring model • Multibody dynamics model • Finite elemement model
3	Human body model	• Lump-mass-spring model • Multibody dynamics model for dummy • Finite element human body model
4	Fundamental Principles for Vehicle/Occupant Systems Analysis	• Restrain systems. • Integrated structural and occupant simulation. • Regulations related to passive safety. • Concept of vehicle /occupant analysis • Analysis of occupant responses in frontal and side impacts
5	Introduction to Impact biomechanics	• Aspect of injury severity • Injury severity score • Injury criteria • Abbrevated injury score (AIS) • Major body regions were involved in car crash. • Head injury, thoracic inury, neck injury, lower extremities injury, abdomen injury.
6	Accident reconstruction	• Accident investigation • How to conduct accident reconstruction • .

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10 Details on Evaluation of Expected Learning Outcomes

		Midterm Exam	Final Exam	Assignments	Project	
		20%	**20%**	**35%**	**25%**	
SELO1	Knowledge and understanding methodology of simulation and design	10%	5%	2%		**17**%
SELO2	Knowledge and understanding of scientific fundamentals relevant for the understanding of numerical simulation in crashworthiness and impact biomechanics	5%				**5**%
SELO5	Skills of using commercial software for simulation in engineering			7%	5%	**12**%
SELO8	Knowledge of applicable laws, guidelines, regulations		5%	4%		**9**%
SELO9	Knowledge, understanding and ability to consider the human body in simulation and design	5%	5%	3%	4%	**17**%
GELO1	Ability to define a technical task or problem, to analyze/structure it and formulate a strategy to solve it		5%	4%	4%	**13**%
GELO2	Awareness of engineering responsibility				2%	**2**%

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GELO3	Ability to write a technical report.				3%	**3%**
GELO4	Ability to work as team member			3%	2%	**5**
GELO5	Competence in literature research and summary			6%		**6**
GLO06	Ability to present a project in front of a professional audience			4%	3%	**7%**
GLO08	Ability to explore information from various resources			2%	2%	**4%**

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