



**Budapest University of Technology and Economics  
Faculty of Transportation Engineering and  
Vehicle Engineering**

**Autonomous Vehicle Control Engineering  
Master Programme  
Recommended curriculum and subject descriptions**

**Valid from September 2025**

**Code:  
6-MA\_közös\_2025 (6N-MA)  
6NAMAR\_2025 (6NAMAR)**

# Recommended curriculum of the Autonomous Vehicle Control Engineering Master Programme

Start in February:

1/spring		2/autumn		3/spring		4/autumn	
1	Control theory and system dynamics BMEKOKJMSA1002-00	Computer vision systems BMEVIIMA19		Safety and reliability in vehicle industry BMEKOKJMSA3003-00		Automotive R&D processes and quality systems BMEKOGJMSA4001-00	
2				2 0 0 m 3 PK KJIT			
3							
4				Project management BMEGT20BS46000-00			
5	2 0 2 e 5 PK KJIT	2 1 0 e 5 PK VIK		2 0 0 m 3 CE GTK		3 0 0 m 4 PK GJT	
6	High-Performance embedded computing BMEVIAUMSA018-00	Traffic modelling, simulation and control BMEKOKJMSA2002-00		Major compulsory elective course BMEKO%		Human factors in traffic environment BMETEKTMskETKK-00	
7				1 1 0 m 3 MA		2 0 0 m 3 CE TTK	
8				Automotive environment sensors BMEKOKJMSA3002-00		Legal framework of autonomous vehicles BMEGT55MSM4000-00	
9						2 0 0 m 3 CE GTK	
10	2 1 0 e 5 PK VIK	2 0 2 m 5 PK KJIT		Elective course 1. BME%		2 0 0 m 3 EC	
11	Engineering mathematics BMEKOKJMSA2001-00	Software development methods and paradigms BMEVIAUMSA000-00		2 0 2 m 5 SP KJIT		Elective course 2. BME%	
12						2 0 0 m 3 EC	
13				Master thesis 1. BMEKO__MSA3551-00			
14	1 0 1 m 5 PK KJIT	2 1 0 e 5 PK VIK					
15	Independent engineering lab 1. BMEKOGJMSA1001-00	Localization and mapping BMEEOFTMsVKO01-00					
16							
17	BMEKOGJMSA1001-00						
18							
19	0 0 4 m 5 PK GJT/KJIT	2 0 2 m 5 PK EMK					
20	Automated driving systems BMEKOGJMSA1A01-00	Independent engineering lab 2. BMEKOGJMSA2001-00					
21		BMEKOKJMSA3001-00					
22							
23	2 0 2 e 5 SP GJT	0 0 4 m 5 PK GJT/KJIT					
24							
25	Automotive network and communication systems BMEKOGJMSA1A02-00	Vehicle dynamics BMEKOGJMSA2A01-00					
26							
27							
28							
29	2 0 2 m 5 SP GJT	2 0 1 e 5 SP GJT					
30				0 9 0 m 16 IP		0 7 0 m 14 IP	
31				Traineeship 4weeks 0 s 0 CR	BMEKO__MSM4501-00		

Start in September:

1/autumn		2/spring		3/autumn		4/spring	
1	Computer vision systems BMEVIIMA19	Control theory and system dynamics BMEKOKJMSA1002-00		Automotive R&D processes and quality systems BMEKOGJMSA4001-00		Safety and reliability in vehicle industry BMEKOKJMSA3003-00	
2							
3							
4							
5	2 1 0 e 5 PK VIK	2 0 2 e 5 PK KJIT		3 0 0 m 4 PK GJT		2 0 0 m 3 PK KJIT	
6	Traffic modelling, simulation and control BMEKOKJMSA2002-00	High-Performance embedded computing BMEVIAUMSA018-00		Human factors in traffic environment BMETEKTMskETKK-00		Project management	
7				2 0 0 m 3 CE TTK		2 0 0 m 3 CE GTK	
8				Legal framework of autonomous vehicles		Elective course 1. BME%	
9				2 0 0 m 3 CE GTK		2 0 0 m 3 EC	
10	2 0 2 m 5 PK KJIT	2 1 0 e 5 PK VIK		Major compulsory elective course BMEKO%		Elective course 2. BME%	
11	Software development methods and paradigms BMEVIAUMSA000-00	Engineering mathematics BMEKOKJMSA2001-00		1 1 0 m 3 MA		2 0 0 m 3 EC	
12							
13				Master thesis 1. BMEKO__MSA3551-00		Automotive environment sensors BMEKOKJMSA3002-00	
14							
15	2 1 0 e 5 PK VIK	1 0 1 m 5 PK KJIT					
16	Localization and mapping	Independent engineering lab 2. BMEKOGJMSA2001-00					
17		BMEKOKJMSA3001-00					
18							
19	2 0 2 m 5 PK EMK	0 0 4 m 5 PK GJT/KJIT					
20	Independent engineering lab 1. BMEKOGJMSA1001-00	Automated driving systems BMEKOGJMSA1A01-00					
21							
22							
23	BMEKOGJMSA1001-00						
24							
25	0 0 4 m 5 PK GJT/KJIT	2 0 2 e 5 SP GJT					
26	Vehicle dynamics BMEKOGJMSA2A01-00	Automotive network and communication systems BMEKOGJMSA1A02-00					
27							
28							
29							
30	2 0 1 e 5 SP GJT	2 0 2 m 5 SP GJT		0 9 0 m 16 IP		0 7 0 m 14 IP	
31				Traineeship 4weeks 0 s 0 CR	BMEKO__MSM4501-00		

- BK basic knowledge
- PK/IP professional knowledge / independent project
- MA major compulsory elective course
- CE compulsory elective economics and human science (BMEGT%) or natural science (BMETE%) course
- EC elective course
- SP specialisation
- MI minor compulsory elective course
- CR criteria requirement
- term for student mobility

## Curriculum Supplement (extracted from the study programme)

The Curriculum Supplement (curriculum appendix) contains **the system of subject prerequisites**, the rules for the selecting specializations, the description of the conditions for the **preparation of the Master thesis and the final examination**, as well as the order of the final examination.

1) The subject prerequisite system expresses the connections between the subjects. The specific subject prerequisites are included in the subject datasheets. This study programme has a so called **indicative prerequisite system**, that means – except in few cases at subjects from other faculties – there are only recommended prerequisites, with the following amendments:

The *recommended core prerequisite* points out a strong correlation with the learning outcomes of the previous subject, so that without meeting the prerequisite, registration for the subject is possible but professionally contraindicated. The *recommended coherent prerequisite* refers to the link between the learning outcomes of the subjects concerned, i.e. it is recommended that the subject is taken after or in parallel with the previous subject. The *recommended complementary prerequisite* reflects a looser link between the subjects, the learning outcomes of the subject can be achieved with some additional time.

2) *The rules for selection of specialisation, and the general conditions of registering for the specialisation subjects:*

There are no general rules for the selection of specialisation and for registering for the specialisation subjects.

3) *Enrollment rules for the Master thesis subjects in all specializations:*

The prerequisite for enrollment in the Master thesis I. course is the collection of a minimum of 55 credits.

The prerequisite for enrollment in the Master thesis II. course are the collection of a minimum of 84 credits and the completion of the four-week traineeship. The Master thesis I. course can be enrolled simultaneously as coherent requisite, in which case the above cumulative acquired credits must be achieved by completing another subjects according to the recommended curriculum.

4) *Term designated for student mobility:*

A student may participate in student mobility in the term designated for this purpose in the recommended curriculum, provided that the conditions laid down in the Code of Studies are met, and the subjects completed in the framework of the mobility are recognised as being the subjects due for the semester of the recommended curriculum which the student would have been entitled to take.

5) *Compulsory elective courses, recommended elective courses*

As part of the training programme, students must complete one (= 3 credits in total) major compulsory elective subjects, and 6 credits in total elective subjects. The Faculty offers at least eight major compulsory elective subjects in the framework of the training programme. The student may choose the subjects at its discretion from among those announced in the current semester. The major compulsory elective subjects and the elective subjects set out in the curriculum and announced in the current term are available in the study system. The current lists of major compulsory elective subjects and of recommended elective subjects are available on the Faculty website.

6) *Criteria for taking the final examination:*

Completion of all subjects included in the recommended curriculum, including elective subjects (all together at least 120 credits), submitting the Master thesis, and fulfillment of all criterion requirements in the curriculum (four weeks of traineeship).

7) *Final examination order:*

The final examination in front of the Final Examination Board consists of defending the Master thesis and passing oral final examinations from three subjects (or subject groups). The final examination subjects (or subject groups) are assigned by the Department responsible for the specialisation. The subjects must be selected partly from the professional subjects, and from the

specialisation subjects, so that each subject has a minimum credit value of 3 and the knowledge of the three subjects (or subject groups) is at least 15 credits in total.

## Subject description explanation

<b>1. Subject name</b>	official name of the subject
<b>2. Subject name in Hungarian</b>	official name of the subject in Hungarian
<b>3. Programme</b>	related programmes: k – transportation eng., j – vehicle engineering, l – logistics engineering, p – professional pilot
<b>4. Subject code</b>	Neptun code of the subject
<b>5. Term / role</b>	the term and the role (k – compulsory; kv - compulsory elective; sp – specialisation; szv – elective) of subject in the recommended curriculum
<b>6. Credits</b>	credit value of the subject
<b>7. Evaluation type</b>	type of academic performance assessment, e - exam grade; m - mid-term grade; s - signature
<b>8. Nature</b>	nature of teaching
<b>9. Weekly contact hours</b>	number of lessons for students by lecture, practice and lab
<b>10. Language</b>	language of teaching
<b>11. SDG</b>	learning outcomes' contribution to the EU/UN sustainable development goals
<b>12. Working hours for fulfilling the requirements of the subject</b>	contact hours – personal appearance at classes in a university preparation for seminars – preparation at home for the classes homework – preparation of homework and other assignments for the classes reading written materials – reviewing and understanding the taken lessons at home midterm preparation – recommended preparation time at home for the midterm test during the semester exam preparation – recommended preparation time at home for the exam
<b>13. Organisational unit in charge</b>	name of the organisational unit in charge of the subject
<b>14. Subject coordinator and its position</b>	name and position of the subject coordinator
<b>15. Email address</b>	email address of the subject coordinator
<b>16. ... organisational unit</b>	name of the organisational unit for the subject coordinator
<b>17. Instructors</b>	name of the subject's instructor(s)
<b>18. Indicative prerequisites</b>	predefined criteria for registering the subject
<b>19. Purpose</b>	subject's role and purpose in the training programme
<b>20. Programme of lectures</b>	detailed content of the lecture course
<b>21. Programme of practices</b>	detailed content of the practice course
<b>22. Programme of laboratories</b>	detailed content of the laboratory course
<b>23. Learning outcomes</b>	results to achieve at the end of the learning process, grouped by competences (lower case), furthermore their link to the training programme's learning outcomes (upper case)
<b>24. Midterm assessments</b>	name and code of assessments in the study period, their share in the final grade, and the evaluated learning outcomes
<b>25. Exams</b>	a name and code of assessments in the exam period, their share in the final grade, and the evaluated learning outcomes
<b>26. Criteria to obtain a signature / midterm grade</b>	criteria that shall be met to obtain the signature / midterm grade from the subject
<b>27. Grading rules</b>	rules of grading in share (%) of the summarised results of assessments
<b>28. Attendance and participation requirements</b>	derogations from the main rule laid down by the Code of Studies
<b>29. Retake and delayed completion</b>	requirements for passing the subject, aspects of performance evaluation, way to determine a grade (obtain a signature)
<b>30. Consultation</b>	consultation opportunities offered by the instructor(s)
<b>31. Learning materials</b>	notes, textbooks, suggested literature, recommended learning support materials in printed or electronic form
<b>32. Start of validity for the subject description</b>	start of validity for the information laid down by the subject description



<b>1. Subject name</b>	<b>Automated driving systems</b>				
<b>2. Subject name in Hungarian</b>	Automated driving systems			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEKOGJMSA1A01-00</b>			<b>5. Term   role</b>	1/2   sp
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>e</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>1 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	42 hours	<b>Preparation for lessons</b>	28 hours	<b>Homework</b>	0 hours
<b>Reading written materials</b>	20 hours	<b>Midterm preparation</b>	30 hours	<b>Exam preparation</b>	30 hours
<b>13. Organisational unit in charge</b>	Department of Automotive Technologies				
<b>14. Subject coordinator and its position</b>	Dr. Szalay Zsolt associate professor	<b>15. Email address</b>	szalay.zsolt@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Automotive Technologies				
<b>17. Instructor(s)</b>	Dr. Szalay Zsolt, Fodor Károly, Domina Ádám, Cserni Márton, Tóth Szilárd Hunor				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
The aim of the course is to provide comprehensive knowledge regarding the challenges related to the design of ADAS functions. Through lectures and laboratory sessions, students gain both theoretical understanding and practical experience with the key issues concerning the structure and operation of various ADAS functions.					
<b>20. Programme of lectures</b>					
Advanced Driving Assistant Systems					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
During the laboratory sessions, the methods introduced in the lectures are implemented. Students can experiment with the parameters and examine their influence.					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
1. knows the basic ADAS functions, their modular structure, understands the steps in the design of an ADAS function (T3-T6,T8,T9)					
<b>b) skills (k)</b>					
1. evaluates the complexity, difficulties and main steps in the development of an ADAS function (K2,K3,K5,K8,K13,K15)					
<b>c) attitude (a)</b>					
1. is open to understand the main concept of how an autonomous driving system function can be built up (A1,A2,A5,A6,A8)					
<b>d) autonomy and responsibility (o)</b>					
1. takes responsibility for the work done					
<b>24. Midterm assessments</b>					
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>		
1. Midterm test	1. D	1. 50%	1. t1,k1,a1,o1		
<b>25. Exams</b>					
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>		
1. Exam	1. V	1. 50%	1. t1,k1,a1,o1		
<b>26. Criteria to obtain a signature / midterm grade</b>					<b>27. Grading rules</b>

Passing the midterm test.	
<b>28. Attendance and participation requirements</b>	50%-61%: pass
According to CoS.	62-74%: satisfactory
<b>29. Retake and delayed completion</b>	75%-87%: good
The midterm test can be retaken once.	88%-100%: excellent
<b>30. Consultation</b>	
With a specific instructor at an agreed time via MS teams	
<b>31. Learning materials</b>	
notes	
<b>32. Start of validity for the subject description</b>	
September 1st, 2025	



<b>1. Subject name</b>	<b>Automotive environment sensors</b>				
<b>2. Subject name in Hungarian</b>	Automotive environment sensors			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEKOKJMSA3002-00</b>			<b>5. Term   role</b>	3/4   k
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>2 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	56 hours	<b>Preparation for lessons</b>	30 hours	<b>Homework</b>	0 hours
<b>Reading written materials</b>	30 hours	<b>Midterm preparation</b>	34 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Control for Transport and Vehicle Systems				
<b>14. Subject coordinator and its position</b>	Dr. Bécsi Tamás associate professor		<b>15. Email address</b>	becsi.tamas@kjk.bme.hu	
<b>16. ...organisational unit</b>	Department of Control for Transport and Vehicle Systems				
<b>17. Instructor(s)</b>	Dr. Aradi Szilárd, Dr. Bécsi Tamás, Dr. Törő Olivér				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>	<p>The course aims to provide students with a comprehensive understanding of modern sensor technologies used in autonomous vehicle environment perception, along with related data processing and sensor fusion methods. Special emphasis is placed on the working principles and application possibilities of various sensors, as well as the fundamental algorithms required for interpreting environmental situations.</p>				
<b>20. Programme of lectures</b>	<p>This course provides an introduction to the environment perception systems of autonomous vehicles, with a focus on the operation, application areas, and limitations of various sensors such as radar, lidar, ultrasonic sensors, and cameras. Students will become familiar with the characteristics of both internal and external vehicle sensors, as well as the theory and practice of data processing and integration (sensor fusion). The course also covers the fundamentals of estimation techniques, including Kalman filtering, SLAM, and particle filtering, through practical examples related to different vehicle functions.</p>				
<b>21. Programme of practices</b>	-				
<b>22. Programme of laboratories</b>	<p>The laboratory sessions aim to provide students with hands-on experience in processing sensor data and implementing various environment perception techniques. Through small-scale projects, students will implement the algorithms introduced in the lectures</p>				
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>	<p>The student</p> <p><b>a) knowledge (t)</b></p> <ol style="list-style-type: none"> <li>1. Knows the vehicle condition measurement sensors related to autonomous vehicles, their operating principles, and the terminology associated with them. (T3,T11,T12)</li> <li>2. Has comprehensive knowledge of modern sensors for environmental sensing (Radar, Lidar, Ultrasound, camera systems), their possibilities, limitations, and related technological and technical relationships. (T4,T6,T8)</li> <li>3. Knows and understands the methods of processing sensor data, including environmental modeling techniques based on sensor fusion. (T5,T7,T12,T15)</li> </ol> <p><b>b) skills (k)</b></p> <ol style="list-style-type: none"> <li>1. Is able to process and interpret data from the sensors of autonomous vehicles, and based on this, determine environmental situations and model them at a system level. (K4,K5,K9)</li> <li>2. Is able to design and further develop a sensor architecture suitable for environmental sensing to implement a designated autonomous function. (K2,K8,K12)</li> </ol> <p><b>c) attitude (a)</b></p> <ol style="list-style-type: none"> <li>1. Open to automotive sensor technologies and related innovations, appreciates the potential of analyzing sensor data. (A1,A2,A8)</li> </ol>				

**d) autonomy and responsibility (o)**

1. Able to work independently and in a team, while taking responsibility for adhering to professional and ethical principles related to the development of vehicle functions.

**24. Midterm assessments**

Name	Code	Share in final grade	Evaluated learning outcomes
1. Midterm test 1	1. ZH1	1. 50%	1. t1,t3,k1,k2,a1,o1
2. Midterm test 2	2. ZH2	2. 50%	2. t1,t2,t3,k1,k2,a1,o1

**25. Exams**

Name	Code	Share in final grade	Evaluated learning outcomes
-	-	-	-

**26. Criteria to obtain a signature / midterm grade**

Passing both midterms

**28. Attendance and participation requirements**

according to the rules of CoS

**29. Retake and delayed completion**

Second retake or delayed completion of one midterm test is possible.

**27. Grading rules**

Excellent 88-100%

Good 75-87%

Satisfactory 63-74%

Pass 50-62%

Fail 0-49%

**30. Consultation**

At a time and in a manner agreed upon with the instructor

**31. Learning materials**

Learning is supported by the provided lecture slides, supplementary notes, and source codes related to the lab sessions.

**32. Start of validity for the subject description**

September 1st, 2025



<b>1. Subject name</b>	<b>Automotive network and communication systems</b>				
<b>2. Subject name in Hungarian</b>	Automotive network and communication systems			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEKOGJMSA1A02-00</b>			<b>5. Term   role</b>	1/2   sp
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>1 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	42 hours	<b>Preparation for lessons</b>	40 hours	<b>Homework</b>	0 hours
<b>Reading written materials</b>	20 hours	<b>Midterm preparation</b>	48 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Automotive Technologies				
<b>14. Subject coordinator and its position</b>	Dr. Pethő Zsombor research fellow	<b>15. Email address</b>	petho.zsombor@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Automotive Technologies				
<b>17. Instructor(s)</b>	Dr. Pethő Zsombor, Dr. Szalay Zsolt, Dr. Török Árpád, Dr. Bokor László (VIK), Jakab Tivadar (VIK), Kazár Tamás Márton				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>	<p>The course aims to provide comprehensive knowledge of vehicle communication systems, focusing on the communication technologies of both conventional and highly automated vehicles. The course provides the necessary theoretical foundations and practical skills essential for understanding, developing, and applying modern vehicle communication systems.</p>				
<b>20. Programme of lectures</b>	<p>Introductory course - Intelligent Transportation System          Introduction to vehicle communication          V2X nowadays: standardization organizations and activities          V2X architectures          Standard V2X network and transport solutions          Standard V2X security and privacy protection          In-vehicle network communication protocols          ECUs operation and structure, ECU-level communication          In-vehicle network cybersecurity          In-vehicle network diagnostics          Functional Safety</p>				
<b>21. Programme of practices</b>	-				
<b>22. Programme of laboratories</b>	<p>The laboratory practices for this course are designed to provide hands-on experience with essential aspects of vehicle communication systems and their integration within intelligent transportation systems. Through six focused sessions, students will develop practical skills in network communication, protocol analysis, security, and diagnostics.</p>				
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>	<p>The student</p> <p><b>a) knowledge (t)</b></p> <ol style="list-style-type: none"> <li>1. Understands network communication and its configuration for V2X and in-vehicle systems. (T1,T3,T6,T14)</li> <li>2. Knows about analyzing and interpreting V2X and in-vehicle communication protocol data. (T3,T14)</li> <li>3. Gets familiar with developing basic applications for V2X communication systems. (T3,T4,T14)</li> <li>4. Knows about implementing cybersecurity measures in in-vehicle networks. (T1,T3,T4,T5,T8)</li> <li>5. Understands how to conduct OBD and UDS diagnostics and troubleshooting for in-vehicle communication systems. (T3,T5,T9,T14)</li> </ol>				

6. Gains proficiency with tools and software commonly used in automotive industry. (T4,T6,T8)

**b) skills (k)**

1. Is able to apply in-vehicle communication protocols. (K2,K12)
2. Is able to design appropriate communication interfaces. (K3,K5)
3. Is able to select the appropriate protocol for a specific autonomous vehicle function. (K1,K8)

**c) attitude (a)**

1. Is open to understanding new communication solutions. (A1,A2,A8)

**d) autonomy and responsibility (o)**

1. Takes responsibility for the completed work.

**24. Midterm assessments**

Name	Code	Share in final grade	Evaluated learning outcomes
1. Midterm test	1. ZH1	1. 40%	1. t1-t6,k1-k3
2. Midterm test	2. ZH2	2. 40%	2. t1-t6,k1-k3
3. Laboratory exercises	3. LF	3. 20%	3. t1-t6,k1-k3,a1,o1

**25. Exams**

Name	Code	Share in final grade	Evaluated learning outcomes
-	-	-	-

**26. Criteria to obtain a signature / midterm grade**

Successful completion of both midterm tests and all laboratories.

**28. Attendance and participation requirements**

According to CoS.

**29. Retake and delayed completion**

In the delayed completion week, it is possible to make up one laboratory exercise, retake both midterm tests and hand in laboratory exercises late.

**27. Grading rules**

50%-61%: pass  
62-74%: satisfactory  
75%-87%: good  
88%-100%: excellent

**30. Consultation**

After the lectures or the practices, and in specified time slots previously agreed appointment.

**31. Learning materials**

Lecture materials, course notes, books

**32. Start of validity for the subject description**


September 1st, 2025



<b>1. Subject name</b>	<b>Automotive R&amp;D processes and quality systems</b>				
<b>2. Subject name in Hungarian</b>	Automotive R&D processes and quality systems			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEKOGJMSA4001-00</b>			<b>5. Term   role</b>	4/3   k
<b>6. Credits</b>	<b>4</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>3 lecture</b>	<b>0 practice</b>	<b>0 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>120 hours</b>
<b>Contact hours</b>	42 hours	<b>Preparation for lessons</b>	12 hours	<b>Homework</b>	18 hours
<b>Reading written materials</b>	10 hours	<b>Midterm preparation</b>	38 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Automotive Technologies				
<b>14. Subject coordinator and its position</b>	Dr. Török Árpád senior research fellow	<b>15. Email address</b>	torok.arpad@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Automotive Technologies				
<b>17. Instructor(s)</b>	Dr. Török Árpád, Dr. Pethő Zsombor, Kazár Tamás Márton				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
<p>The aim of the course is to familiarize students with the processes used in the automotive industry, research and development, and the relevant regulations. Students will gain insight into the standards and process models required by the automotive industry for development processes. Within the framework of the course, students can get acquainted with the individual elements of the flow, their structure and their relationships. In addition, students can learn about quality methods that support development.</p>					
<b>20. Programme of lectures</b>					
<p>Presentation of the life cycle of vehicle development. Quality assurance during vehicle development, control points and models. Product and process testing. Automotive Qualification Management Standards, Audits (IATF16949). Software Development Processes, Graduation Models (Automotive SPICE). Manage your requirements. Application of FMEA in product design. Project management. Change management. Software development processes. Testing processes. Supplier quality control. Configuration management.</p>					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
-					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
1. is familiar with standard solutions for automotive research development processes, taking into account life cycle planning and quality assurance aspects, (T3,T4,T5,T6,T8,T9,T10)					
2. knows the automotive quality management standards (T4,T7,T16)					
3. know project and change management processes, (T4,T5,T16)					
4. is familiar with testing and supplier control processes (T4,T7,T16)					
<b>b) skills (k)</b>					
1. is able to engage in automotive development, understand its project structure, (K2,K11,K13,K15)					
2. is able to design and implement a project management project for automotive development (K3,K5,K8,K11,K12,K14)					
<b>c) attitude (a)</b>					
1. is open to work on a project-based approach					
2. is open to work in team					
<b>d) autonomy and responsibility (o)</b>					
1. responsible for the work done (O1-O4)					
<b>24. Midterm assessments</b>					

Name	Code	Share in final grade	Evaluated learning outcomes
1. Midterm test	1. ZH	1. 50%	1. t1-t4,k1,k2
2. Individual assignment	2. ÖF	2. 50%	2. t1-t4,k1,k2,a1,a2,o1
<b>25. Exams</b>			
Name	Code	Share in final grade	Evaluated learning outcomes
-	-	-	-
<b>26. Criteria to obtain a signature / midterm grade</b>			<b>27. Grading rules</b>
Passing the midterm test, presenting the assignment.			50%-61%: pass 62-74%: satisfactory 75%-87%: good 88%-100%: excellent
<b>28. Attendance and participation requirements</b>			
According to CoS.			
<b>29. Retake and delayed completion</b>			
The midterm test can be retaken once, the individual assignment can be resubmitted once.			
<b>30. Consultation</b>			
After the lectures or the practices, and in specified time slots previously agreed appointment.			
<b>31. Learning materials</b>			
Lecture notes			
<b>32. Start of validity for the subject description</b>			
September 1st, 2025			



<b>1. Subject name</b>		<b>Computer vision systems</b>			
<b>2. Subject name in Hungarian</b>		Computer vision systems		<b>3. Programme</b>	
<b>4. Subject code</b>		BMEVIIIIMA19		<b>5. Term   role</b>	
<b>6. Credits</b>		<b>7. Evaluation type</b>		<b>8. Nature</b>	
5		e		contact lessons	
<b>9. Weekly contact hours</b>		<b>10. Language</b>		English	
2 lecture		1 practice		0 laboratory	
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>		150 hours			
<b>Contact hours</b>		<b>Preparation for lessons</b>		<b>Homework</b>	
42 hours		10 hours		25 hours	
<b>Reading written materials</b>		<b>Midterm preparation</b>		<b>Exam preparation</b>	
20 hours		20 hours		33 hours	
<b>13. Organisational unit in charge</b>		Department of Control Engineering and Information Technology (VIK)			
<b>14. Subject coordinator and its position</b>		Dr. Szemenyei Márton associate professor		<b>15. Email address</b>	
<b>16. ...organisational unit</b>		Department of Control Engineering and Information Technology (VIK)			
<b>17. Instructor(s)</b>		Dr. Szemenyei Márton			
<b>18. Indicative prerequisites</b>		---			
<b>19. Purpose</b>		<p>The demand for processing image-based information has been rapidly increasing over the past decades. Examples include industrial quality control, the gaming and entertainment industry, modern imaging diagnostic tools, and more recently, the development of autonomous vehicles and the fight against terrorism. The aim of the course is to familiarize students with the theory and practice of computer-based image processing, object recognition, and comparative analysis. Based on what they learn in the course, students will be able to apply the fundamentals of machine vision (such as image capture, storage, and processing), as well as solve more complex image processing tasks and carry out development work</p>			
<b>20. Programme of lectures</b>		<p>1. Introduction, basic tasks and challenges of computer vision, semantic gap. Fundamentals of image sensing, human vision, photodiode, CCD, CMOS, color vision. Sources of image noise and defects, blurriness, focus, image storage techniques. Role of color components, color spaces. Image enhancement techniques, intensity transformations, histograms, histogram transformations.</p> <p>2. Filtering in the image domain, convolution, smoothing, sharpening, and edge detection filters, nonlinear filters. Edge detection, Canny algorithm. Image arithmetic, interpolation techniques, fittings.</p> <p>3. Image processing in the frequency domain, 2D Fourier transform, analysis of image spectrum. Filtering in the frequency domain, properties of ideal and other filters. Classification based on spectrum, analysis of periodic noise. DCT, JPEG compression, Wiener deconvolution.</p> <p>4. Types and extraction of image features. Template matching, similarity metrics. Corner detection, local structure matrix, KLT, Harris. Invariances to transformations, SIFT, ORB. Classification methods: Haar features, Viola-Jones, Bag of Visual Words, Deformable Parts. Tracking solutions: Pixel-based tracking, Optical Flow, LK and Farneback methods. Iterative and pyramid optical flow. Application of HMM and Kalman Filter, object matching based on affinity.</p> <p>5. (Listed twice as 6 in original) Categorization of segmentation methods. Intensity-based segmentation, thresholding, histogram-based methods. Clustering techniques: k-Means, MoG, Mean-shift. Region growing, Split &amp; Merge, SRM. Watershed, graph cuts, motion segmentation.</p> <p>6. Processing of binary images, basic morphological operations, opening, closing, contour detection. Distance and adjacency, Jordan property. Skeletonization. Binary object descriptors: Euler number, fingerprint, position, orientation. Object counting and labeling. Hough transform.</p> <p>7. Basics of machine learning, structure of learning systems, types of learning. Examples of learning systems, kNN. Neural networks, fundamental learning challenges, overfitting, data quality. Steps of supervised learning. Perceptron model, decision function. Error functions, gradient method, higher-order methods. MLP and backpropagation.</p> <p>8. Structure of convolutional networks. Well-known architectures: VGG, Inception, ResNet, DenseNet, EfficientNet. Neural network visualization, adversarial attacks.</p> <p>9. Deep learning in practice, ensuring convergence, avoiding overfitting. Hyperparameter search, model compression, pruning and ensembles.</p> <p>10. Detection architectures: R-CNN variants, YOLO. Key metrics and databases, anchor-based and anchor-free solutions. Mask and other R-CNN extensions. Segmentation methods: U-Net, upscaling techniques. ASPP and CRF extensions.</p>			

11. Video processing, levels of fusion, 3D convolution. Recurrent architectures: RNN, BPTT, vanishing gradients. LSTM and GRU, soft attention mechanisms. Self-attention and vision transformer solutions.
12. Basics of projective geometry, types of transformations and their properties. Imaging geometry, pinhole camera model, extrinsic and intrinsic parameters. Camera calibration methods: 3D marker-based and chessboard-based solutions, self-calibration.
13. Stereo setup, epipolar geometry, essential and fundamental matrix. Stereo calibration, rectification. Concept of disparity and methods for its determination: BM, SGBM, BP. 3D reconstruction and its invariances, practical applications. SLAM and SfM, multi-view reconstruction.

### 21. Programme of practices

1. Writing/scanning images, image enhancement, filtering, colour space and histogram transformations, elimination, simple segmentation procedures (clustering, region expansion)
2. Image feature extraction, edge and corner detection, Hough transformations. Binary image processing, open-close, object counting, description and identification
3. Video stream processing, object tracking using optical flow, motion detection using adaptive background model
4. Creation and training of deep neural networks for classification problems, training, validation, hyperparameter tuning
5. Perform camera calibration, perform stereo calibration, perform 3D reconstruction, segmentation in 3D
6. Consultation session for homework

### 22. Programme of laboratories

-

### 23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)

The student

#### a) knowledge (t)

1. is familiar with the mathematical and physical descriptive theories of image perception and imaging, and their practical implementations, (T1,T5)
2. knows the tools of image description, methods of geometric description of image details, (T12)
3. know the basic algorithms for image processing, (T12)
4. knowledge of image filtering techniques, segmentation and object recognition methods (T11)

#### b) skills (k)

1. able to design image processing algorithms independently, (K1)
2. be able to apply development environments used in industry, (K7,K12)
3. be able to perform object recognition and tracking tasks (K4)

#### c) attitude (a)

1. motivated to learn new advances in the constantly evolving field of image processing, (A1)
2. motivated to apply the knowledge acquired to the development of advanced automated vehicle functions (A8)

#### d) autonomy and responsibility (o)

1. can independently interpret and learn new results of image processing,
2. can independently learn to use the development environment of a vision system

### 24. Midterm assessments

Name	Code	Share in final grade	Evaluated learning outcomes
1. Homework	1. OF	1. 0%	1. t1-t4,k1-k3,a1-a3,o1,o2 2. t1-t4,k1-k3,a1-a3,o1,o2
2. Homework	2. OF	2. 0%	
3. Midterm test	3. ZH	3. 20%	

### 25. Exams

Name	Code	Share in final grade	Evaluated learning outcomes
1. written exam	1. IRV	1. 80%	1. t1-t4,k1-k3,a1-a3,o1,o2

### 26. Criteria to obtain a signature / midterm grade

1. Successful completion of two homeworks given during the semester (grade: pass/fail).
2. Summative assessment: writing of one midterm test (min 40%).

### 28. Attendance and participation requirements

According to CoS.

### 29. Retake and delayed completion

During the semester you will be given the opportunity to make up the midterm test. The test cannot be made up during the delayed completion week. Both homeworks can be handed in during the delayed completion week.

0-39%: fail  
40-54%: pass  
55-69%: satisfactory  
70-84%: good  
85-100%: excellent

### 30. Consultation

If required, a consultation can be arranged by prior appointment.


### 31. Learning materials

1. Lecture notes and presentation
2. John C. Russ, The Image Processing Handbook, CRC Press, 2017, <https://doi.org/10.1201/b18983>
3. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016, <https://www.deeplearningbook.org/>

### 32. Start of validity for the subject description

September 1st, 2025



<b>1. Subject name</b>	<b>Control theory and system dynamics</b>				
<b>2. Subject name in Hungarian</b>	Control theory and system dynamics		<b>3. Programme</b>	A	
<b>4. Subject code</b>	<b>BMEKOKJMSA1002-00</b>		<b>5. Term   role</b>	1/2   k	
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>e</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>2 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>				<b>150 hours</b>	
<b>Contact hours</b>	56 hours	<b>Preparation for lessons</b>	10 hours	<b>Homework</b>	14 hours
<b>Reading written materials</b>	20 hours	<b>Midterm preparation</b>	20 hours	<b>Exam preparation</b>	30 hours
<b>13. Organisational unit in charge</b>	Department of Control for Transport and Vehicle Systems				
<b>14. Subject coordinator and its position</b>	Dr. Gáspár Péter professor	<b>15. Email address</b>	gaspar.peter@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Control for Transportation and Vehicle Systems				
<b>17. Instructor(s)</b>	Dr. Gáspár Péter, Dr. Mihály András				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
<p>The course aims the study of the analytical and control design methods of electromechanical systems. First, the modeling paradigms and state space representations are outlined. After this, system analysis is presented, such as controllability, observability and stability, Through the control design problem, the course examines the different qualitative properties, and the consideration techniques of system uncertainties and disturbances. From the classical methods, the pole allocation and the quadratic linear control is presented. The course focuses on the interpretation of the observer design and the separation principle.</p>					
<b>20. Programme of lectures</b>					
<p>Course thematic:</p> <ul style="list-style-type: none"> <li>- System modeling based on physical principles</li> <li>- Analysis in time and frequency domain</li> <li>- State space of dynamic systems</li> <li>- Quantitative properties and stability analysis of closed loop systems</li> <li>- Properties of state space representations</li> <li>- Controllability and observability of state space representations</li> <li>- Compensator design</li> <li>- Full state feedback with pole allocation</li> <li>- Controller design with linear quadratic method</li> <li>- Separation principle and observer design</li> </ul>					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
In the laboratory practice the computerized implementation and evaluation of the known control theory models and algorithms is performed.					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
1. know the basic paradigms of dynamic system modelling and their mathematical background, (T1,T3,T5,T8)					
2. know the time and frequency domain description methods of linear time-invariant systems, (T1,T3,T5,T11)					
3. know control principles, their quantitative and qualitative criteria, (T1,T3,T5,T8)					
4. knowledge of state space theory, (T1,T3,T5,T11)					
5. knowledge of various simple feedback control methods, (T1,T3,T5,T8)					

6. know the basics of modern control theory, the principle of quadratic control, (T1,T3,T5,T8)

7. knows the methods of observer design, (T1,T3,T5,T11)

**b) skills (k)**

1. can independently design a given system model, (K1,K2,K4,K7,K8)

2. can independently apply control design methods, (K1,K2,K4,K7,K8)

3. be able to use common software in the field (K4,K7,K12,K13)

**c) attitude (a)**

1. is interested in mathematical solutions to control problems, (A8)

2. develops a systemic way of thinking (A8)

**d) autonomy and responsibility (o)**

1. can independently provide quality and quantity parameters for a system's performance, enabling them to make decisions about system redesign

**24. Midterm assessments**

Name	Code	Share in final grade	Evaluated learning outcomes
1. written midterm test	1. ZH	1. 50%	1. t1,t2,t3,t4,t5,t6,t7,k1,k2,k3,a1,a2,o1

**25. Exams**

Name	Code	Share in final grade	Evaluated learning outcomes
1. written exam	1. Vizsga	1. 50%	1. t1,t2,t3,t4,t5,t6,t7,k1,k2,k3,a1,a2,o1

**26. Criteria to obtain a signature / midterm grade**

The midterm exam is successful if 50% of its points are reached. The written exam is successful, if 50% of its points are reached.

**28. Attendance and participation requirements**

according to the rules of CoS

**29. Retake and delayed completion**

The midterm exam can be retried once

**30. Consultation**

Consultation is possible at a time and in a form agreed with the teacher.

**31. Learning materials**

lecture notes

**32. Start of validity for the subject description**

September 1st, 2025

**27. Grading rules**

Excellent 88-100%


Good 75-87%

Satisfactory 63-74%

Pass 50-62%

Fail 0-49%



<b>1. Subject name</b>	<b>Engineering mathematics</b>				
<b>2. Subject name in Hungarian</b>	Engineering mathematics			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEKOKJMSA2001-00</b>			<b>5. Term   role</b>	1/2   k
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>1 lecture</b>	<b>0 practice</b>	<b>1 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	28 hours	<b>Preparation for lessons</b>	32 hours	<b>Homework</b>	90 hours
<b>Reading written materials</b>	0 hours	<b>Midterm preparation</b>	0 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Control for Transport and Vehicle Systems				
<b>14. Subject coordinator and its position</b>	Dr. Varga Balázs research fellow	<b>15. Email address</b>	varga.balazs@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Control for Transport and Vehicle Systems				
<b>17. Instructor(s)</b>	Dr. Varga Balázs, Ormándi Tamás				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
The subject gives an introduction and tools to modelling and solving different problems in vehicle control engineering. The main topics covered are numerical errors, error propagation, numerical solution of differential equations and optimization.					
<b>20. Programme of lectures</b>					
<ol style="list-style-type: none"> <li>Numerical errors, error propagation, condition numbers</li> <li>Selected topics from matrix algebra (eigenvalues, eigenvectors, matrix decompositions, matrix inversion, pseudoinverse)</li> <li>Stability and convergence of numerical solutions of ordinary differential equations, A-stability of numerical algorithms, local and global errors, Euler and higher order methods</li> <li>Numerical solution of partial differential equations, discrete and semi-discrete solutions, Lax equivalence theorem, Courant, Friedrichs, and Lewy condition</li> <li>Introduction to optimization: cost functions and constraints – categorization and how to solve them.</li> <li>Multi-objective optimization, pareto front</li> </ol>					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
During the labs Matlab/Simulink and Python will be used.					
<ol style="list-style-type: none"> <li>Numerical precision, number representation errors in different programming languages</li> <li>Singular value decomposition, Principal component analysis</li> <li>Deep dive into Simulink's solvers</li> <li>PDE lab</li> <li>Optimization lab</li> <li>Pareto fronts, test functions</li> </ol>					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					

1. Knows how errors propagate through algorithms (T1,T4,T7)
  2. Knows the different types of numerical solvers and their stability regions (T1,T4,T5,T7,T15)
  3. Familiar with different types of cost functions and constraints (T1,T4,T5,T7)
- b) skills (k)**
1. Can model error propagation in numerical calculations (K1,K5)
  2. Identify the cause of instability in numerical methods (K1)
  3. Can formulate optimization problems and choose appropriate cost functions and constraints and implement them (K1,K3,K5,K15)
- c) attitude (a)**
1. Open to understanding how calculations are done with a computer (A1)
  2. Motivated to solve individual tasks in high quality (A2,A8)
- d) autonomy and responsibility (o)**
1. Can independently and responsibly model engineering problems and solve them with a computer.

#### 24. Midterm assessments

Name	Code	Share in final grade	Evaluated learning outcomes
1. Midterm test 1.	1. ZH1	1. 33%	1. t1,t2,t3,k1,k2,k3,a1,a2,o1
2. Midterm test 2.	2. ZH2	2. 33%	2. t1,t2,t3,k1,k2,k3,a1,a2,o1
3. Midterm test 3.	3. ZH3	3. 34%	3. t1,t2,t3,k1,k2,k3,a1,a2,o1

#### 25. Exams

Name	Code	Share in final grade	Evaluated learning outcomes
-	-	-	-

#### 26. Criteria to obtain a signature / midterm grade

Completing all midterm tests to a satisfactory level

#### 28. Attendance and participation requirements

according to the rules of CoS

#### 29. Retake and delayed completion

Second retake or delayed completion of one midterm is possible.

#### 27. Grading rules

Excellent 88-100%

Good 75-87%

Satisfactory 63-74%

Pass 50-62%

Fail 0-49%

#### 30. Consultation

Consultation is possible at a time and in a form agreed with the teacher.

#### 31. Learning materials

1. Gergó Lajos: Numerikus módszerek, ELTE Eötvös kiadó Kft, 2013
2. Bürgisser, Peter, and Felipe Cucker. Condition: The geometry of numerical algorithms. Vol. 349. Springer Science & Business Media, 2013
3. Butcher, John Charles. Numerical methods for ordinary differential equations. John Wiley & Sons, 2016.
4. Ames, William F. Numerical methods for partial differential equations. Academic press, 2014.
5. Chong, E. "An Introduction to Optimization." (2013).
6. Campi, Marco C., and Simone Garatti. "A sampling-and-discarding approach to chance-constrained optimization: feasibility and optimality." Journal of optimization theory and applications 148.2 (2011): 257-280.
7. Hwang, C-L., and Abu Syed Md Masud. Multiple objective decision making—methods and applications: a state-of-the-art survey. Vol. 164. Springer Science & Business Media, 2012.

#### 32. Start of validity for the subject description

September 1st, 2025



<b>1. Subject name</b>	<b>High-performance embedded computing</b>				
<b>2. Subject name in Hungarian</b>	High-performance embedded computing			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEVIAUMSXA018-00</b>			<b>5. Term   role</b>	1/2   k
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>e</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>1 practice</b>	<b>0 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	42 hours	<b>Preparation for lessons</b>	24 hours	<b>Homework</b>	0 hours
<b>Reading written materials</b>	16 hours	<b>Midterm preparation</b>	32 hours	<b>Exam preparation</b>	36 hours
<b>13. Organisational unit in charge</b>	Department of Automation and Applied Informatics (VIK)				
<b>14. Subject coordinator and its position</b>	Dr. Nagy Ákos senior lecturer	<b>15. Email address</b>	nagy.akos@aut.bme.hu		
<b>16. ...organisational unit</b>	Department of Automation and Applied Informatics (VIK)				
<b>17. Instructor(s)</b>	Dr. Nagy Ákos, Dr. Kiss Domokos, Kovács Viktor				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
<p>The course aims to provide a broad understanding of the architectures and building blocks of high-performance embedded computer systems. After analyzing traditional architectures, it presents modern solutions designed to increase performance, which include various options for parallelizing execution. It also discusses the characteristics of special architectures (e.g. GPGPU, FPGA) and compares them with each other. Students of the course become familiar with methods for increasing performance and reducing consumption. They deal in detail with the characteristics and operation of the bus systems (UART, I2C, SPI, CAN, USB) connecting parts of the control system, as well as the on-chip communication systems of SoC devices.</p>					
<b>20. Programme of lectures</b>					
<ol style="list-style-type: none"> <li>1. Review of basic concepts of computer architectures: instruction set architecture and microarchitecture, CISC and RISC processors.</li> <li>2. Concept of processor performance, Iron Law of Processor Performance. Performance measurement and possibilities of increasing performance. Amdahl's law.</li> <li>3. Fundamentals of pipelining. Ordinary and superscalar instruction pipeline. Interaction of instructions: RAW, WAW, WAR and control dependencies and their elimination, operand forwarding, register renaming, branch prediction.</li> <li>4. Types of superscalar organization: uniform, diversified and dynamic pipelines. Structure and operation of VLIW processors. Support of thread-level parallelism in microprocessors, temporal and simultaneous multithreading. Physical and logical processor cores.</li> <li>5. History of graphics processors, development, relationship between CPU and GPU, architectural support for 3D graphics tasks (rasterization, ray tracing), graphics pipeline. GPU memories, major GPU architectures. Non-graphics applications of GPUs, universal shaders.</li> <li>6. Features of AMD TeraScale and AMD GCN architectures. Programming GPUs, vertex and pixel shaders, compute shaders, OpenCL, CUDA. Architectural support for the application of neural networks.</li> <li>7. General features of the System-on-Chip (SoC) systems. Historical overview, System-on-Chip (SoC), Network-on-Chip (NoC), System-in-Package (SiP), Intellectual property (IP). RTL and HDL description. Overview of the Verilog language. FPGA-based SoC systems. Introduction to Xilinx 7th generation FPGA family.</li> <li>8. FPGA development process. CPU basic peripherals: Timer, PWM, Incremental encoders.</li> <li>9. CPU basic peripherals #2: GPIO, ADC.</li> <li>10. Serial communication interfaces: I2C, SPI, UART</li> <li>11. General characteristics of external interfaces. Overview of mechanical, electrical, logical characteristics. CAN interface.</li> <li>12. Universal Serial Bus (USB). General characteristics and system architecture. Electrical and logical characteristics. Thunderbolt interface. Software properties and requirements: USB classes and descriptors, libusb.</li> <li>13. Soft and Hard CPU cores, Xilinx MicroBlaze Soft CPU, Xilinx Zynq SoC. On-chip communication buses. Introduction to the ARM AMBA bus family: APB, AHB and AXI buses, AXI4-Stream and AXI4-Lite solutions.</li> </ol>					
<b>21. Programme of practices</b>					
The theoretical material presented in the lectures is deepened in the form of examples and case studies:					

1. Examination of the operation of instruction pipelines on the example of a typical five-phase RISC pipeline
2. Practical impact of dependencies in the superscalar pipeline. Case study: implementation of dynamic instruction pipeline and simultaneous multithreading in Intel's modern superscalar microarchitectures.
3. Examination of OpenCL host and kernel codes
4. Practical problems and solutions of serial communication. Message Authentication Code (MAC) generation. Message framing.
5. FPGA development process. Xilinx Vivado IDE, IP-based design approach.
6. Xilinx Zynq PSoc case study: camera interface, different options for implementing image processing.
7. Nvidia Jetson case study: general introduction. Neural network inference capability. Image processing examples.

## 22. Programme of laboratories

-

## 23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)

The student

### a) knowledge (t)

1. knows modern processor architectures, (T1,T5,T11)
2. is familiar with modern microcontroller interfaces and bus networks (T1,T5,T11)
3. knows the programmable logic tools (T1,T5,T11)
4. knows integrated and embedded systems (T1,T5,T11)

### b) skills (k)

1. is able to select a system with the right performance, consumption and proper interfaces for a given task, (K1,K12)
2. can design and implement communication structures on microcontrollers, (K4,K7)
3. can design and implement simple functions in a microcontroller environment (K4,K7,K12)

### c) attitude (a)

1. open to new processor technologies and communication interfaces,
2. endeavor to select the appropriate tools and program design at a high level (A8)

### d) autonomy and responsibility (o)

1. independently learn how to operate, develop and program an unknown processor family,
2. is able to view, test and improve software implemented by others

## 24. Midterm assessments

Name	Code	Share in final grade	Evaluated learning outcomes
1. midterm test	1. ZH	1. 30%	1. t1-t4,k1-k3,a1,a2,o1,o2

## 25. Exams

Name	Code	Share in final grade	Evaluated learning outcomes
1. written exam	1. IRV	1. 70%	1. t1-t4,k1-k3,a1,a2,o1,o2

## 26. Criteria to obtain a signature / midterm grade

A comprehensive and detailed overview of knowledge is measured once during the lecture term with an in-class term test. The condition for obtaining the signature is to attend at the in-class term test and have at least pass (minimum 40%) result. The condition for being admitted to the exam is the presence of the signature.

## 28. Attendance and participation requirements

according to the rules of CoS

## 29. Retake and delayed completion

The midterm test can be repeated once during the semester and once during the repeat period in accordance with the Code of Studies and Exams (CoS). The possibility of a second replacement can only be provided in justified cases, after individual consultation.

## 27. Grading rules

0-39%: fail  
 40-54%: pass  
 55-69%: satisfactory  
 70-84%: good  
 85-100%: excellent

## 30. Consultation

Upon request, appointed with the lecturer.

## 31. Learning materials

The presentation slides are shared with the students attending the course. These contain all the material needed to prepare for the tests. Further literature:

Nicholas Carter: Schaum's Outline of Computer Architecture. McGraw-Hill, 2002. ISBN 0-07-136207-X

Kai Hwang: Advanced Computer Architecture. Parallelism, Scalability, Programmability. McGraw-Hill, 1993. ISBN 0-07-031622-8

J. P. Shen, M. H. Lipasti: Modern Processor Design: Fundamentals of Superscalar Processors. Waveland Press, 2013. ISBN 9781478610762

M. Paolo: Scalable System-on-Chip Design, Columbia University, 2017.

S. Pasricha és N. Dutt: On-Chip Communication Architectures (System on Chip Interconnect), Morgan Kaufmann, 2008.

Gál T.: Interfésztechnikák. SZAK Kiadó, 2010. (Hungarian)

Gál T., Tevesz G., Kiss D., Nagy Á., Kovács V.: Nagyteljesítményű mikrokontrollerek és interfészek (Electronics textbook – in Hungarian). BME AUT, 2025

**32. Start of validity for the subject description**

September 1st, 2025



<b>1. Subject name</b>	<b>Human factors in traffic environment</b>				
<b>2. Subject name in Hungarian</b>	Human factors in traffic environment		<b>3. Programme</b>	A	
<b>4. Subject code</b>	<b>BMETEKTMsKETKK-00</b>		<b>5. Term   role</b>	4/3   k	
<b>6. Credits</b>	<b>3</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>0 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>	<b>90 hours</b>				
<b>Contact hours</b>	28 hours	<b>Preparation for lessons</b>	16 hours	<b>Homework</b>	46 hours
<b>Reading written materials</b>	0 hours	<b>Midterm preparation</b>	0 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Cognitive Science (TTK)				
<b>14. Subject coordinator and its position</b>	Dr Babarczy Anna associate professor	<b>15. Email address</b>	babarczy.anna@ttk.bme.hu		
<b>16. ...organisational unit</b>	Department of Cognitive Science				
<b>17. Instructor(s)</b>	Dr Babarczy Anna, Dr Lukics Krisztina				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>	The course discusses human factors involved in transport.				
<b>20. Programme of lectures</b>	<p>Overview of human risk factors, basic concepts of transport, research methodology of vehicle driving behavior and description of its models. Overview of human vision, visual attention and search processes, in particular the increased cognitive load resulting from parallel processing. Human-specific aspects of spatial navigation. Factors permanently influencing information processing and decision-making mechanisms, eg. age and experience, personality traits, circumstance evaluation, driving style, and factors with a temporary effect, eg. substance abuse, distraction stimuli, tools, and tiredness psychological mechanisms. Analysis of psychological causes of traffic accidents, direct and indirect human factors in accidents. The possibility of reducing the risk of accidents in human-machine interactions, avoidance, precautionary measures, and psychological aspects of safe driving. An overview of safety-relevant psychological studies.</p>				
<b>21. Programme of practices</b>	-				
<b>22. Programme of laboratories</b>	-				
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>	<p>The student</p> <p><b>a) knowledge (t)</b></p> <ol style="list-style-type: none"> <li>1. Knows the basic human psychological concepts relevant to road traffic. (T1)</li> <li>2. Is familiar with the methodology and models of human-machine interactions, especially human behavior-related behavioral behavior. (T5)</li> <li>3. Knows the relevant physiological and psychophysical qualities and laws of human vision. (T6)</li> <li>4. Possesses basic psychological knowledge of attention. (T2)</li> <li>5. Is familiar with the human-specific psychological factors that are related or fundamentally affect the evaluation and decision-making mechanisms while driving. (T9)</li> <li>6. Knows the human psychological qualities that are decisive for behavior even in the social sphere, if we are part of the transport. (T6)</li> <li>7. Is familiar with the behavioral characteristics of other human agents involved in transport (not just the driver), their impact on road safety. (T8)</li> <li>8. Is familiar with the human aspects of basic traffic safety principles and the human-specific background factors of traffic accidents. (T6)</li> </ol> <p><b>b) skills (k)</b></p>				

1. In engineering, always keeps in mind that the device/system you are working with will work under the partial/full control of another person whose innumerable predictable and even more unknown parameters may affect the use of the device and the effectiveness of the device. (K1)
2. Is able to use the psychological literature of human-machine interactions with the appropriate expertise and critical. (K8)
3. Is able to design a human experimental methodology that may be relevant in its engineering field, to design the experimental design. (K8)
4. Uses sophisticated human-specific psychological knowledge when designing and testing operational processes and tools. (K8)

**c) attitude (a)**

1. Strives for a better understanding of the human factors relevant to transport, especially driving, researching and researching new solutions. (A8)
2. Open to a human approach to the problems and tasks raised by new systems. (A5)

**d) autonomy and responsibility (o)**

1. Makes decisions carefully and responsibly, considering human, environmental and legal aspects. (O2, O3, O4)

**24. Midterm assessments**

Name	Code	Share in final grade	Evaluated learning outcomes
1. project assignment	1. PF	1. 85%	1. t1,t2,t3,t4,t5,t6,t7,t8,k1,k2,k3,k4,a1,a2
2. project result presentation	2. EA	2. 15%	2. a1,a2

**25. Exams**

Name	Code	Share in final grade	Evaluated learning outcomes
-	-	-	-

**26. Criteria to obtain a signature / midterm grade**

A research project involving data collection completed in groups. Presentation of the project and the results.

**28. Attendance and participation requirements**

according to the rules of CoS

**29. Retake and delayed completion**

Make-up research project and presentation during the delayed completion week.

**27. Grading rules**

0%-49%: fail; 50%-60%: pass; 61%-70%: satisfactory; 71-80%: good; 81%-100%: excellent

**30. Consultation**

Consultation is possible at a time and in a form agreed with the teacher.



**31. Learning materials**

Campbell et al. (2012). Human Factors Guidelines for Road Systems (2nd ed.), TRB, Washington, ISBN 978-0-309-25816-6  
 Castro, C. (2009). HUMAN FACTORS OF VISUAL AND COGNITIVE PERFORMANCE IN DRIVING. CRC Press, FL, ISBN 13: 978-1-4200-5530-6  
 Fuller, R., & Santos, J.A. (2002). HUMAN FACTORS FOR HIGHWAY ENGINEERS, PERGAMON, ISBN-13: 978-0080434124  
 Shinar D., (2007). Traffic Safety and Human Behavior, Elsevier, ISBN: 978-0-08-045029-2

**32. Start of validity for the subject description**



September 1st, 2025



<b>1. Subject name</b>	<b>Independent engineering lab 1.</b>				
<b>2. Subject name in Hungarian</b>	Independent engineering lab 1.		<b>3. Programme</b>	A	
<b>4. Subject code</b>	<b>BMEKOGJMSA1001-00</b>		<b>5. Term   role</b>	1   k	
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>0 lecture</b>	<b>0 practice</b>	<b>4 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>	 				
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	56 hours	<b>Preparation for lessons</b>	0 hours	<b>Homework</b>	94 hours
<b>Reading written materials</b>	0 hours	<b>Midterm preparation</b>	0 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Control for Transport and Vehicle Systems				
<b>14. Subject coordinator and its position</b>	Dr. Aradi Szilárd associate professor	<b>15. Email address</b>	aradi.szilard@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Control for Transportation and Vehicle Systems				
<b>17. Instructor(s)</b>	Dr. Aradi Szilárd, Dr. Bécsi Tamás, Dr. Fehér Árpád				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
<p>The aim of the course is to apply the knowledge gained from the previous courses through the elaboration of an individual or group project. This is carried out by the student with the support and supervision of a teacher. The students cover the entire development cycle of the assignment over two semesters.</p> <p>The steps in the first semester of the course series are as follows:</p> <ul style="list-style-type: none"> <li>- Getting to know the problem, during which the task is to explore the assigned topic and learn about existing solutions and methods.</li> <li>- Finalizing the assignment, creating a specification, choosing a project schedule and platform.</li> <li>- Optionally, starting the development.</li> </ul>					
<b>20. Programme of lectures</b>					
-					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
During the lab exercises, the task is to consult with the instructor and check the progress.					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
-					
<b>b) skills (k)</b>					
1. Is able to break down a project task into elements based on a specification. (K3)					
2. Is able to find the technologies needed to solve the task and analyze and compare them. (K3)					
3. Is able to plan a development process. (K11,K15)					
<b>c) attitude (a)</b>					
1. Is open to independently exploring possible solutions to a technical problem. (A1-A3,A6-A8)					
<b>d) autonomy and responsibility (o)</b>					
1. Is able to work responsibly in a team to design an autonomous vehicle function. (O2)					
1. is able to make responsible decisions during the specification and design phases of a development project. (O1,O3,O4)					
<b>24. Midterm assessments</b>					
<b>Name</b>		<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>	



1. project assignment	1. PF	1. 100%	1. k1-k3,a1,o1,o2
<b>25. Exams</b>			
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>
-	-	-	-
<b>26. Criteria to obtain a signature / midterm grade</b>			<b>27. Grading rules</b>
Completion of the project assignment.			0%-49%: fail; 50%-60%: pass; 61%-70%: satisfactory; 71-80%: good; 81%-100%: excellent
<b>28. Attendance and participation requirements</b>			
Participation in the labs is mandatory.			
<b>29. Retake and delayed completion</b>			
Project assignment submission is possible until the end of the delayed completion period.			
<b>30. Consultation</b>			
Consultation is possible during the lab exercises.			
<b>31. Learning materials</b>			
online available scientific literature			
<b>32. Start of validity for the subject description</b>			
September 1st, 2025			



<b>1. Subject name</b>	<b>Independent engineering lab 1.</b>				
<b>2. Subject name in Hungarian</b>	Independent engineering lab 1.			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEKOKJMSA1001-00</b>			<b>5. Term   role</b>	1   k
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>0 lecture</b>	<b>0 practice</b>	<b>4 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>	 				
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	56 hours	<b>Preparation for lessons</b>	0 hours	<b>Homework</b>	94 hours
<b>Reading written materials</b>	0 hours	<b>Midterm preparation</b>	0 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Automotive Technologies				
<b>14. Subject coordinator and its position</b>	Dr. Szalay Zsolt associate professor	<b>15. Email address</b>	szalay.zsolt@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Automotive Technologies				
<b>17. Instructor(s)</b>	Dr. Szalay Zsolt				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
<p>The aim of the course is to apply the knowledge gained from the previous courses through the elaboration of an individual or group project. This is carried out by the student with the support and supervision of a teacher. The students cover the entire development cycle of the assignment over two semesters.</p> <p>The steps in the first semester of the course series are as follows:</p> <ul style="list-style-type: none"> <li>- Getting to know the problem, during which the task is to explore the assigned topic and learn about existing solutions and methods.</li> <li>- Finalizing the assignment, creating a specification, choosing a project schedule and platform.</li> <li>- Optionally, starting the development.</li> </ul>					
<b>20. Programme of lectures</b>					
-					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
During the lab exercises, the task is to consult with the instructor and check the progress.					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
-					
<b>b) skills (k)</b>					
1. Is able to break down a project task into elements based on a specification. (K3)					
2. Is able to find the technologies needed to solve the task and analyze and compare them. (K3)					
3. Is able to plan a development process. (K11,K15)					
<b>c) attitude (a)</b>					
1. Is open to independently exploring possible solutions to a technical problem. (A1-A3,A6-A8)					
<b>d) autonomy and responsibility (o)</b>					
1. Is able to work responsibly in a team to design an autonomous vehicle function. (O2)					
1. is able to make responsible decisions during the specification and design phases of a development project. (O1,O3,O4)					
<b>24. Midterm assessments</b>					
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>		



1. project assignment	1. PF	1. 100%	1. k1-k3,a1,o1,o2
<b>25. Exams</b>			
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>
-	-	-	-
<b>26. Criteria to obtain a signature / midterm grade</b>			<b>27. Grading rules</b>
Completion of the project assignment.			0%-49%: fail; 50%-60%: pass; 61%-70%: satisfactory; 71-80%: good; 81%-100%: excellent
<b>28. Attendance and participation requirements</b>			
Participation in the labs is mandatory.			
<b>29. Retake and delayed completion</b>			
Project assignment submission is possible until the end of the delayed completion period.			
<b>30. Consultation</b>			
Consultation is possible during the lab exercises.			
<b>31. Learning materials</b>			
online available scientific literature			
<b>32. Start of validity for the subject description</b>			
September 1st, 2025			



<b>1. Subject name</b>	<b>Independent engineering lab 2.</b>				
<b>2. Subject name in Hungarian</b>	Independent engineering lab 2.		<b>3. Programme</b>	A	
<b>4. Subject code</b>	<b>BMEKOKJMSA3001-00</b>		<b>5. Term   role</b>	2   k	
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>0 lecture</b>	<b>0 practice</b>	<b>4 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>	 				
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	56 hours	<b>Preparation for lessons</b>	0 hours	<b>Homework</b>	94 hours
<b>Reading written materials</b>	0 hours	<b>Midterm preparation</b>	0 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Control for Transport and Vehicle Systems				
<b>14. Subject coordinator and its position</b>	Dr. Aradi Szilárd associate professor	<b>15. Email address</b>	aradi.szilard@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Control for Transportation and Vehicle Systems				
<b>17. Instructor(s)</b>	Dr. Aradi Szilárd, Dr. Bécsi Tamás, Dr. Fehér Árpád				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
<p>The aim of the course is to apply the knowledge gained from the previous courses through the elaboration of an individual or group project. This is carried out by the student with the support and supervision of a teacher. The students cover the entire development cycle of the assignment over two semesters.</p> <p>The steps in the first semester of the course series are as follows:</p> <ul style="list-style-type: none"> <li>- Development.</li> <li>- Testing, verification and validation.</li> <li>- Documentation and presentation, during which the student prepares documentation of the entire development process and gives a presentation on the completed task.</li> </ul>					
<b>20. Programme of lectures</b>					
-					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
During the lab exercises, the task is to consult with the instructor and check the progress.					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
-					
<b>b) skills (k)</b>					
1. Is able to follow and document a development process (K11)					
2. Is able to synthesize and use previously acquired knowledge to solve a development task. (K3,K15)					
3. Is able to present the results in a clear manner to experts in the field within the prescribed time frame. (K11)					
<b>c) attitude (a)</b>					
1. Is open to carrying out development tasks independently. (A1-A3,A6-A8)					
<b>d) autonomy and responsibility (o)</b>					
1. Is able to make responsible decisions during the development and documentation phases of a development project. (O1-O4)					
<b>24. Midterm assessments</b>					
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>		
1. project assignment	1. PF	1. 100%	1. k1-k3,a1,o1		


<b>25. Exams</b>			
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>
-	-	-	-
<b>26. Criteria to obtain a signature / midterm grade</b>			<b>27. Grading rules</b>
Completion of the project assignment.			0%-49%: fail; 50%-60%: pass; 61%-70%: satisfactory; 71-80%: good; 81%-100%: excellent
<b>28. Attendance and participation requirements</b>			
Participation in the labs is mandatory.			
<b>29. Retake and delayed completion</b>			
Project assignment submission is possible until the end of the delayed completion period.			
<b>30. Consultation</b>			
Consultation is possible during the lab exercises.			
<b>31. Learning materials</b>			
online available scientific literature			
<b>32. Start of validity for the subject description</b>			
September 1st, 2025			



<b>1. Subject name</b>	<b>Independent engineering lab 2.</b>				
<b>2. Subject name in Hungarian</b>	Independent engineering lab 2.		<b>3. Programme</b>	A	
<b>4. Subject code</b>	<b>BMEKOGJMSA2001-00</b>		<b>5. Term   role</b>	2   k	
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>0 lecture</b>	<b>0 practice</b>	<b>4 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>	 				
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	56 hours	<b>Preparation for lessons</b>	0 hours	<b>Homework</b>	94 hours
<b>Reading written materials</b>	0 hours	<b>Midterm preparation</b>	0 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Automotive Technologies				
<b>14. Subject coordinator and its position</b>	Dr. Szalay Zsolt associate professor	<b>15. Email address</b>	szalay.zsolt@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Automotive Technologies				
<b>17. Instructor(s)</b>	Dr. Szalay Zsolt				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
<p>The aim of the course is to apply the knowledge gained from the previous courses through the elaboration of an individual or group project. This is carried out by the student with the support and supervision of a teacher. The students cover the entire development cycle of the assignment over two semesters.</p> <p>The steps in the first semester of the course series are as follows:</p> <ul style="list-style-type: none"> <li>- Development.</li> <li>- Testing, verification and validation.</li> <li>- Documentation and presentation, during which the student prepares documentation of the entire development process and gives a presentation on the completed task.</li> </ul>					
<b>20. Programme of lectures</b>					
-					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
During the lab exercises, the task is to consult with the instructor and check the progress.					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
-					
<b>b) skills (k)</b>					
1. Is able to follow and document a development process (K11)					
2. Is able to synthesize and use previously acquired knowledge to solve a development task. (K3,K15)					
3. Is able to present the results in a clear manner to experts in the field within the prescribed time frame. (K11)					
<b>c) attitude (a)</b>					
1. Is open to carrying out development tasks independently. (A1-A3,A6-A8)					
<b>d) autonomy and responsibility (o)</b>					
1. Is able to make responsible decisions during the development and documentation phases of a development project. (O1-O4)					
<b>24. Midterm assessments</b>					
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>		
1. project assignment	1. PF	1. 100%	1. k1-k3,a1,o1		

<b>25. Exams</b>			
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>
-	-	-	-
<b>26. Criteria to obtain a signature / midterm grade</b>			<b>27. Grading rules</b>
Completion of the project assignment.			0%-49%: fail; 50%-60%: pass; 61%-70%: satisfactory; 71-80%: good; 81%-100%: excellent
<b>28. Attendance and participation requirements</b>			
Participation in the labs is mandatory.			
<b>29. Retake and delayed completion</b>			
Project assignment submission is possible until the end of the delayed completion period.			
<b>30. Consultation</b>			
Consultation is possible during the lab exercises.			
<b>31. Learning materials</b>			
online available scientific literature			
<b>32. Start of validity for the subject description</b>			
September 1st, 2025			



<b>1. Subject name</b>	<b>Legal framework of autonomous vehicles</b>				
<b>2. Subject name in Hungarian</b>	Legal framework of autonomous vehicles			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEGT55MSM4000-00</b>			<b>5. Term   role</b>	4/3   k
<b>6. Credits</b>	<b>3</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>0 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>90 hours</b>
<b>Contact hours</b>	28 hours	<b>Preparation for lessons</b>	0 hours	<b>Homework</b>	0 hours
<b>Reading written materials</b>	38 hours	<b>Midterm preparation</b>	24 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Business Law (GTK)				
<b>14. Subject coordinator and its position</b>	Dr. Grad-Gyenge Anikó associate professor	<b>15. Email address</b>	grad-gyenge.aniko@gtk.bme.hu		
<b>16. ...organisational unit</b>	Department of Business Law (GTK)				
<b>17. Instructor(s)</b>	Dr. Grad-Gyenge Anikó				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
The objective of the course is to present the basic issues of the legal regulatory environment related to the operation of autonomous vehicles, the baseline of related regulatory trends, the present and possible future perspectives of the legal environment.					
<b>20. Programme of lectures</b>					
Autonomous vehicles in the current legal environment in particular:					
(a) administrative and private law issues (autonomous vehicle regulation in public and private law, administrative and private law framework, vehicle registration, hazardous operation, liability for damages, product liability, warranty issues, contractual forms of risk management - insurance liability insurance, software law issues.					
b) data protection and data security issues					
c) criminal law implications.					
Among the possible future directions for the legal regulation of autonomous vehicles in particular:					
a) types and definition of autonomous vehicles from a legal point of view - minimum requirements technical compliance standards					
b) the different possible uses of autonomous vehicles and their possible impact on the law					
c) legal problems of the human-machine interface; new requirements for the human element					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
-					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
1. knows the basic directions of the autonomous regulatory environment of autonomous vehicles (T1,T2,T5-T9,T16)					
2. knows the basic administrative requirements of the legal environment (T1,T2,T5-T9,T16)					
3. is familiar with the fundamental private law (liability and contract law) related to autonomous vehicles (T1,T2,T5-T9,T16)					
4. is familiar with the fundamental data-law context of autonomous vehicles (T1,T2,T5-T9,T16)					
5. is familiar with the fundamental criminal relations related to autonomous vehicles (T1,T2,T5-T9,T16)					
<b>b) skills (k)</b>					
1. be able to navigate the regulatory context of autonomous vehicles, identify the main directions of the current legal environment (K1,K8)					
2. is able to identify legal issues related to autonomous vehicles and to identify possible relationships (K1,K8)					
<b>c) attitude (a)</b>					

1. endeavor to take account of the legal context of autonomous vehicles, to identify legal risks and to determine compliance points for normative subsystems (A2,A8)
2. open to regulatory approaches to problems and tasks raised by new systems (A2,A8)
3. is able to perform the assigned tasks in a team (A2,A8)

**d) autonomy and responsibility (o)**

1. Is able to independently model a related legal problem (O2-O4)
2. is responsible for performing a legal analysis, taking into account the basic questions of the regulatory environment (O2-O4)
3. in the performance of its tasks, strives for technical activity that meets the normative requirements (O2-O4)

**24. Midterm assessments**

Name	Code	Share in final grade	Evaluated learning outcomes
1. midterm test	1. ZH	1. 50%	1. t1-t5,k1,k2,a1-a3,o1-o3
2. midterm test	2. ZH	2. 50%	2. t1-t5,k1,k2,a1-a3,o1-o3

**25. Exams**

Name	Code	Share in final grade	Evaluated learning outcomes
-	-	-	-

**26. Criteria to obtain a signature / midterm grade**

Successful completion of two midterm test.

**28. Attendance and participation requirements**

according to the rules of CoS

**29. Retake and delayed completion**

Both midterm exams can be retried once.

**27. Grading rules**

Excellent 88-100%  
 Good 75-87%  
 Satisfactory 63-74%  
 Pass 50-62%  
 Fail 0-49%

**30. Consultation**

At a time and in a manner agreed upon with the instructor

**31. Learning materials**

Lecture Notes

Verebics János – Pétervári Kinga – Pázmándi Kinga: Law of Contracts (in Hungarian) (Budapest, February 2018)


Pétervári Kinga-Pázmándi Kinga - Zódi Zsolt: Autonóm járművek jogi keretei (in Hungarian) note, February 2018)

Pétervári Kinga: A kereskedelmi szerződések joga (in Hungarian) (Typotex, 2015)

**32. Start of validity for the subject description**

September 1st, 2025



<b>1. Subject name</b>	<b>Localization and mapping</b>				
<b>2. Subject name in Hungarian</b>	Localization and mapping			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEEOFTMSVK001-00</b>			<b>5. Term   role</b>	2/1   k
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>2 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	56 hours	<b>Preparation for lessons</b>	11 hours	<b>Homework</b>	30 hours
<b>Reading written materials</b>	31 hours	<b>Midterm preparation</b>	22 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Photogrammetry and Geoinformatics (ÉMK)				
<b>14. Subject coordinator and its position</b>	Dr. Barsi Árpád professor	<b>15. Email address</b>	barasi.arpad@emk.bme.hu		
<b>16. ...organisational unit</b>	Department of Photogrammetry and Geoinformatics (ÉMK)				
<b>17. Instructor(s)</b>	Dr. Barsi Árpád				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
<p>Goal of the subject is to present the basics of positioning and localization, the map making procedure, the requirements against the maps, as well as the use of maps. During the semester the surveying methods, the basics of geoinformatics (GIS) and the modern map making is demonstrated. The students get knowledge about positioning and its accuracy measures by own conducted measurements. The latest map standards, the newest research results and the future trends are also presented.</p>					
<b>20. Programme of lectures</b>					
<p>Semester requirements. History, grouping and goals of geodesy, surveying and cartography. Basic terms          Figure of the Earth and its approximations. Measurement methods. Reference surfaces and their fitting          Map projection systems, map series          Surveying methods, map making techniques, photogrammetry, map update          Groups of positioning methods, basics of global positioning          Satellite based positioning: basics, measurement methods, instruments, corrections, software          Augmentation system for global positioning methods, instruments, error sources, accuracy measures          Terrestrial positioning techniques, indoor solutions, instruments, accuracy measures          Navigation: basics, methods, map matching          Geoinformatics (GIS): systems, standards, data bases, analyzing possibilities, visualizations          Online GIS, crowd-sourcing in GIS, web cartography, change detection, HD map, SLAM          Map as a database, update, query, data exchange, LDM</p>					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
<p>Individual laboratory measurements are performed by the students using different positioning tools, and after processing their measurement results, mapping is performed. Laboratory measurements include the evaluation of the results acquired and the determination of their accuracy characteristics.</p>					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
1. knows the introductory basics of cartography, (T1,T4-T9,T11)					
2. know the common positioning technology, (T1,T4-T9,T11)					
3. knows the principles of satellite positioning, (T1,T4-T9,T11)					
4. knows the basic principles of navigation (T1,T4-T9,T11)					

**b) skills (k)**

1. is able to perform measurements with various positioning devices and evaluate them, (K1,K3-K5,K7,K8,K12,K13)
2. is able to use mapping method from positioning data (K1,K3-K5,K7,K8,K12,K13)

**c) attitude (a)**

1. open to new mapping and positioning methods (A1,A2,A8)
2. open for use in positioning in technical tasks (A1,A2,A8)

**d) autonomy and responsibility (o)**

-

**24. Midterm assessments**

Name	Code	Share in final grade	Evaluated learning outcomes
1. midterm test	1. ZH	1. 35%	1. t1-t4,k1,k2,a1,a2
2. midterm test	2. ZH	2. 35%	2. t1-t4,k1,k2,a1,a2
3. individual homework	3. EF	3. 30%	3. t1-t4,k1,k2,a1,a2

**25. Exams**

Name	Code	Share in final grade	Evaluated learning outcomes
-	-	-	-

**26. Criteria to obtain a signature / midterm grade**

Passing the two midterm tests and completing the individual homework.

**28. Attendance and participation requirements**

according to the rules of CoS

**29. Retake and delayed completion**

One midterm test can be retaken, final deadline for the homework is the end of the delayed completion week.

**27. Grading rules**

Excellent 88-100%  
 Good 75-87%  
 Satisfactory 63-74%  
 Pass 50-62%  
 Fail 0-49%

**30. Consultation**

At a time and in a manner agreed upon with the instructor

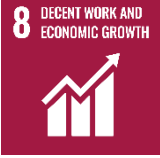

**31. Learning materials**

The lecture notes are available in the form of Powerpoint presentations, including recommended reading.

**32. Start of validity for the subject description**

September 1st, 2025



<b>1. Subject name</b>	<b>Project management</b>				
<b>2. Subject name in Hungarian</b>	Project management			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEGT20BS46000-00</b>			<b>5. Term   role</b>	3/4   k
<b>6. Credits</b>	<b>3</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>0 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>	 				
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>90 hours</b>
<b>Contact hours</b>	28 hours	<b>Preparation for lessons</b>	0 hours	<b>Homework</b>	30 hours
<b>Reading written materials</b>	12 hours	<b>Midterm preparation</b>	20 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Management and Business Economics (GTK)				
<b>14. Subject coordinator and its position</b>	Dr. Sebestyén Zoltán associate professor		<b>15. Email address</b>	sebestyen.zoltan@gtk.bme.hu	
<b>16. ...organisational unit</b>	Department of Management and Business Economics				
<b>17. Instructor(s)</b>	Dr. Sebestyén Zoltán				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
The course introduces students to project management terminology, basic tools and techniques. The curriculum briefly summarizes the knowledge necessary to manage a project within the framework of the subject in a structured way. The course also emphasizes practical solutions.					
<b>20. Programme of lectures</b>					
1 Characteristics of project phases, relationship between the project life cycle and the product life cycle. 2 Processes, process groups. 3 Project Success. 4 Main documents: project definition document, preliminary project scope description, project management plan. 5 Life cycle analysis. 6 Participants, roles. 7 Organizational issues: personnel management plan, organizational forms, human resource planning tools. 8 Network-based planning: basics of graph theory, work breakdown structure, dependency definition, predecessor and successor activity lists, drawing and analysis of networks. 9 CPM 10 PERT 11 MPM 12 Estimation: errors, rules, accuracy, three levels, general techniques. 13 Resources: load, S-curve, resource allocation. 14 Tracking: EVM, ES. 15 Risk: qualitative and quantitative risk analysis. 16 Contract types. 17 Tendering. 18 Project portfolio management: definition, steps, ranking.					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
-					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					

1. Know all the important elements of the project management concept.
2. Know and understand the organization and operation procedures of the technical processes in the field. (T16)
3. Understand the connections between the areas of corporate operation and project management. (T10)
4. Have an overview of the corporate processes in the field and the possible application of the methods of the field. (T2)
5. Have confident methodological knowledge in various areas of project management, see and understand their application possibilities and perspectives. (T5)
6. Are familiar with the most basic graph-theoretic algorithms for management purposes and their solution procedure. (T5)
7. Know the most important monitoring techniques.
8. Understand how a prevalent project management software works. (T16)

**b) skills (k)**

1. Are able to synthesize the basic theories and concepts of project management, to formulate rational arguments, to form and defend one's opinion during discussions in different fields of project communication. (K6,K16,K17)
2. Are able to manage, organize, control and coordinate the development of technical, technological, investment, manufacturing, logistics, quality assurance and IT processes. (K3,K10,K14)
3. In the course of their professional vocabulary, they confidently use the vocabulary of the project management profession, the basic scientific concepts of the profession and the elements of the special vocabulary based on them. (K17)
4. Are able to formulate network analysis as a linear programming problem.
5. Can perform a comprehensive analysis using standard monitoring techniques (e.g. EVM). (K13)
6. Can plan a project using project management software.

**c) attitude (a)**

1. Are critical of their own work and the work of their subordinates, they are innovative and proactive in dealing with economic problems. Are open and inclusive to new advances in economics and practice. (A2,A5,A8)
2. Strive to improve its knowledge and working relationships, and encourages, helps and supports its employees and subordinates. (A3,A4,A7)

**d) autonomy and responsibility (o)**

1. Independently select and apply the relevant problem-solving methods in areas of organizational policy, strategy and management.
2. Take responsibility for its own work, the organization it manages, its business, and its employees. (O5)
3. Perform economic analysis, decision preparation and consulting tasks independently.
4. Involve in research and development projects, mobilize their theoretical and practical knowledge and skills in the project group in an autonomous way, in cooperation with the other members of the group. (O5)

**24. Midterm assessments**

Name	Code	Share in final grade	Evaluated learning outcomes
1. partial performance measurement (assignment, case study)	1. CS	1. 10%	1. k1,k2,k3,k4,k5,k6,a1,o1,o2,o3
2. classroom activity	2. CA	2. 10%	2. k1,k3,a2,o2,o4
3. 1. summary performance measurement	3. SPM1	3. 40%	3. t1,t2,t3,t4,k3
4. 2. summary performance measurement	4. SPM2	4. 40%	4. t5,t6,t7,t8,k3

**25. Exams**

Name	Code	Share in final grade	Evaluated learning outcomes
-	-	-	-

**26. Criteria to obtain a signature / midterm grade**

Successful completion of two midterm test.

**28. Attendance and participation requirements**

Based on the Code of Studies

**29. Retake and delayed completion**

Both midterm test and the case study can be retried once.

**30. Consultation**

At a time and in a form agreed with the teacher.

**31. Learning materials**

Sebestyén Z.: Projekt management (in Hungarian), handout, 2018

Other materials released by the lecturer (download from: <https://edu.gtk.bme.hu>)

**32. Start of validity for the subject description**

September 1st, 2025

**27. Grading rules**

Excellent 95%-

Very good 90–94%

Good 75–89%

Satisfactory 60–74%

Pass 50–59%

Fail 0-49%



<b>1. Subject name</b>	<b>Safety and reliability in vehicle industry</b>				
<b>2. Subject name in Hungarian</b>	Safety and reliability in vehicle industry			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEKOKJMSA3003-00</b>			<b>5. Term   role</b>	3/4   k
<b>6. Credits</b>	<b>3</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>0 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>90 hours</b>
<b>Contact hours</b>	28 hours	<b>Preparation for lessons</b>	20 hours	<b>Homework</b>	0 hours
<b>Reading written materials</b>	14 hours	<b>Midterm preparation</b>	28 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Control for Transport and Vehicle Systems				
<b>14. Subject coordinator and its position</b>	Dr. Bécsi Tamás associate professor	<b>15. Email address</b>	becsi.tamas@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Control for Transport and Vehicle Systems				
<b>17. Instructor(s)</b>	Dr. Bécsi Tamás, Dr. Török Árpád				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
<p>The course aims to provide students with a comprehensive overview of safety and reliability analysis methods used in the automotive industry and to familiarize them with the relevant standards, with particular emphasis on ISO 26262. The objective is also to equip students with the theoretical and practical foundations necessary for hazard and risk analysis and the development of safety-critical systems.</p>					
<b>20. Programme of lectures</b>					
<p>This course provides an overview of the fundamental principles, methods, and regulations of safety and reliability in the automotive industry. Students will explore the development processes of safety-critical systems, commonly used hazard and risk analysis techniques (e.g., FMEA, FTA, HAZOP), and the basics of reliability modeling. Special emphasis is placed on the ISO 26262 standard and its practical applications. Through real-world examples, students will be introduced to safety architectures, reliability parameters, and the definition of safety goals.</p>					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
-					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
1. Knows the main guidelines of the ISO 26262 standard applied in the automotive industry, as well as the basic concepts of safety technology. (T6)					
2. Knows the conceptual framework of safety and reliability, methods of hazard analysis and risk analysis, and their application possibilities. (T3,T5)					
3. Knows the development methods of safety-critical systems, safety architectures, and numerical characteristics and calculation procedures of reliability. (T8,T9)					
<b>b) skills (k)</b>					
1. Able to perform safety calculations and risk analysis tasks based on a given specification. (K2,K8)					
2. Able to design the reliability and safety of complex systems, using a systems approach. (K13)					
<b>c) attitude (a)</b>					
1. Strive to think from a systems perspective in their professional work and are interested in the safety and risk issues of autonomous vehicles. (A2,A6,A8)					
<b>d) autonomy and responsibility (o)</b>					

1. Performs his/her work independently and responsibly, taking into account the relevant legal, ethical and safety regulations. (O2,O3,O4)

#### 24. Midterm assessments

Name	Code	Share in final grade	Evaluated learning outcomes
1. Midterm test 1	1. ZH1	1. 50%	1. t1,t2,t3,k1,k2,a1,o1
2. Midterm test 2	2. ZH2	2. 50%	2. t1,t2,t3,k1,k2,a1,o1

#### 25. Exams

Name	Code	Share in final grade	Evaluated learning outcomes
-	-	-	-

#### 26. Criteria to obtain a signature / midterm grade

Passing both midterm tests

#### 28. Attendance and participation requirements

according to the rules of CoS

#### 29. Retake and delayed completion

Second retake or delayed completion of one midterm test is possible.

#### 27. Grading rules

Excellent 88-100%

Good 75-87%

Satisfactory 63-74%

Pass 50-62%

Fail 0-49%

#### 30. Consultation

At a time and in a manner agreed upon with the instructor

#### 31. Learning materials

Learning is supported by the provided lecture slides and supplementary notes.

#### 32. Start of validity for the subject description

September 1st, 2025



<b>1. Subject name</b>		<b>Software development methods and paradigms</b>				
<b>2. Subject name in Hungarian</b>	Software development methods and paradigms			<b>3. Programme</b>	A	
<b>4. Subject code</b>	<b>BMEVIAUMSXA000-00</b>			<b>5. Term   role</b>	2/1   k	
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>e</b>		<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>1 practice</b>	<b>0 laboratory</b>	<b>10. Language</b>	<b>English</b>	
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>						
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>	
<b>Contact hours</b>	42 hours	<b>Preparation for lessons</b>	21 hours	<b>Homework</b>	0 hours	
<b>Reading written materials</b>	19 hours	<b>Midterm preparation</b>	20 hours	<b>Exam preparation</b>	48 hours	
<b>13. Organisational unit in charge</b>						
Department of Automation and Applied Informatics (VIK)						
<b>14. Subject coordinator and its position</b>		Dr. Hideg Attila senior lecturer		<b>15. Email address</b>	hideg.attila@aut.bme.hu	
<b>16. ...organisational unit</b>						
Department of Automation and Applied Informatics (VIK)						
<b>17. Instructor(s)</b>						
Dr. Lengyel László, Kövesdán Gábor, Albert István						
<b>18. Indicative prerequisites</b>						
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<b>19. Purpose</b>						
<p>The goal of this course is to teach the software development methodologies, their application possibilities and conditions, practices and tools required and preferred for the design and development of methods. Students become practiced in treating issues of common software architectures and software systems, furthermore, they will have a good knowledge related to software development methods. The course discusses the software development methodologies, the methods and techniques supporting methodologies and development processes, furthermore, practices, architectural requirements and solutions related to software systems.</p>						
<b>20. Programme of lectures</b>						
<ol style="list-style-type: none"> <li>1. Effective use of development tools, learn best practices, build a variety of devices, major development, debugging, testing, mapping processes.</li> <li>2. Typical architectural expectations and possible solutions related to the project management methodologies, showing the advantages and difficulties in each direction.</li> <li>3. The manual application testing processes, methods, presentation of some assets. Guidelines for the preparation of unit tests, the conditions for the application, advantages and disadvantages.</li> <li>4. Source code management methods, widespread source code management tools, branching strategies, introduction of best practice guidelines for effective teamwork.</li> <li>5. Specification and business analysis methods: Structured Systems Analysis and Design Method (SSADM), requirements analysis, requirements specification, logical and physical planning, types of requirements, measurable objectives, prototypes, business analysis techniques, business processes and documentation requirements.</li> <li>6. Software Design methods: software design, UML, UML profile, description and communication of user requirements, architecture, design, Domain Driven Design, Model Driven Development</li> <li>7. User Experience design, typical process steps and best practices, role in the software development process, the user testing methods.</li> <li>8. Methodologies, classic methodologies: the software development process, software development models, Rational Unified Process (RUP), Capability Maturity Model Integration (CMMI)</li> <li>9. Agile development methods 1 (Agile values and principles) Why do we need methodologies?, managing change in the software industry, agile methods, values, principles, agile manifesto, agile practices.</li> <li>10. Agile development methods 2 (supporting the implementation practice): agile design, goals of design, levels of design, vision, release planning, iteration planning, stand-up. User stories, estimates, iteration, "done, done", Agile modeling.</li> <li>11. Agile development methods 3 (Agile methodologies): eXtreme Programming (XP), Scrum, Microsoft Solution Framework (MSF), characteristics of methodologies, their use in everyday life.</li> <li>12. Project management methods and tools 1: general project management principles, constraints, resources and competence matrices, tasks, dependencies. General description of project design tools.</li> <li>13. Project management methods and tools 2: specific characteristics of IT projects, agile and classic methodologies, resource and task management, monitoring, device support.</li> </ol>						

14. Case studies: concrete case studies demonstrate the effective use of development tools, testing, source code management practices, collaboration tools. Experiences, best practices.

### 21. Programme of practices

1. Unit testing in practice: creating simple unit tests, application testing, mocking, error handling.
2. Source code management methods 1: Microsoft Team Foundation Server, GIT, check-in / check-out, pull / push, merge, branching, offline repository management.
3. Source code management methods 2: build automation, continuous integration, automated unit tests start, configuration-release devices, metrics.
4. Specification and design: developing practical examples (SSADM), CMMI in practice, requirements analysis, business analysis.
5. Agile Planning: practical examples of vision, release planning, iteration planning.
6. Agile tools: common agile practices (test driven development, continuous integration, refactoring).
7. Project management tools in practice: planning, resource management, scrum meetings, sprints, product backlog.

### 22. Programme of laboratories

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### 23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)

The student

#### a) knowledge (t)

1. knows the architectural expectations and framework of software design, (T1,T5,T7,T11)
2. know the basic methods of software testing and source code management, (T1,T5,T7,T11)
3. knows the agile development methods, (T1,T5,T7,T11)
4. knows project management methods and tools, their specific IT features (T1,T5,T7,T11)

#### b) skills (k)

1. can handle common architectural issues related to software systems, (K1,K4,K7,K12,K15)
2. is able to select the appropriate methods and solutions to follow the task, (K1,K4,K7,K12,K15)
3. capable of performing software testing tasks (K1,K4,K7,K12,K15)

#### c) attitude (a)

1. open to learning new development methods and environments (A1,A8)
2. suitable to work with the selected frames when working in different projects for different projects (A1,A8)

#### d) autonomy and responsibility (o)

1. can independently design a process,
2. can coordinate the work of a team and lead the development process

### 24. Midterm assessments

Name	Code	Share in final grade	Evaluated learning outcomes
1. midterm test	1. ZH	1. 40%	1. t1-t4,k1-k3,a1,a2,o1,o2

### 25. Exams

Name	Code	Share in final grade	Evaluated learning outcomes
1. written exam	1. IRV	1. 60%	1. t1-t4,k1-k3,a1,a2,o1,o2

### 26. Criteria to obtain a signature / midterm grade

The condition for obtaining the signature is the acceptable (at least sufficient) solution of the mid-term exam. The condition for admission to the exam is the existence of a signature.

### 28. Attendance and participation requirements

according to the rules of CoS

### 29. Retake and delayed completion

The midterm test can be repeated during the repeat period in accordance with the Code of Studies and Exams.

### 27. Grading rules

90 – 100% excellent  
 75 – 89.99% good  
 60 – 74.99% satisfactory  
 45 – 59.99% pass  
 0 – 44.99% fail

### 30. Consultation

Arranged on demand by the lecturer or instructor.

### 31. Learning materials

James Shore: The Art of Agile Development, O'Reilly Media, 2007.

Martin Fowler with Kent Beck, John Brant, William Opdyke, and Don Roberts: Refactoring (Improving the Design of Existing Code), Addison-Wesley, 1999.

Kent Beck et al.: Manifesto for Agile Software Development, Agile Alliance, 2001.

Kent Beck: Test Driven Development: By Example, Addison-Wesley, 2003.

Martin Fowler: Domain-Specific Languages, Addison-Wesley Professional, 2010.

Martin Fowler: Using an Agile Software Process with Offshore Development, Martinfowler.com

James Shore: The Art of Agile Development: Refactoring.

### 32. Start of validity for the subject description

September 1st, 2025



<b>1. Subject name</b>	<b>Traffic modeling, simulation and control</b>				
<b>2. Subject name in Hungarian</b>	Traffic modeling, simulation and control			<b>3. Programme</b>	A
<b>4. Subject code</b>	<b>BMEKOKJMSA2002-00</b>			<b>5. Term   role</b>	2/1   k
<b>6. Credits</b>	<b>5</b>	<b>7. Evaluation type</b>	<b>m</b>	<b>8. Nature</b>	<b>contact lessons</b>
<b>9. Weekly contact hours</b>	<b>2 lecture</b>	<b>0 practice</b>	<b>2 laboratory</b>	<b>10. Language</b>	<b>English</b>
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>	56 hours	<b>Preparation for lessons</b>	34 hours	<b>Homework</b>	0 hours
<b>Reading written materials</b>	34 hours	<b>Midterm preparation</b>	26 hours	<b>Exam preparation</b>	0 hours
<b>13. Organisational unit in charge</b>	Department of Control for Transport and Vehicle Systems				
<b>14. Subject coordinator and its position</b>	Dr. Tettamanti Tamás professor	<b>15. Email address</b>	tettamanti.tamas@kjk.bme.hu		
<b>16. ...organisational unit</b>	Department of Control for Transportation and Vehicle Systems				
<b>17. Instructor(s)</b>	Dr. Tettamanti Tamás, Dr. Varga István, Dr. Varga Balázs, Ormándi Tamás, Wágner Tamás				
<b>18. Indicative prerequisites</b>	---				
<b>19. Purpose</b>					
The aim of the course is to familiarise students with the design and operation of road traffic management systems, from modeling and measurement to applied control tools/methods.					
<b>20. Programme of lectures</b>					
The course provides cutting-edge theoretical and practical knowledge in the field of road traffic automation and control. Students will become familiar with the fundamental concepts of road traffic control systems and their typical hardware/software architectures. The course introduces vehicle detection technologies, traffic control equipment, as well as traffic control centers. In addition, students will study the mathematical foundations of traffic modeling and control, which will be practiced using the MATLAB environment and the SUMO traffic simulation software.					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
Microscopic and macroscopic traffic modeling (MATLAB, SUMO). Road traffic parameter estimation (smoothing, Recursive Least Squares Estimator, Kalman Filter, MHE), model-based controller design (PID, LQ, MPC).					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
1. understands the structure and operation of traffic control systems, and is familiar with the levels and methods of traffic modeling (T2,T3,T4,T6,T8,T9,T11,T13,T14)					
<b>b) skills (k)</b>					
1. capable of modeling a traffic network, designing its control, and designing traffic measurement and estimation systems (K2,K3,K4,K5,K7,K8,K12)					
<b>c) attitude (a)</b>					
1. open to conduct research in traffic management systems (A1,A5,A8)					
<b>d) autonomy and responsibility (o)</b>					
1. able to independently design traffic management strategies					
<b>24. Midterm assessments</b>					
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>		
1. written midterm test	1. ZH	1. 50%	1. t1,k1,a1,o1		
2. individual oral report	2. GYF1	2. 0%	2. t1,k1,a1,o1		

	3. GYF2 4. GYF3 5. GYF4 6. ÖB	3. 0% 4. 0% 5. 0% 6. 50%	3. t1,k1,a1,o1 4. t1,k1,a1,o1 5. t1,k1,a1,o1 6. t1,k1,a1,o1
<b>25. Exams</b>			
<b>Name</b>	<b>Code</b>	<b>Share in final grade</b>	<b>Evaluated learning outcomes</b>
-	-	-	-
<b>26. Criteria to obtain a signature / midterm grade</b>			<b>27. Grading rules</b>
Successful (min. 50%) completion of the midterm test, submission of assignments on lessons, and individual oral report based on the assignments.			Excellent 88-100% Good 75-87% Satisfactory 63-74% Pass 50-62% Fail 0-49%
<b>28. Attendance and participation requirements</b>			
according to the rules of CoS			
<b>29. Retake and delayed completion</b>			
Second retake or delayed completion of the midterm test is possible.			
<b>30. Consultation</b>			
Consultation is possible at a time and in a form agreed with the teacher.			
<b>31. Learning materials</b>			
Materials for lectures and tutorials shared on the Moodle site of the course, Tettamanti T., Luspay T., Varga I.: Road Traffic Modeling and Simulation (Tutorial), Akadémiai Kiadó, Budapest, 2019			
<b>32. Start of validity for the subject description</b>			
September 1st, 2025			



<b>1. Subject name</b>		<b>Vehicle dynamics</b>			
<b>2. Subject name in Hungarian</b>		Vehicle dynamics		<b>3. Programme</b>	
<b>4. Subject code</b>		BMEKOGJMSA2A01-00		<b>5. Term   role</b>	
<b>6. Credits</b>		5		<b>7. Evaluation type</b>	
		e		<b>8. Nature</b>	
<b>9. Weekly contact hours</b>		2 lecture		0 practice	
				1 laboratory	
<b>10. Language</b>		English			
<b>11. SDG Learning outcomes' contribution to the EU/UN sustainable development goals</b>					
<b>12. Working hours for fulfilling the requirements of the subject</b>					<b>150 hours</b>
<b>Contact hours</b>		42 hours		<b>Preparation for lessons</b>	
		5 hours		<b>Homework</b>	
<b>Reading written materials</b>		30 hours		<b>Midterm preparation</b>	
		31 hours		<b>Exam preparation</b>	
		10 hours			
<b>13. Organisational unit in charge</b>					
Department of Automotive Technologies					
<b>14. Subject coordinator and its position</b>			<b>15. Email address</b>		
Dr. Domina Ádám acting expert			domina.adam@kjk.bme.hu		
<b>16. ...organisational unit</b>					
Department of Automotive Technologies					
<b>17. Instructor(s)</b>					
Dr. Domina Ádám					
<b>18. Indicative prerequisites</b>					
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<b>19. Purpose</b>					
The aim of the course is to familiarize students with the dynamic models of road vehicles. Within the scope of the course, students will be able to familiarize themselves with the various combined longitudinal and lateral vehicle dynamics models, including tire models. The subject assumes the knowledge of the basic mechanics of the vehicle.					
<b>20. Programme of lectures</b>					
Vehicle behavior and stability issues. Modeling Basics. Modeling solo vehicles with a bike model. Tire models. Two-gauge four-wheeled vehicle model. Tire brush model. The "Magic Formula" tire model.					
<b>21. Programme of practices</b>					
-					
<b>22. Programme of laboratories</b>					
Modeling basics. Modeling ICE. Gear teeth contact modeling. Bicycle model. Three-state vehicle model. Brush and Pacejka tire models. Four-wheel vehicle models. Evaluating understeer and oversteer.					
<b>23. Learning outcomes (lower case) and their link to the training programme's learning outcomes (upper case)</b>					
The student					
<b>a) knowledge (t)</b>					
1. is familiar with the basic vehicle dynamics modelling paradigms, the dynamic behaviour of vehicles, the terms describing them and their meanings, the different vehicle models, the so-called "vehicle dynamics models", the so-called "vehicle dynamics models" and the so-called "vehicle dynamics models". (T3,T5)					
<b>b) skills (k)</b>					
1. can construct a vehicle dynamics model from a given vehicle description, apply vehicle dynamics models in design, select a suitable model for a given vehicle control task, use his/her knowledge to learn about and understand other vehicle models, model vehicle-track interaction in a specific environment (K2)					
<b>c) attitude (a)</b>					
1. is open to the use of new vehicle dynamics models, applies his/her knowledge of vehicle dynamics and other knowledge together, cooperates with fellow students and instructors in the processing of different problems (A8)					
<b>d) autonomy and responsibility (o)</b>					
1. independently expands his/her knowledge in the field of modelling IT solutions, examines technical tasks in a systemic way, is able to responsibly carry out an assigned dynamics task, which provides support for his/her colleagues.					
<b>24. Midterm assessments</b>					
<b>Name</b>		<b>Code</b>		<b>Share in final grade</b>	
				<b>Evaluated learning outcomes</b>	
1. Midterm test		1. ZH		1. 35%	
				1. t1,k1	

2. Homework	2. HF	2. 35%	2. t1,k1,a1,o1
<b>25. Exams</b>			
Name	Code	Share in final grade	Evaluated learning outcomes
1. Written exam	1. V	1. 30%	1. t1,k1,a1,o1
<b>26. Criteria to obtain a signature / midterm grade</b>			<b>27. Grading rules</b>
Passing the midterm test, presenting the homework.			50%-61%: pass 62-74%: satisfactory 75%-87%: good 88%-100%: excellent
<b>28. Attendance and participation requirements</b>			
According to CoS.			
<b>29. Retake and delayed completion</b>			
The midterm test can be retaken once, the homework can be resubmitted once.			
<b>30. Consultation</b>			
After the lectures or the practices, and in specified time slots previously agreed appointment.			
<b>31. Learning materials</b>			
Presentation materials of lectures and practices, MATLAB modeling files.			
<b>32. Start of validity for the subject description</b>			
September 1st, 2025			