University of Debrecen

Faculty of Engineering

Vehicle Engineering BSc Program

2021

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DEAN'S WELCOME

Welcome to UD's Faculty of Engineering!

The Faculty of Engineering of the University of Debrecen has become an outstanding centre of education and research in the Eastern Hungarian region. Following the footsteps of our predecessors, the academic and administrative staff of the Faculty work hand in hand to make our training programmes and researches meet both national and international standards.

The Faculty of Engineering is one of Hungary's most significant institutions of higher-education, and its 3000 students make it a dominant faculty of the University of Debrecen which - having the most international students, offering the most academic programmes among Hungarian universities and having been classified as a research university, the highest of qualifications - is officially listed among the best universities in the country.

We welcome the most outstanding and inquisitive students of the region with an enthusiastic and professional team of academics and researchers, and a set of laboratories unique in the country. We consciously aspire to develop the quality of education and research further, based on a close cooperation between the Faculty and the industry. Our students enter many prestigious competitions and they are becoming increasingly successful and acclaimed, while our instructors are working on a growing number of national and international projects of basic and applied research.

The Faculty bridges the gap between theory and practice and provides a high-quality theoretical background merged into practice-oriented training based on industrial relations. We do our best to maintain the high prestige of the engineering diplomas awarded by the University of Debrecen and to make sure that the knowledge and achievements of students who graduate from our Faculty continue to be recognised in the labour market.

All things considered, you are kindly advised to read this bulletin which hopefully reflects our endeavours appropriately and provides all the information you need to know about your chosen training programme. We are looking forward to supporting the personal and professional growth of our future engineers.

With the best of wishes for the years to come,

Géza Husi

Dean

HISTORY OF THE UNIVERSITY

The history of Debrecen's higher education dates back to the 16th century. The Calvinist Reformed College, established in 1538, played a central role in education, teaching in the native language and spreading Hungarian culture in the region as well as in the whole country. The College was a sound base for the Hungarian Royal University, founded in 1912. Apart from the three academic faculties (arts, law, theology) a new faculty, the Faculty of Medicine was established, and the University soon became one of the regional citadels of Hungarian higher education. Today, University of Debrecen is classified as "University of National Excellence" and offers the highest number of academic programs in the country, therefore it is considered to be one of the best universities in Hungary. Its reputation is the result of its quality training, research activities and the numerous training programs in different fields of science and engineering in English. With 14 faculties and a student body of almost 30.000, out of which about 3700 are international students, the University of Debrecen is one of the largest higher education institutions in Hungary.

The history of the Faculty of Engineering dates back to 1965, when the Technical College was established. In 1972 it was renamed Ybl Miklós Polytechnic and in 1995 it became part of Kossuth Lajos University. In 2000 the Faculty of Engineering became part of the integrated University of Debrecen.

In 2005 the Bologna System was introduced which supports the competitiveness of qualifications received at the University of Debrecen against universities all over Europe.

The Faculty of Engineering is practice-oriented and develops skills required for the current needs of the national and international labour market. The teaching staff is involved in numerous domestic and international research and design projects. The recently-opened new building wing with its ultra-modern design hosts several lecture halls, seminar rooms and laboratories equipped with the latest technology. Our students are provided with practical knowledge, training and field practice from numerous prestigious domestic and multi-national industry partners. The internship periods are excellent opportunities for students to experience how theory is put into practice at the most renowned industry representatives and become more successful in the labour market of this highly competitive sector. Students learn how to work in the working environment of multi-national companies and adapt to challenges easily. After graduation they will be able to work at a strategic decision-making level, giving priority to efficiency and engineering ethics.

The Faculty of Engineering offers a great variety of BSc, MSc courses and post-graduate training courses tailored to the needs of the rapidly changing world of engineering and focusing on European and international trends. In 2011 the Faculty of Engineering launched engineering trainings in English. In order to optimize the quality of training, the Faculty continuously strives to expand the number of industrial and educational partners at home and abroad.

The Faculty of Engineering has been a pioneer in the introduction of Quality Management System at faculty level to measure and evaluate the efficiency of its education and

teaching staff in order to improve the quality of education and training from the feedback received.

The Faculty of Engineering has a vivid student life. There is a film club waiting for movie buffs and the door of the Faculty library is always open. The library is not only the host to the latest technical books, exhibitions and tea afternoons with invited speakers, but students can also purchase theatre and concert tickets from the librarians. The Borsos József Dormitory is also a hub of activities for students.

The increasing number of international students brings cultural and ethnic diversity to the faculty.

Our aim is to aid students to become efficient members of the labour market and enrich the world of engineering in Hungary and abroad with their knowledge and expertise.

ADMINISTRATION UNITS FOR INTERNATIONAL PROGRAMMES

COORDINATING CENTER FOR INTERNATIONAL EDUCATION

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The Coordinating Centre for International Education supports the international degree programmes of the University of Debrecen in giving new students information on admission and entrance exam. It has tasks in promoting and is in charge of tasks like enrolment, study contracts, modifying student status or degree programme, activating student status, modifying students' personal data, requesting and updating student cards, providing certificates for the Immigration Office (for residence permit), issuing student status letters and certificates on credit recognition, concluding health insurance contract and providing Health Insurance Card, helping students with visa process application.

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The International Office has been functioning since 2014 in order to ensure the smooth running of the international degree courses. The office is responsible for student administration (full-time students, full-time transfer students, visiting/Erasmus students), providing certificates for students, considering and accepting requests, solving problems related to course registration, giving information about internship, final exam, thesis, etc.

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Department of Basic Technical Studies
Department of Building Services and Building Engineering
Department of Civil Engineering
Department of Engineering Management and Enterprise
Department of Environmental Engineering
Department of Mechanical Engineering
Department of Mechatronics
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ACADEMIC CALENDAR

General structure of the academic year:

Study period	1st week	Registration*	1 week
	2nd – 7th week	Teaching Block 1	6 weeks
	8th week	1st Drawing Week	1 week
	9th – 14th week	Teaching Block 2	6 weeks
	15th week	2nd Drawing Week	1 week
Exam period	directly after the study period	Exams	7 weeks

*Usually, registration is scheduled for the first week of September in the fall semester, and for the first week of February in the spring semester.

ACADEMIC CALENDAR OF THE FACULTY OF ENGINEERING 2021/2022

Opening ceremony of the academic year	5 September 2021 (Sunday)
Registration week	30 August - 3 September 2021
Revision week (exams in Exam courses may be scheduled during this week)	30 August - 3 September 2021
1st semester study period in MSc and BSc programs	6 September - 10 December 2021 (14 weeks) In case of finalist courses: 6 September 2021 - 5 November 2021 (9 weeks)
Reporting period I (Drawing week I)	18 - 22 October 2021 (4 working days without scheduled lessons, consultation schedule announced previously)
Faculty Conference of Scientific Students' Association	11 November 2021
Reporting period II (Drawing week II)	6-10 December 2021 (5 working days without scheduled lessons, consultation schedule announced previously)
1st semester examination period	13 December 2021 - 28 January 2022 (7 weeks)

	In case of finalist courses: 8 November - 10 December 2021 (5 weeks)
Thesis (BSc, MSc) submission deadline	As defined by the departments; max. 14 days of the beginning of the final examination period.
Final examination period	As defined by the departments; at least one occasion between 13 December 2021 and 28 January 2022.
Registration week	31 January - 4 February 2022
2nd semester study period in MSc and BSc programs	7 February - 13 May 2022 (14 weeks) In case of finalist courses: 7 February - 8 April 2022 (9 weeks)
Reporting period I (Drawing week I)	21 - 25 March 2022 (5 working days without scheduled lessons, consultation schedule announced previously)
Conferences	21 - 25 March 2022
Career Days – "Industry Days in Debrecen 2021" (working days without teaching for Mechanical Eng. BSc, Mechanical Eng. MSc, Environmental Eng. MSc, Mechatronics Eng. BSc, Mechatronical Eng. MSc, Civil Eng. BSc students)	21 - 25 March 2022
Career Days and Exhibition in Building Services Engineering (organised by the Department of Building Services and Building Engineering)	5 May 2022
Reporting period II (Drawing week II)	9 – 13 May 2022 (5 working days without scheduled lessons, consultation schedule announced previously).
2nd semester examination period	16 May - 1 July 2022 (7 weeks) In case of finalist courses: 11 April - 13 May 2022 (5 weeks)

Thesis (BSc, MSc) submission deadline	As defined by the departments; max. 14 days of the beginning of the final examination period.
Final examination period	As defined by the departments; at least one occasion between 16 May and 17 June 2022. The departments shall announce the date of the final examination until 15 February 2022.

THE VEHICLE ENGINEERING UNDERGRADUATE PROGRAM

INFORMATION ABOUT THE PROGRAM

Name of undergraduate program:	Vehicle Engineering BSc
Specializations available:	• Vehicle Manufacturing • Automotive Vehicle Engineering
Field, branch:	Engineering, vehicle engineering
Level:	undergraduate (BSc)
Qualification:	Vehicle Engineer
Mode of attendance:	Full-time
Faculty:	Faculty of Engineering
Program coordinator:	Zsolt Tiba,PhD habil. College Professor
Person in charge of the specialization:	*Vehicle Manufacturing Specialization:* Sándor Bodzás,PhD Associate Professor *Automotive Vehicle Engineering Specialization:* Zsolt Tiba,PhD habil. College Professor
Program length:	7 semesters
Credits total:	210 (thesis: 15, optional subjects: 10)

Objectives of the undergraduate program and professional competencies

The aim of the programme is to train vehicle engineers who are able to solve basic engineering problems related to the design, manufacturing, systems thinking perspective of operation, and the repair of automotive, railway, naval and aerospace vehicles, vehicle systems, building and material handling machines and mobile machinery, considering the technicalities of transportation and logistics. They perform these tasks in accordance with the ruling principles of safety, environmental protection and power management. Students will be prepared to continue their studies at Master's (MSc) level.

Professional competencies to be acquired

A vehicle engineer's

a) knowledge

He/She

- has an expansive knowledge of the basic facts, directions and borderlines of the professional field of engineering.
- knows the general and specific principles, rules, relations and procedures of mathematics, natural and social sciences necessary to work in the professional field of vehicles and mobile machinery.
- knows the conceptual system and the problem-solving methods of the professional field of vehicles and mobile machinery.
- knows the basic economic, entrepreneurial and legal rules and devices related to the manufacturing and operation of vehicles and mobile machinery.
- knows the fundamentals, limits and requirements of the professional fields of logistics and transportation closely associated with vehicle engineering.
- knows the logistics and transport processes carried out by using vehicles and mobile machinery as well as their necessities, expectations and the set of conditions.
- knows the working principles and structural units of vehicles and mobile machinery.
- knows the measurement technologies used in vehicle technology, as well as their tools, instruments and measurement facilities.
- knows the basic principles of design, methods, regulations and standards of vehicle technology, as well as the control techniques and operation processes.
- knows the learning and the information and data collection methods of the field of vehicle engineering, as well as their ethical limits and problem-solving methods.
- knows computer communication and the major application software of the professional field.
- knows the major organisational, management and communication techniques.
- knows the expectations and the requirements of the fields of work and fire safety, industrial safety and quality assurance, and the regulations of environmental protection related to his/her profession.

b) abilities

He/She is able to

- carry out a basic analysis of disciplines that make up the epistemic system of the field of engineering, to summarise correspondences and to make adequate assessments.
- apply the most important theories, procedures and terminology of the field of vehicles and mobile machinery when carrying out relevant tasks.
- apply calculation and operational principles, methods and technical specifications related to the operation and basic design of vehicles, mobile machinery and their systems.

- understand and describe the structure and operation of the different units of vehicles and mobile machinery, the construction of the applied constituents and the relation between them.
- apply the technical regulations relating to the operation of automotive systems and mobile machinery, and the principles and economical relations of installing and operating machines and mechanical systems.
- control and supervise industrial manufacturing and operational processes without neglecting the principles of quality assurance and quality control.
- diagnose mechanical failures and to select preventive mechanisms.
- identify routine problems and the theoretical and practical background necessary to solve them, and to solve the given problem by the practical application of standard operations.
- plan, organise and carry out studying independently.
- understand and use scientific literature and the computer and library sources related to the field of vehicles and mobile machinery.
- solve professional problems by using the acquired computer skills.
- model engineering structures and processes.
- manage workplace resources in a creative way using his/her knowledge acquired.
- apply and conform to industrial safety, workplace and fire safety and hygienic rules and regulations in the course of his/her work.
- communicate in a professionally adequate manner both in writing and orally in his/her mother tongue and in at least one foreign language.

c) attitude

He/She

- identifies with the social role his/her profession plays in the world, and acts as a credible representative of it.
- represents and takes responsibility for the values of engineering, and is open towards professionally reasonable critical remarks.
- follows the legal, technical, technological and administrative changes of his/her field of profession.
- is open and apt to learn, accept and credibly mediate professional and technological developments and innovations in the field of vehicle engineering.
- endeavours to constantly train him-/herself in vehicle engineering in accordance with his/her profession.
- endeavours to solve problems and make leadership decisions by taking into account the opinion of his/her co-workers and cooperating with them.
- makes decisions after a thorough consideration of legal and ethical norms even in unexpected situations, or situations demanding a complex approach.
- endeavours to promote the aspects of environmental protection and health consciousness at his/her job.
- pays attention to the professional development of his/her co-workers, manages and helps their endeavours.
- shares experiences with his/her colleagues helping their professional development.

d) autonomy and responsibility

He/She

- is capable of considering complex, fundamental questions of his/her field of profession and elaborating them on the basis of given sources even in unexpected decision-making situations.
- cooperates with experts from other fields of profession (primarily experts of economics and law) when completing professional tasks.
- detects deficiencies of the applied technologies and the risks of the processes and initiates measures to reduce them.
- is fully aware of the legal, economic, safety, social, health and environmental consequences of his/her work and decisions.
- is capable of following the instructions of his/her superior, supervises the work of personnel he/she is in charge of and monitors the operation of machines and facilities.
- evaluates the efficiency, adeptness and safety of his/her colleagues.

COMPLETION OF THE ACADEMIC PROGRAM

Credit System

Majors in the Hungarian Education System have generally been instituted and ruled by the Act of Parliament under the Higher Education Act. The higher education system meets the qualifications of the Bologna Process that defines the qualifications in terms of learning outcomes: statements of what students know and can do on completing their degrees. In describing the cycles, the framework uses the European Credit Transfer and Accumulation System (ECTS).

ECTS was developed as an instrument of improving academic recognition throughout the European Universities by means of effective and general mechanisms. ECTS serves as a model of academic recognition, as it provides greater transparency of study programmes and student achievement. ECTS in no way regulates the content, structure and/or equivalence of study programmes.

Regarding each major, the Higher Education Act prescribes which professional fields define a certain training program. It contains the proportion of the subject groups: natural sciences, economics and humanities, subject-related subjects and differentiated field-specific subjects.

The following professional fields define the training program of the Vehicle Engineering BSc:

- Natural Sciences [Mathematics, Engineering Physics, Technical Chemistry, Mechanics, Materials Science, Thermodynamics and Fluid Mechanics] 40-50 credit points;
- Economics and Humanities (Business Law, Economics, Engineering Management) 14-30 credit points;
- Field-specific professional skills for vehicle engineers (Information Technology, Technical Drawing, Electronics and Electrotechnics, Control Theory, Measurement Technology, Mechatronics, Electric Machines and Drives, Vehicle Operation and Technologies, Vehicle Design, Manufacturing and Maintenance) 70-105 credit points.
- The specialization offered by the institution is worth at least 40 credit points.

Minimum of credit points assigned to optional subjects: 10

Credit points assigned to thesis: 15

Credits total: 210

During the program students have to complete a total amount of 210 credit points. It means approximately 30 credits per semester. The curriculum contains the list of subjects (with credit points) and the recommended order of completing subjects which taking into account the prerequisite(s) of each subject. You can find the recommended list of subjects in chapter “Guideline”.

Guideline (List of Subjects/Semesters)

The total number of credit points (210) of the training program can be obtained by completing the subjects of the curriculum. There is a certain degree of freedom in the order students can complete the subjects. However, it is recommended to follow the suggested order because some subjects can only be taken after the completion of prerequisite subject(s), and/or can be the prerequisites for other subjects.

The list of subjects you have to complete in the semesters according to the model curriculum of Vehicle Engineering BSc programme Vehicle Manufacturing Specialisation:

1st semester	2nd semester
Mathematics I Engineering Physics Technical Chemistry Materials Engineering Basic Theory of Vehicle Engineering Technical Drawing I	Mathematics II Mathematics Comprehensive Exam Statics and Strength of Materials Micro- and Macroeconomics Programming Vehicles and Mobile Machinery Technical Drawing II Electronics and Electrotechnics Optional Subject I
3rd semester	**4th semester**
Mathematics III Dynamics and Vibration Thermodynamics Vehicle and Drive Elements I Vehicle Materials and Technologies Measurement Technology Optional Subject II	Fluid Mechanics Business Law Management and Business Economics Systems of Quality Management Vehicle and Drive Elements II Vehicle Manufacturing and Repair Control Theory I Optional Subject III
5th semester	**6th semester**
Thermodynamics and Fluid Machines of Vehicles Control Theory II Materials of Vehicles Vehicle Manufacturing I Quality Assurance in Manufacturing Processes Optional Subject IV.	Vehicle Design and Diagnostics Applied Automation Electric Machines and Drives Vehicle Engineering Comprehensive Exam Vehicle Manufacturing II Manufacturing Planning and Lean Management Vehicle Diagnostics Internship
7th semester	
Group Project for Vehicle Engineers Thesis	

The list of subjects you have to complete in the semesters according to the model curriculum of Vehicle Engineering BSc programme **Automotive Vehicle Engineering Specialisation**:

1st semester	**2nd semester**
Mathematics I Engineering Physics Technical Chemistry Materials Engineering Basic Theory of Vehicle Engineering Technical Drawing I	Mathematics II Mathematics Comprehensive Exam Statics and Strength of Materials Micro- and Macroeconomics Programming Vehicles and Mobile Machinery Technical Drawing II Electronics and Electrotechnics Optional Subject I
3rd semester	**4th semester**
Mathematics III Dynamics and Vibration Thermodynamics Vehicle and Drive Elements I Vehicle Materials and Technologies Measurement Technology Optional Subject II	Fluid Mechanics Business Law Management and Business Economics Systems of Quality Management Vehicle and Drive Elements II Vehicle Manufacturing and Repair Control Theory I Optional Subject III
5th semester	**6th semester**
Thermodynamics and Fluid Machines of Vehicles Control Theory II Vehicle Powertrain Systems Vehicle Suspensions Automotive Electronics and Mechatronics Optional Subject IV	Vehicle Design and Diagnostics Applied Automation Electric Machines and Drives Vehicle Engineering Comprehensive Exam Automotive Engines Automotive Operation Systems Internship
7th semester	
Group Project for Vehicle Engineers Thesis	

About the prerequisites of each subject please read the chapter “Course Descriptions”!

Work and Fire Safety Course

According to the Rules and Regulations of University of Debrecen, students must complete the online course for work and fire safety in the first semester of their studies. Registration for the course and completion are necessary for graduation.

Registration in the Neptun system by the subject: MUNKAVEDELEM

Students have to read an online material until the end to get the signature on Neptun for the completion of the course. The link of the online course is available on the webpage of the Faculty.

Internship

Internship is a mandatory and integral part of the course of studies and strongly related to thesis writing. It covers 6 weeks after the 6th semester.

Credit points: 0

Aim of internship, competencies

To obtain specific practical skills from the field of vehicle engineering and automotive engineering, which form the basis for the final semester of the training program, the efficiency of preparing thesis and the period after graduation.

The aim of the internship is to familiarize students with professional work done at the selected company (its profile is in accordance with the requirements for internship), involve them in the daily routine of the company, solve tasks individually assigned by the supervisor, gain experience which makes it easier for them to enter the labour market later. During internship general and professional competencies can be acquired and improved.

General competencies: work to a deadline precisely depending on the task type (individually or in team showing cooperation), use language for academic purposes.

Professional competencies: practical application of professional skills gained during studies, acquiring new skills and gaining proficiency (depending on the selected specialisation).

Completion of internship

Students are expected to prepare a 15-20-page long report relating to the work done during internship. The topic should be negotiated with the employer and closely related to the work done during internship and the practical tasks students get acquainted with.

Physical Education

According to the Rules and Regulations of University of Debrecen, students must complete Physical Education courses at least in two semesters during their Bachelor training. Our University offers a wide range of facilities to complete them. Further information is available from the Sport Centre of the University, its website: http://sportsci.unideb.hu.

Optional Courses

According to the Rules and Regulations of University of Debrecen, student must complete optional courses during their studies.

Students of the Faculty may register for any courses announced by the Faculty without the approval of the Faculty Education Committee, in which case these will be counted as optional courses in the amount of credits indicated in the study plan of the given major or specialisation.

During your training you can complete elective subjects in any semester. In the Vehicle Engineering BSc programme, you have to gain at least 10 credits by completing elective subjects.

Pre-degree Certificate

A pre-degree certificate verifies in the Neptun system that the student has successfully completed the study and exam requirements as set out in the curriculum, namely gained the necessary credit points (210), completed all the required subjects and the criterium subjects (Physical Education, Internship, Work and Fire Safety course). Submitting thesis is not a requirement for the pre-degree certificate. Student status ends at the end of that semester when the pre-degree certificate is obtained.

Students who obtained the pre-degree certificate can take the final exam. Final exam can be taken both in the beginning of January and at the end of June.

It is possible to sit for the final exam in any examination period within two years after the termination of the student status, according to the effective academic requirements. If the final exam is taken more than two years after obtaining the pre-degree certificate the conditions of taking the exam are stipulated by the Faculty. No final exam can be taken later than five years after the termination of the student status.

Thesis

A thesis is the creative elaboration of a professional task (scientific, engineering, design, development, research or research development) in a written form as defined in the requirements of the training program. By solving the task, the student relies on his/her studies using national and international literature under the guidance of an internal supervisor previously approved by the Department of Department of Air and Road Vehicles or depending on the topic of the thesis with the assistance of an external supervisor as well, also previously approved by the Department. By writing and successfully defending a thesis, students of the Vehicle Engineering undergraduate programme prove that they are able to apply the acquired knowledge in practice, to summarize the work done and its results in a professional way, to solve the tasks related to their topic creatively, and to complete individual professional work.
Thesis topics are announced by the departments no later than the end of the fourth week of the study period of the last but one semester. Students are free to come up with their own thesis topics as well, however, the Programme Coordinator/Head of Department of Air and Road Vehicles decides on the acceptance of the topic. The conditions on the acceptance of a SSS (Student Scientific Society) paper as a degree thesis are defined by the Faculty. SSS papers are supposed to meet the requirements of a thesis both in form and content. Furthermore, it is necessary that the committee of the Pre-SSS make suggestions on the SSS papers to be accepted as theses.

Formal requirements of thesis are announced in writing by the Department of Air and Road Vehicles.

The latest that thesis can be submitted to the department is the date provided in the Thesis Topic Announcement Form.
The thesis submission deadline is defined in the academic calendar of the Faculty (issued by the Vice-Rector for Education) or, failing that, it is 12 a.m. on the 14th day before the first day of the final exam. The thesis is evaluated by the reviewer and the department separately, and the Head of the Department of Air and Road Vehicles makes a suggestion to the final examination board on its classification based on a five-grade scale.

If the reviewer and the department unanimously evaluate the thesis as fail, the student may not take the final exam and must create a new or a modified thesis. Students must be informed about it. Conditions on resubmitting the thesis are designated by the head of the relevant educational unit responsible for the major or specialisation.

Final exam

Students having obtained the pre-degree certificate will finish their studies by taking the final exam. Final exam can be taken in active student status in the forthcoming exam period after gaining the pre-degree certificate then after termination of student status in any exam period within two years according to the valid education requirements. If the final exam is taken more than two years after obtaining the pre-degree certificate (and termination of the student status) the conditions of taking the exam are stipulated by the Faculty. After the fifth year of the termination of student status the candidate is not allowed to take the final exam. Only students who do not have outstanding charges are allowed to take the final exam.

The final exam shall be taken in front of a board in the examination period following the award of the pre-degree certificate. Final exam can be taken both in the beginning of January and at the end of June.

The final exam shall test and assess the knowledge, skills and abilities requisite to the award of the degree, whereby students shall also prove their ability to apply the acquired knowledge in practice. The conditions for taking the final exam and the parts of the final exam itself shall be defined in the requirements for the training program (see entry 'Completion of studies').

Final exam consists of two parts:
The candidate presents and defends his/her thesis in front of a committee and gives account of his/her knowledge in subjects of the thesis. Candidates are supposed to defend thesis and take the oral exam on the same day.
All candidates (independent from the order of candidates taking the final exam) are expected to arrive at the venue 15 minutes before the start of the final exam and the presentation of thesis. The order of the candidates taking the final exam and the expected end of the final exam will be announced by the committee chair at the beginning of the final exam. Dress code: Candidates are expected to wear something smart which reflects that this is a special and more formal occasion.

1. Thesis defence:
The candidate presents his/her thesis in 10 minutes in front of the final exam board. Presentation is mandatory, the examination room will be provided with computer and slide projector. In the presentation the candidate is supposed to highlight his/her own work and the research results. Taking into account the thesis review report and the questions of the referee and the members of the committee ask questions about thesis. Candidates are expected to answer without any preparation time.

2. Oral exam:
The members of the committee ask questions about the topic of the thesis. Candidates are expected to answer without any preparation time.

The thesis defence and the oral exam are evaluated on a five-point scale by the members of the committee. Final grade for the final exam will be decided on by voting in a closed sitting. In case of equal votes, the committee chair will take the decision. Final exam results will be announced by the committee chair. Results of the final exam and thesis defence will be announced at the end of the given exam day (when all candidates finished final exam and thesis defence on the given day). A note of the final exam will be taken.

Improving failed final exam
Final exam can be retaken if any of its part is a fail. The retake of the final exam may be attempted in the following examination period at the earliest. Final exam can be retaken twice.

The order of subject follows the subject list in the model curriculum below.

Subject group "Basic Natural Sciences" (for both specialisations)

Mathematics I

Code: MK3MAT1A08JX20-EN
ECTS Credit Points: 8
Evaluation: mid-semester grade
Semester: 1st semester
Its prerequisite(s): -
Further courses are built on it: Yes/No
Number of teaching hours/week (lecture + practice): 4+4

Topics:

Analysis. Set theory: set operations, relations, functions. Axioms for the Real Number System. Infimum, minimum, supremum, maximum. The set of the complex numbers, operations, cardinality. Topology of the Reals. Real and complex sequences and series, convergence tests. Real functions: continuity, limit. Sequences and series of real functions, power series, elementary functions. Differentiation of real functions: linear approximation, rules of the differentiation, derivative functions of elementary functions. Tangent line, osculating circle. Mean Value Theorems. Taylor polynomials, investigation of differentiable functions. Primitive functions, indefinite integrals: integration b parts, integral with substitutions. Riemann integral, Newton-Leibniz rule. Applications: area, volume and surface area of bodies of revolution, arc length of plane curves determined by real functions Applications in Engineering. Improper integral. Calculations with mathematical software.

Linear Algebra. Vector geometry: addition and scalar multiplication, inner product, cross product, mixed product. Applications in geometry and physics: area, volume, angles, work done by a constant force. Equations of lines and planes. Matrices: determinants (Sarrus' rule, Gaussian elimination, Laplace expansion), inverse matrix. Vector spaces: linearly independent and dependent vector systems, basis, dimensions. Change of basis. Ranks of vector systems and matrices. Systems of linear equations: Cramer's rule, Inverse Matrix Method, Gaussian elimination. Applications in Engineering.

Literature:

Recommended:

- Thomas' Calculus, Addison Wesley (11th edition, 2005), ISBN: 0-321-24335-8
- S. Minton, Calculus Concept and Connections, McGraw Hill (2006), ISBN 0-07111200-6
- M. D. Greenberg, Fundamentals of engineering analysis, Cambridge University Press, ISBN 978-0-521-80526-1

Schedule

1st week Registration week

2nd week:

Lecture:

Real numbers - Axiom system. Boundary, inf, sup, min, max. Dedekind-complete, real line. Distance, neighbourhood, interior point, accumulation point. Intervals. The sets $\mathbb{R}$, $\mathbb{R}^2$, $\mathbb{R}^3$ and their geometric interpretations. Natural numbers, integer numbers, rational numbers.

Real functions - Definitions: domain, range, restriction, composition, inverse, zero set. Properties: monotonicity, convexity, parity, period. Exponential and logarithm functions, and their properties. Trigonometric and hyperbolic functions and their inverses.

Practice: Real numbers Operations of sets, Boole- algebra. Cartesian product, 2-tuple, n-tuple. Cardinality. Illustrations of sets on the plane and in the space.

Real functions

Illustration of transformed functions, Determination of the inverse function, the largest possible domain, the zero set. Proof of parity.

3rd week:

Lecture: Polynomials, interpolation Factoring polynomials, Euclidean division, rational fractions. Lagrange interpolation.

Real sequences monotonicity, bounded sequences. Convergence, famous sequences, limits and operations. Squeeze theorem.

Practice: Polynomials, interpolation Roots of polynomials, polynomial factorization, sign, tendency of the values at infinity. Solutions of Polynomial equations. Interpolation.

Real sequences Investigation of convergence

4th week:

Lecture: Real series Criteria of convergence. Power series, convergence domain, radius of convergence.

Complex numbers Rectangular form, trigonometric form, exponential form and operations. Solutions of polynomial equations on the set of the complex numbers. The sum of complex series.

Practice: Real series Determination of sums of series, investigation of convergence domains of real series. Complex numbers

5th week:

Lecture: Limits of real functions Continuity, namely limits, limits and operations. Left- and right-limits.

Differentiability Differentiability and continuity, rules of differentiation of real functions. Linear approximation, tangent line.

Practice: Limits of real functions Determinations of function limits.

Operations, equations. Factorization of polynomials	Differentiability applications of the rules of the differentiation
6th week:	**7th week:**
Lecture:	**Lecture:**
Lecture: Mean value theorems: Cauchy, Lagrange Roll. Investigation of differentiable functions. L'Hospital's rule, Taylor polynomials.	**Lecture:** Summary, sample test.
Practice: Investigation of differentiable functions. Applications in Physics.	**Practice:** Applications of differentiation in Physics. Searching of Maximum and minimum values on a closed bounded interval.
8th week: 1st drawing week, Test1	
9th week:	**10th week:**
Lecture: Primitive function (antiderivative), indefinite integral integration by parts, integral with substitution. Riemann integral Newton-Leibniz formula	**Lecture:** Improper integral. Applications of the integration in physics and geometry. Numerical integration.
Practice: Determinations of primitive functions	**Practice:** Applications of Newton- Leibniz formula, calculations of improper integrals. Trapezoidal rule, Simpson's rule, errors
11th week:	**12th week:**
Lecture: Vectorgeomety, vectoralgebra Unit vector in the direction of a vector, projections. Geometric applications: lines and planes in the space. The area of a triangle, the volume of a tetrahedron. The distance between a point and a line, or between a point and a plane Matrices The arithmetic of matrices, determinants and their properties: operations, the notions of symmetrical matrix, skew-symmetrical matrix, determinant, the inverse matrix	**Lecture:** Vectorspaces The notion of linear (or vector) space, linear combinations of vectors, linearly dependent and independent systems, basis, dimension, coordinates. Ranks of vector systems, ranks of matrices Systems of linear equations Gauss elimination (addition method) and Cramer's rule, by the inverse matrix method. Applications: Calculations for direct current using Kirchhoff's current and voltage laws.
Practice: Vector geometry, vector algebra The algebra of vectors in 2 and 3 dimensions: operations, coordinate systems. The algebraic definition of the cross product. Geometric interpretations of	**Practice:** Vector spaces Linearly independent and dependent systems, bases. Ranks of vector systems, ranks of matrices

the scalar product and the cross product. The mixed product. Applications: Mechanical work, moment of a force with respect to a point, moment of a force with respect to an axis. Matrices Operations, determinants and inverses with adjoint matrices	Systems of linear equations Gauss elimination (addition method) and Cramer's rule, inverse matrix method
13th week: **Lecture:** Linear functions The notion of the linear function, the matrices of linear functions. Bases transformation. Eigenvalues, eigenvectors **Practice:** Descriptions of reflections, orthogonal projections, rotations on the plane and in the space.	**14th week:** **Lecture:** Summary, sample test. **Practice:** Determination of eigenvalues, eigenvectors. Applications of a mathematical software.
15th week: 2nd drawing week, Test2	

Requirements

A, for a signature and mid-semester grade:

Participation at practice classes is compulsory. Students must attend practice classes and may not miss more than three practice classes during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. The final grade can be obtained in the following way:

- students write a mid-term test (Test I) from the linear algebra part of the material in the first drawing week; maximum 50 points can be achieved
- students write a mid-term test (Test I) from the differential and integral calculus part of the material in the first drawing week; maximum 50 points can be achieved
- students write an end-term test (Test II) from the linear algebra part of the material in the second drawing week; maximum 50 points can be achieved
- students write an end-term test (Test II) from the differential and integral calculus part of the material in the second drawing week; maximum 50 points can be

Mark ranges after the four tests:

- 175-200 points: excellent (5)
- 150-174 points: good (4)
- 125-149 points: satisfactory (3)
- 100-124 points: sufficient (2)
- 0-99 points: insufficient (1)

Those who fail, or do not accept their marks, can write a Test in any of the first three weeks of the exam period. This Test is a combination of the previous four tests, maximum 50 points can be achieved, and the mark ranges are proportional to the above table. For exam dates see Neptun. If someone does not accept her/his mark, it is possible to get any mark (better, the same, or worse) than the original mark by writing this Test.

Mathematics II

Code:MK3MAT2A06JX20-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Semester: 2nd semester

Its prerequisite(s): Mathematics I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

Topics:

Differentiation and integration of multivariable and vector-valued functions, differential equations.

Part A: Differentiation and integration of multivariable vector-valued functions (2 hours lecture+2 hours practise/week): Metric, topology, sequences in the space. Linear functions. Parametric curves. Notions of differentiation, linear approximation, curvature, torsion. Parametric surfaces, tangent plane, linear approximation. Surfaces of revolution, ruled surfaces. Scalar field, gradient. Young's theorem. Directional derivative. Local and global extrema. Vector fields. Derivatives. Divergence and curl. Potential function. The notion of double and triple integrals on 2 and 3 dimensional intervals. The extensions of the integrals. Integrals over general regions. The arc length of curves, surface area. Line and surface integrals. The theorems of Gauss and Stokes, Green's formulae. Applications in physics.

Part B: Differential equations (2 hours practise/week): Notions of differential equations, classification of differential equations, initial value problem. Problems leading to differential equations. First order linear differential equations (homogeneous and inhomogeneous, method of variation). Determination of solutions of inhomogeneous first order linear differential equations. Higher order linear differential equations. Solution of linear homogeneous differential equations of order two having constant coefficients. Method of undetermined coefficients. Special second order differential equations. The Laplace transform and its applications. Slope fields, numerical methods. (Euler, Runge-Kutta).

Literature:

Compulsory: -

Recommended:

- Thomas' Calculus, Addison Wesley (11th edition, 2005), ISBN: 0-321-24335-8
- S. Minton, Calculus Concept and Connections, McGraw Hill (2006), ISBN 0-07111200-6

- M. D. Greenberg, Fundamentals of engineering analysis, Cambridge University Press, ISBN 978-0-521-80526-1

Schedule

1st week Registration week	
2nd week: Lecture: Part A: Metric, topology, sequences in $\mathbb{R}^n$. Practice: Part A: Limits of vector sequences Part B: Notions of differential equations	3rd week: Lecture: Part A: Parametric curves I. Practice: Part A: Differentiation. Part B: Problems leading to differential equations.
4th week: Lecture: Part A: Parametric curves II. Practice: Part A: Curvature, torsion Part B: First-order linear differential equations	5th week: Lecture: Part A: Differentiable functions of type $\mathbb{R}^n \to \mathbb{R}^m$. Practice: Part A: Derivatives of functions of type $\mathbb{R}^n \to \mathbb{R}^m$. Part B: Higher-order linear differential equations.
6th week: Lecture: Part A: Parametric surfaces Practice: Part A: Surfaces of revolution Part B: Solution of linear homogeneous differential equations of order two having constant coefficients	7th week: Lecture: Part A: Scalar field, gradient. Young's theorem. Directional derivative. Practice: Part A: The domains of functions of type $\mathbb{R}^2 \to \mathbb{R}$. Directional derivative and gradient. Part B: Summary, sample test
8th week: Test 1	
9th week: Lecture:	10th week: Lecture:

Part A: Local and global extrema **Practice:** Part A: Local extremas of functions of type $\mathbb{R}^2 \to \mathbb{R}$, $\mathbb{R}^3 \to \mathbb{R}$. Part B: Method of undetermined coefficients	Part A: Vector fields **Practice:** Part A: Vector fields Part B: Special second order differential equations.
11th week: **Lecture:** Part A: Double and triple integrals **Practice:** Part A: Integrals on 2 and 3 dimensional intervals Part B: Laplace transform	**12th week:** **Lecture:** Part A: Integrals over general regions **Practice:** Part A: Applications Part B: Slope fields, numerical methods.
13th week: **Lecture:** Part A: Line and surface integrals. **Practice:** Part A: arc length of curves, surface area. Line and surface integrals Part B: Potential functions	**14th week:** **Lecture:** Part A: Mathematical software **Practice:** Part A: Summary, sample test Part B: Summary, sample test
15th week: Test 2	

Requirements

A, for a signature and mid-semester grade:

Participation at practice classes is compulsory. Students must attend practice classes and may not miss more than three practice classes during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented.

The final grade can be obtained in the following way:

- students write a mid-term test (Test I) from differential equation part of the material in the first drawing week; maximum 30 points can be achieved
- students write a mid-term test (Test I) from the differential and integral calculus part of the material in the first drawing week; maximum 50 points can be achieved
- students write an end-term test (Test II) from the differential equation part of the material in the second drawing week; maximum 30 points can be achieved

- students write an end-term test (Test II) from the differential and integral calculus part of the material in the second drawing week; maximum 50 points can be achieved

Mark ranges after the four tests:

144-160 points: excellent (5)

128-143 points: good (4)

104-127 points: satisfactory (3)

80-103 points: sufficient (2)

0-79 points: insufficient (1)

Those who fail, or do not accept their marks, can write a Test in any of the first three weeks of the exam period. This Test is a combination of the previous four tests, maximum 80 points can be achieved, and the mark ranges are proportional to the above table.

For exam dates see Neptun. If someone does not accept her/his mark, it is possible to get any mark (better, the same, or worse) than the original mark by writing this Test.

Mathematics III

Code: MK3MAT3A04JX20-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Semester: 3rd semester

Its prerequisite(s): Mathematics II

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Sample space, events. Probability function basic theorems. Discrete and continuous random variables. Cumulative distribution function, probability mass function, probability density function. Mean, variance. Some important models. Sample, descriptive statistics. Point estimation, confidence intervals. Hypothesis testing. Regression.

Orthonormal systems, Fourier series. Trigonometric system, exponential system. Integral transforms: Fourier transform, Laplace transform. Linear differential equations and systems. Introduction to partial differential equations, fundamental examples. Analytical and numerical solution methods.

Literature:

Compulsory:

- Kocsis, I., Integral Transforms with Applications in Engineering, DUPress, 2019.

Recommended:

- Montgomery, D. C., Runger, G. C., Applied Statistics and Probability for Engineers, John Wiley & Sons Inc., 2003
- Soong, T. T., Fundamentals of probability and statistics for engineers, John Wiley & Sons, Inc., 2004.
- Chapra, S. C., Numerical Methods for Engineers, Mc Graw Hill, 2006.
- Greenberg, M. D., Advanced Engineering Mathematics, New Jersey, Prentice Hall, 1998.
- 5. Logan, J. D., Applied Partial differential equations, New York, Springer, 2004.
- 6. Dyke, P., An Introduction to Laplace Transforms and Fourier Series, Springer, 2014.

Schedule

1st week Registration week	
2nd week: Lecture: Sample space, events. Probability function, basic theorems. Practice: Sample space, events. Probability function, basic theorems.	3rd week: Lecture: Discrete and continuous random variables. Cumulative distribution function, probability mass function, probability density function. Practice: Discrete and continuous random variables. Cumulative distribution function, probability mass function, probability density function.
4th week: Lecture: Mean, variance. Some important models. Practice: Mean, variance. Some important models.	5th week: Lecture: Sample, descriptive statistics. Practice: Sample, descriptive statistics.
6th week: Lecture: Point estimation, confidence intervals. Practice: Point estimation, confidence intervals.	7th week: Lecture: Hypothesis testing. Practice: Hypothesis testing.
8th week: Mid-term test	
9th week: Lecture: Regression. Practice: Regression	10th week: Lecture: Regression. Practice: Regression.

11th week: **Lecture:** Orthonormal systems, Fourier series. Trigonometric system, exponential system. **Practice:** Orthonormal systems, Fourier series. Trigonometric system, exponential system.	12th week: **Lecture:** Integral transforms: Fourier transform, Laplace transform. **Practice:** Integral transforms: Fourier transform, Laplace transform
13th week: **Lecture:** Linear differential equations and systems. **Practice:** Linear differential equations and systems.	14th week: **Lecture:** Analytical and numerical solution methods of partial differential equations. **Practice:** Analytical and numerical solution methods of partial differential equations.
15th week: 2nd drawing week – Test 2	

Requirements

A, for a signature:

Participation at practice classes is compulsory.

During the semester there are two written tests: the mid-term test on the 8th week and the end-term test on the 15th week. Students must sit for the tests.

B, for a grade:

The grade is based on the average grade of the two tests.

The minimum requirement of the mid-term and the end-term test is 50% separately. The grade for each test is given according to the following:

Score	Grade
0-49%	fail (1)
50-64%	pass (2)
65-79%	satisfactory (3)
80-89%	good (4)
90-100%	excellent (5)

If the score of a test is below 50%, the student once can write a retake test.

Mathematics Comprehensive Exam

Code: MK3MATSA00JX20-EN

ECTS Credit Points: 0

Evaluation: exam

Semester: 2nd semester

Its prerequisite(s): Mathematics II at the same time or later

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+0

Subjects of the comprehensive exam: Mathematics I-II

Engineering Physics

Code: MK3MFIZA04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 1st semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Geometrical optics, kinematics and dynamics of particles, concept of mechanical work, kinetic and potential energy, electrostatics, electric fields around conductors, transport processes, steady-state transport of electric charge, steady-state heat transfer (conduction, convection and radiation)

Literature:

Compulsory:

- Alvin Halpern: 3,000 Solved Problems in Physics, SCHAUM'S SOLVED PROBLEM SERIES (2011), ISBN-13: 978-0071763462
- Jerry S. Faughn, Raymond A. Serway, Chris Vuille, Charles A. Bennett: Serway's College Physics, Published 2005 by Brooks Cole Print, ISBN 0-534-99723-6

Schedule

1st week Registration week	
2nd week: **Lecture:** Concept of geometrical optics, law of reflection and refraction (Snell's law), Brewster's angle, Optics of prisms and lenses, imaging properties and	3rd week: **Lecture:** Description of the motion by scalar quantities: Scalar position, velocity and acceleration. Example: uniform and uniformly varying motion

magnification, aberrations, compound lenses

Practice: Solving problems for the reflection and refraction of light beams and for the imaging of lenses and compound lenses.

Practice: Solving problems for uniform and uniformly varying motions.

4th week:

Lecture: Description of the motion by vector quantities:

Position vector, vector velocity and acceleration.

Example: throwing problems, circular motion.

Practice: Solving throwing and circular motion problems.

5th week:

Lecture: Kinetics of a particles I

Inertial frame of reference, Newton's Laws, force formulas. Application of Newton's Laws in static and dynamic problems.

Practice: Application of Newton's laws in kinetic problems.

6th week:

Lecture: Kinetics of a particles II

Concept of work and kinetic energy, work-energy theorem. Application of work-energy theorem in dynamic problems.

Practice: Application of Newton's laws and the work energy theorem in kinetic problems.

7th week:

Lecture: Electrostatics I

Electric field strength and flux, Gauss's law for electricity (Maxwell's first equation), potential energy in electric fields.

Practice: Calculation of the electric field strength and its flux in the electrostatic fields of different charge arrangements.

8th week: 1st midterm test

9th week:

Lecture: Electrostatics II

Electric voltage and potential, capacitance, capacitance of planar, cylindrical and spherical capacitors, the energy of capacitors, capacitor circuits

Practice: Calculating the capacitance and stored energy of different types of capacitors and capacitor connections

10th week:

Lecture: Concept of physical system, current intensity and source strength, extensive and intensive physical properties, conduction and convection current. Equation for steady-state conduction. Thermal conductivity and conductive resistance. Conductive resistance circuits.

Practice: Application of the equation of balance and steady-state conduction in different physical problems.

11th week:

Lecture: Steady state transport of electric charge (Direct electric current)

Electric current intensity, electrical conductivity and resistance, Ohm's law, electric work and power, characteristics of DC sources, Kirchhoff's circuit laws, solution of electric circuits

Practice: Solution of DC circuits

12th week:

Lecture: Steady-state heat transfer I - Thermal conduction

Concept of heat current and thermal conduction, equation of steady-state thermal conduction, thermal conductivity and resistance, steady state temperature distribution in a one dimensional wall of thermal conductivity

	Practice: Solving thermal conduction problems
13th week:	14th week:
Lecture: Steady-state heat transfer II - Thermal convection	**Lecture: Steady-state heat transfer III - Thermal radiation**
Concept of thermal convection and heat transfer, equation of steady-state heat transfer, heat transfer coefficient and resistance, overall heat transfer coefficient and resistance	Thermal radiation characteristics, concept of black body radiation, fundamental laws of thermal radiation (Planck distribution, Wien displacement law, Stefan-Boltzmann and Kirchhoff's law), gray body radiation
Practice: Calculating the steady state temperature distribution in a one dimensional wall of thermal conductivity	**Practice:** Solving thermal radiation problems
15th week: 2nd midterm test	

Requirements

A, for a signature:

Participation at lectures is compulsory. Students must attend lectures and may not miss more than three of them during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at lectures will be recorded by the lecturer. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed lectures must be made up for at a later date, being discussed with the tutor.

Students have to write two midterm tests during the semester. The first (40 points max) in the 8th, the second (40 points max) in the 14th week. At the end of the semester everybody will get a seminar grade on the basis of the table below:

0-39 points = Fail (1); 40-50 points = Close fail (2); 51-60 points = Improvement needed (3) = 61-70 points = Very good (4); 71-80 points =Excellent (5)

If somebody fails, then he has to write both tests in the 1st week of the exam period again. If the result is 40 points (50%) or better, then he can take an exam. If somebody has to repeat his midterm tests, then his seminar grade cannot be better than (2).

There will be homework from week to week. Only students who have handed in all their homework at the time of the midterm test will be allowed to write it. The problems in the midterm tests will be selected from the homework assignments.

B, for a grade:

For their exam, everybody will get an exam grade. The final grade will be the average of the seminar and exam grade. If it is for example (3.5) then the lecturer decides if it is (3) or (4).

Technical Chemistry

Code: MK3MKEMK04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 1st semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+1

Topics:

Basic definitions in general chemistry. Energy carriers used in engineering practice, chemical aspects and environmental issues of energy production. Properties and production of motor fuels. Exhaust Gas Composition and Exhaust Gas Purification. Alternative energy sources and alternative motor-driven materials. Electrochemical Power Sources (batteries, fuel cells). Characterization, production and classification of lubricants. Structural materials of particular importance to the automotive industry (metals, plastics and polymer composites). Specific automotive applications of polymer and polymer composites.

Literature:

Compulsory:

- Darrell Ebbing, Steven D. Gammon: General Chemistry (Hardcover) Publisher: Brooks Cole; 11 edition, 2015, 864 pages ISBN: 978-1-305-58034-3.
- Geoffrey M. Bowers Ruth A. Bowers: Understanding chemistry through cars, Publisher: Taylor & Francis Group, 2015, ISBN: 13: 978-1-4665-7184-6 (eBook)

Recommended:

- Roy M. MortierStefan T. Orszulik: Chemistry and Technology of Lubricants: Edition 2, Publisher: Springer Science & Business Media, 2013, 387 pages ISBN: 9789401710213
- Omar Faruk, Jimi Tjong, Mohini Sain: Lightweight and Sustainable Materials for Automotive Applications, CRC Press, ISBN: 978-1-3516-4900-1(ePub)
- S. P. Srivastava, Jenõ Hancsók: Fuels and Fuel-Additives, Publisher: John Wiley & Sons, Inc., 2014, 370 pages ISBN 978-0-470-90186-1

Schedule

1st week Registration week	
2nd week: Lecture: Basic definitions in general chemistry I. Atoms, molecules, ions. Electron configurations and periodicity. Ionic and covalent bonding. States of matter: Gases, Liquids and solids. Practice: Practical tasks related to theoretical material.	3rd week: Lecture: Basic definitions in general chemistry II. Solutions: Solution formation, Colligative properties, Colloid formation. Practice: Practical tasks related to theoretical material.
4th week: Lecture: Energy carriers (coal, petroleum, natural gas) used in engineering practice, chemical aspects and environmental issues of energy production.	5th week: Lecture: Properties and production of motor fuels (Crude oil, crude oil refining). Blending of fuels (Blending of gasolines,

Practice: Practical tasks related to theoretical material.	Blending of diesel gasoils). Aviation fuels (Aviation gasolines, Jet fuels). **Practice:** Practical tasks related to theoretical material.
6th week: **Lecture:** Properties of motor fuels (gasoline and diesel gasoils) and their effects on engines and the environment. Emission regulation of automotive vehicles and quality of automotive fuels. (Direct regulation of emissions. Indirect emission regulations – International standards.) **Practice:** Practical tasks related to theoretical material.	**7th week:** **Lecture**: Alternative energy sources and alternative motor-driven materials. (Alternative fuels: Light (gaseous) hydrocarbons, Propane-butane gas, Mixtures of synthetic liquid hydrocarbons, Oxygen-containing engine fuels and blending component, Hydrogen; Biogas, Bio alcohols.) **Practice:** Mid-term test
8th week: 1st drawing week	
9th week: **Lecture:** Voltaic cells: Construction of voltaic cells, Notation for voltaic cells, Cell potential, Commercial voltaic cells (Leclanché, lithium-iodine battery, lead storage battery, nickel-cadmium cell, Lithium-ion batteries, hydrogen fuel cell) **Practice:** Practical tasks related to theoretical material.	**10th week:** **Lecture:** Characterization, production and classification of engine oils and automotive lubricants. **Practice:** Practical tasks related to theoretical material.
11th week: **Lecture:** Structural materials of particular importance to the automotive industry I. Chemistry of the main group metals (Characteristics and production. Bonding in metals. Superconductivity). Properties of the transition elements. Corrosion, corrosion protection. Alloys. **Practice:** Practical tasks related to theoretical material.	**12th week:** **Lecture:** Structural materials of particular importance to the automotive industry II. Polymers: Types of Polymers, Molecular Structure of Polymers, Polymer Morphology, Characterization of Molecular Weight, Thermal Transitions in Polymers, Polymer Solubility and Solutions, Polymer Applications: Rubbers and Thermoplastic, Surface Finishes and Coatings. **Practice:** Practical tasks related to theoretical material.
13th week: **Lecture:** Structural materials of particular importance to the automotive industry III. Polymer composites: Classification of	**14th week:** **Lecture:** Specific automotive applications of polymer and polymer composites.

Composites, Polymer Matrix Composites, Fabrication of Composites, Structure and properties of Macro-, Micro- and Nanocomposites. Carbon Fiber-Reinforced Polymer Composites, Kevlar Fiber-Reinforced Polymer Composites, Carbon Black-Filled Natural Rubber Composites **Practice:** Practical tasks related to theoretical material.	**Practice:** Closing test of the semester
15th week: 2nd drawing week	

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test in the 7th week and the closing test in the 14th week. **Practice grading** is based on a five-level scale: 1 (fail), 2 (pass), 3 (average), 4 (good), 5 (excellent) calculated from as an average of the midterm test and closing test. Minimum requirement for the tests is 50%. Students have to sit for the tests.

B, for a grade:

For their exam everybody will get an exam grade. The final grade will be the average of the practice grade and exam grade. If it is for example (3.5) then the lecturer decides if it is (3) or (4).

Sample exam test questions provided on the moodle in the beginning of December. All lecture materials are posted at least one day before the lecture.

The grade for each test is given according to the following table:

Score	Grade
0-49	fail (1)
50-64	pass (2)
65-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 50, once students can take a retake test of the whole semester material.

Statics and Strength of Materials

Code: MK3STSZG04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 2nd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Introduction to engineering mechanics. Newton's laws of motion. Force, moment, and couples. Statics of a particle. Statics of rigid body. Planar force systems. Statics of planar structures. Internal force systems of rigid bodies. Loading of beams (cantilevers, freely supported beams, fraction lined beams). Determination of stress resultant diagrams (normal force, shear force and bending moment diagrams). Statically determined beam structures (hinged-bar systems, compound beams, truss systems). Fundamentals of Strength of Materials. Physical interpretation of strain terms. State of deformation. State of stresses. Constitutive equation (Hooke's law). Simple loadings (tension, compression, bending, torsion, shear). Sizing methods. Mohr's circle. Combined loadings (tension and bending, inclined bending, excentrical tension, tension and torsion, bending and torsion). An introduction to the finite element method.

Literature:

Compulsory:

- Tamás Mankovits, Dávid Huri (2018): Strength of Materials (Problems and solutions), University of Debrecen
- Russel C. Hibbeler (2006): Engineering Mechanics – Statics and Dynamics, Prentice Hall, 2006. ISBN-13 9780132215091
- Ladislav Cerny (1981): Elementary Statics and Strength of Materials, McGraw-Hill, ISBN 0070103399, 9780070103399
- László Kocsis (1988): Brief Account of the Lectures of Mechanics, Strength of Materials, BME
- Ferdinand P. Beer, E. Russel Johnston, Jr., John T. DeWolf (2006): University of Connecticut Mechanics of Materials, 4th Edition, © 2006, ISBN-13 9780073107950

Recommended:

- Stephen Timoshenko (1955): Strength of Materials: Elementary Theory and Problems, Van Nostrand
- Jacob Pieter Den Hartog (1961): Strength of Materials, Courier Dover Publications, ISBN 0486607550, 9780486607559

Schedule

1st week Registration week	
2nd week:	3rd week:

Lecture: Mathematical preliminaries (vector-, matrix algebra). Introduction to engineering mechanics. Statics of a particle.

Practice: Calculation the resultant of 2 and 3 dimensional force systems acting on particles.

4th week:

Lecture: Statics of planar structures. Supports and reaction forces.

Practice: Practical examples for the determination of the reaction forces of statically determined structures.

6th week:

Lecture: Determination of stress resultant diagrams of beams.

Practice: Practical examples for the determination of the normal force, shear force and bending moment diagrams of beams.

Lecture: Statics of rigid bodies. Moments. Equilibrium state of a rigid body. Planar force systems.

Practice: Calculation of moments. Examples for equilibrium state of rigid bodies and for planar force systems.

5th week:

Lecture: Internal force systems of rigid bodies. Loading of beams.

Practice: Practical examples for the determination of the normal force, shear force and bending moment functions of beams.

7th week: Lecture: Statically determined beam structures.

Practice: Analysis of hinged-bar systems and truss systems.

8th week: 1st drawing week

9th week:

Lecture: Fundamentals of Strength of Materials. Displacement-, strain- and stress field. Constitutive equation (Hooke's law).

Practice: Practical examples for strain and stress calculations..

11th week: Lecture: Simple loadings II: torsion of prismatic beams with circular and ring cross sections. Mohr's circle. Shear.

Practice: Practical examples for torsion and shear.sis of simple machines

13th week:

Lecture: Combined loadings II: tension and torsion, bending and torsion. Sizing methods.

Practice: Practical examples for combined loadings.

10th week:

Lecture: Simple loadings I: tension, compression and bending of prismatic beams. Fundamentals of sizing and control.

Practice: Practical examples for tension, compression and bending.

12th week: Lecture: Combined loadings I: tension and bending, inclined bending, excentrical tension.

Practice: Practical examples for combined loadings.

14th week:

Lecture: The finite element method.

Practice: Case studies for numerical calculation of engineering structures.

15th week: 2nd drawing week

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory.

Participation at practice is compulsory. Students must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments to the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

During the semester there are two tests: the 1st test in the 7th week and the 2nd test in the 14th week. Students have to sit for the tests.

B, for a grade:

The course ends in a mid-semester grade (AW5) based on the test results. The minimum requirement for both mid-term and end-term test is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score Grade 0-39 fail (1) 40-52 pass (2) 52-63 satisfactory (3) 64-71 good (4) 72-80 excellent (5)

If the score of the sum of the two tests is below 40, the student once can take a retake test of the whole semester material.

Dynamics and Vibrations

Code: MK3MREZG04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 3rd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Motion of a particle: position, velocity and acceleration and the mathematical relations between them, description of the motion of the particle in Cartesian coordinate system and Frenet-frame, Newton's laws and differential equation of the motion of the particle, theorems of kinetics, force fields, kinetic, potential and mechanical energy, constrained motion along a two or three dimensional curve.

Motion of a rigid body: description of the translational, rotational and general plane motion of a rigid body, concept and determination of the instantaneous centre of zero velocity and acceleration, rolling motion

without slipping, description of the plane motion of a rigid body in a time interval, centre of mass, momentum and angular momentum, moment of inertia and its calculation, mechanical work, Newton's laws and theorem of kinetics for rigid bodies, rotating and swinging of the body about an axis, rolling without slipping.

Vibrations: Description and classification of vibratory motions and vibrating systems. Basic definitions and properties of vibratory motion. Investigation of the elements of vibrating systems: masses and inertial elements, flexible and damping elements. Investigation of the dynamic models. Two ways for the generation of motion equations: the D'Alembert's principle and the Lagrange equations of motion. Investigation and properties of the free vibrations of single DOF undamped and damped systems. Solution of the homogenous motion equation. Investigation and properties of the forced vibrations of single DOF undamped and damped systems. Basic types of forced vibrating systems. Multiple DOF systems: introduction, basic properties, natural frequencies and modes, modal transform and decoupling.

Literature:

Compulsory:

- Russel C. Hibbeler: Engineering Mechanics – Statics and Dynamics, Prentice Hall, 2006. ISBN-13 9780132215091
- Jerry Ginsberg: Engineering Dynamics, 3rd edition, Cambridge University Press, 2007. ISBN-13: 978-0521883030
- Lakshmana C. Rao, J. Lakshminarasimhan, Raju Sethuraman, Srinivasan M. Sivakumar: Engineering Mechanics: Statics and Dynamics, PHI Learning Pvt. Ltd., 2004. ISBN 8120321898, 9788120321892
- Meirovitch, Leonard: Fundamentals of Vibration, McGraw-Hill Publishing Company, 2000. ISBN 0071181741

Recommended:

- Ferdinand P. Beer, E. Russell Johnston, Jr.: University of Connecticut, Mechanics for Engineers: Statics and Dynamics (Package), 4th Edition, ©1987, ISBN-13 9780070045842
- Joseph F. Shelley: 700 solved problems in vector mechanics for engineers, Volume II: Dynamics. (SCHAUM'S SOLVED PROBLEM SERIES), McGraw-Hill, 1990. ISBN 0-07-056687-9

Schedule

1st week Registration week	
2nd week: **Lecture:** Kinematics of a particle Scalar and vector position, velocity and acceleration and the mathematical relations between them. Description of the motion in Cartesian coordinate system and Frenet-frame. Special motion types: Motion with constant acceleration, circular motion. **Practice:** Particle kinematics problems.	**3rd week:** **Lecture:** Kinetics of a particle I Newton's laws and differential equation of the motion of the particle. Theorems of kinetics (impulse-momentum, workenergy and angular impulse-angular momentum theorems). Mechanical Power. Force fields (homogeneous, central and conservative). Kinetic, potential and mechanical energy. **Practice:** Particle kinetics problems.
4th week:	**5th week:**

Lecture: Kinetics of a particle II Formulas for work and potential energy in homogeneous and central force fields. Motion of the particle in gravitational and elastic spring force fields. Constrained motion along a two or three dimensional curve. **Practice:** Particle kinetics problems II.	**Lecture:** Kinematics of a rigid body I Basic concepts (rigid body and disc, planar, translational, rotational and general plane motion). Connections between the velocity and acceleration of the different points of a rigid body undergoing translational, rotational and general plane motion. Instantaneous centre of zero velocity and acceleration and procedure for the determination of them with calculation and construction. **Practice:** Rigid body kinematics problems.
6th week:	**7th week:**
Lecture: Kinematics of a rigid body II Rolling motion without slipping. Description of the plane motion of a rigid body in a time interval. Pole curves. **Practice:** Rigid body kinematics problems.	**Lecture:** Kinetics of a rigid body I Basic concepts: centre of mass, momentum and angular momentum, moment of inertia and its calculation, parallel axis theorem, mechanical work. **Practice:** Rigid body kinetics problems.
8th week: 1st drawing week	
9th week:	**10th week:**
Lecture: Kinetics of a rigid body II Newton's laws and theorem of kinetics for rigid bodies (impulse-momentum, angular impulse-angular momentum and work-energy theorems). Special motion types: Rotating and swinging about an axis, rolling without slipping. **Practice:** Rigid body kinetics problems.	**Lecture:** Description and classification of vibratory motions and vibrating systems. Basic definitions and properties of vibratory motion. Investigation of the elements of vibrating systems: masses and inertial elements, flexible and damping elements. **Practice:** Reduction of masses. Replacement of rigid bodies by lumped masses. Reduction of springs and damping elements.
11th week:	**12th week:**
Lecture: Investigation of the dynamic models. Two ways for the generation of motion equations: the D'Alembert's principle and the Lagrange equations of motion. **Practice:** Generating the equations of motion for single- and multiple degrees of freedom (DOF) systems.	**Lecture:** Investigation and properties of the free vibrations of single DOF undamped and damped systems. Solution of the homogenous motion equation. **Practice:** Calculation problems related to the free vibrations of single DOF undamped and damped systems.
13th week:	**14th week:**
Lecture: Investigation and properties of the forced vibrations of single DOF undamped	**Lecture:** Multiple DOF systems: introduction, basic properties, natural

and damped systems. Basic types of forced vibrating systems.	frequencies and modes, modal transform and decoupling.
Practice: Calculation examples of several kinds of forced vibrations in case of single DOF undamped and damped systems.	**Practice:** Calculation problems related to the free and forced vibrations of multiple DOF undamped and damped systems.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at practice is compulsory. Students must attend the practices and may not miss more than three practice classes during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Student can't make up a practice with another group. Attendance at practices will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor.

During the semester there are two tests: the mid-term test is in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for grade:

The course ends in mid-semester grade based on the average grade of the two tests. The minimum requirement for the mid-term and end-term tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score Grade 0-59 fail (1) 60-69 pass (2) 70-79 satisfactory (3) 80-89 good (4) 90-100 excellent (5)

If the score of any test is below 60, the student once can take a retake test covering the whole semester material.

Materials Engineering

Code: MK3ANISG06JX20-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Semester: 1st semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 3+2

Topics:

Atomic bonding in solids. Typical properties of metals. Crystal systems, basic concepts of crystallography. The properties of metallic materials, manufacturing of metals. Crystalline structure of metals. The concept of allotropy, anisotropy, texture. Elastic and plastic deformation of materials. Straining hardening. Changes in the properties of metals influence of cold forming. Imperfections in solids, deformation mechanisms, diffusion. Thermodynamic basics. The process of solidification of liquids is single-phase and in multiphase systems. The concept of phase, phase transformation, alloy, types of alloys. Pure metals and characteristic equilibrium diagrams of binary alloys. Ideal binary diagrams. The Fe-Fe_3C system and the characteristics of this alloy system, allotropic modifications. Phase diagram, microstructure diagram. Influence of alloying elements on the phase diagram. $\gamma \rightarrow \alpha$ transformations, derivation of TTT-curves. Cooling methods. Cooling speed. Principles of transformation diagrams (isothermal, continuous cooling). Properties of non-metallic structural materials. Materials used in the automotive industry (natural and synthetic polymers, ceramic materials, composites) and their properties (physical, mechanical, electrical, optical).

Literature:

Compulsory:

- William D. Callister, David G. Rethwisch: Fundamentals of materials science and engineering: SI version, John Wiley and Sons, 2013., ISBN 978 1 118 32269 7
- V. Raghavan: Materials science and engineering: A First Course, 5th ed., PHI Learning Private Limited, New Delhi, ISBN-978-81-203-2455-8
- Ashby, M. F.: Materials selection in mechanical design, Fourth Edition, Elsevier Ltd. ISBN 978-1-85617-663-7

Recommended:

- ASM Handbook, Vol. 3: Alloy Phase Diagrams, ASM International, 1992., ISBN-10: 0871703815

Schedule

1st week Registration week	
2nd week: **Lecture:** Introduction to material science. The classes and functions of materials and their properties. **Practice:** Overview of periodic system.	3rd week: **Lecture:** Manufacturing process of metals. Chemical reactions during the production of iron. Steel, aluminium and copper production. **Practice:** Classification of steels and cast iron.
4th week: **Lecture:** Crystal structures. Crystalline and noncrystalline materials. Imperfections in solids. Defects type: point, line, bulk, surface. **Practice:** Crystallographic points, directions, and planes.	5th week: **Lecture:** Mechanical properties of metals. Concepts of stress and strain. Elastic, plastic deformation. **Practice:** Tensile Test. Calculation of load to produce specified diameter change.
6th week: **Lecture**: Dislocations and strengthening mechanisms. Mechanisms of strengthening in metals.	7th week: **Lecture:** Phase diagrams. Basic concepts, binary and multi-component systems, the

Practice: Failure: fracture, fatigue, creeps.	Gibbs phase rule. Development of microstructure in isomorphous alloys. **Practice**: Determination of phase amounts, lever rules, types of phase diagrams.
8th week: 1st drawing week	
9th week: **Lecture:** Development of microstructure in iron–carbon alloys. **Practice:** Construction of Fe-Fe_3C phase diagram.	**10th week:** **Lecture:** Types of metal alloys. Classification scheme for the various ferrous alloys and alloying elements. **Practice**: Structure of alloyed steels.
11th week: **Lecture:** Phase transformations: Microstructural and Property Changes in Iron–Carbon alloys. **Practice:** TTT diagrams - Microstructural Determinations for Isothermal Heat Treatments	**12th week:** **Lecture:** Structures, characteristics, applications and processing of polymers. **Practice:** Production and design of ceramics.
13th week: **Lecture:** Structures, characteristics, applications and processing of polymers. **Practice:** Production and design of polymers.	**14th week:** **Lecture:** The classes and functions of composite materials and their properties. **Practice:** Production and design of composites
15th week: 2nd drawing week	

Requirements

A, for a signature:

Attendance on the **lectures** is recommended, but not compulsory.

Participation at **practice** is compulsory. Student must attend the practices and may not miss more than three practices during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student cannot make up a practice with another group. The attendance on practice will be recorded by the practice leader. Being late counts as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence due to the lack of active participation in class.

Students have to submit all the reports from seminar as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test is in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for grade:

The course ends in **mid-semester grade**. Based on the average of the marks of the reports and the average of the test results, the mid-semester grade is calculated as an average of them:

- 40 % grade of the seminar reports,
- 60 % average grade of the two tests.

The minimum requirement for the mid-term and end-term tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, the student once can take a retake test covering the whole semester material.

Thermodynamics

Code: MK3HOTAL04JX20
ECTS Credit Points: 4
Evaluation: mid-term grade
Semester: 3rd semester
Its prerequisite(s): Mathematics II
Further courses are built on it: Yes/No
Number of teaching hours/week (lecture + practice): 2+2

Topics:

The 1st law of thermodynamics. Ideal gas equation. Gas mixtures. Calorific properties, internal energy, specific heat capacity. Isothermal, isovolumetric, isobaric, adiabatic processes. Politropicprocess. Cycle of vehicles (Otto, Diesel). Rankine-Clausius cycle. Technical work. Enthalpy. The 2nd law of thermodynamics. Entropy. Performance. Heat engines. Maximal work, exergy. T-s diagram. Changes in t-s diagram. Phase changes. Tension curve, boundary curves. Critical state. Melting, sublimation. Melting heat, heat of evaporation. Water-vapor T-s diagram. Heat flux. Fourier's heat conductivity equation. One dimensional steady state heat transfer through plain and cylindricyal walls. Multilayered wall structures. Similitude modelling of heat transfer. Surface heat transfer coefficient.

Literature:

Compulsory:

- Dr. Lakatos Ákos. Basics of Heat Transfer and Fluid Mechanics. Debrecen, Magyarország : University of Debrecen (2014) ISBN: 9789634737988
- Müller – Müller: Fundamentals of Thermodynamics and Applications. Springer Verlag, 2009.
- Cengel: Thermodynamics: An Engineering Approach. 5th ed. Boston [etc]: McGraw-Hill Higher education, 2006

Schedule

1st week Registration week	
2nd week: **Lecture:** Definitions and Fundamental Ideas of Thermodynamics. **Practice:** Solving ideal gas law problems.	3rd week: **Lecture:** Changing the State of a System with Heat and Work. Zeroth Law of Thermodynamics **Practice:** Solving ideal gas law problems.
4th week: **Lecture:** The isothermal, isovolumetric, isobar, adiabatic and polytrophic process. The First Law of Thermodynamics: Conservation of Energy **Practice:** Solving 1st law problems, polytropic problems.	5th week: **Lecture:** Mixtures, Partial pressure, Dalton's laws. Gas mixtures. Gas mixtures. Real gases. **Practice:** Solving gas mixture problems.
6th week: **Lecture** Corollaries of the First Law. Generalized Representation of Thermodynamic Cycles (Joule, Otto, Diesel). **Practice:** Solving cycle problems, gas turbine problems.	7th week: **Lecture:** The Carnot Cycle. Entropy. The second law of Thermodynamics. Reversibility and Irreversibility in Natural Processes. Technical work. Enthalpy. Exergy. **Practice:** Solving the Carnot efficiency problem and Joule's heat engine.
8th week: 1st test	
9th week: **Lecture:** Free convection, forced convection (the Reynolds, Grasshof, Prandtl, Galilei, Nusselt numbers). **Practice:** Solving surface heat transfer coefficient problems.	10th week: **Lecture:** Changes and phase changes in T-s diagram (water-vapour). **Practice:** Solving water vapour T-s diagram problems, gas turbine.
11th week:	12th week:

Lecture: Heat transfer. Basic forms of heat transfer. **Practice:** Solving heat equation problems	**Lecture**: Fundamental equations. General differential equation of heat conduction. Steady state and transient conduction. **Practice:** Solving heat equation problems.
13th week: **Lecture:** Thermal resistance. Conduction (plane walls, cylindrical walls, spherical walls). Convection: concepts and basic relations, boundary layers, similarity concept. **Practice:** Solving problems in the theme of the lecture	**14th week:** **Lecture:** Free convection, forced convection (the Reynolds, Grasshof, Prandtl, Galilei, Nusselt numbers). **Practice:** Solving surface heat transfer coefficient problems.
15th week: 2nd test	

Requirements

A, for signature:

Attendance on the **lectures** is compulsory, minimum 50 % attendance is required.

Participation at **practice** is compulsory. Student must attend the practices and my not miss more than three practice during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student can't make up a practice with another group. The attendance on practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence due to the lack of active participation in class.

During the semester there are two tests from the seminar's topic: the mid-term test is in the 8th week and the end-term test in the 15th week. Moreover, there is a test from the theory on the 15th week, too. Students have to sit for the tests.

B, for grade:

The course ends with end term grade. Based on the average of the seminar test results x 0.3 + the grade of from the test of theory x 0.7.

The minimum requirement for the mid-term, end-term tests and for the theory test is 51%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-50	fail (1)
51-60	pass (2)
61-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

Fluid Mechanics

Code: MK3ARATL04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 4th semester

Its prerequisite(s): Thermodynamics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

The Law of Archimedes, surface tension, capillarity, experiment of Torricelli. Theoretical fluid flow. Vector operators. Fluid mechanics. Laws of the fluid flows (continuity and Euler equation, Bernoulli's principle, law of impulse and momentum. Navier-stokes equation). Hydraulics (losses, frictions). Vortex, Helmholtz and Thomson laws. Real flows. Diffuser. Forces acting on the solid body. Propulzional equipment. Movements of ships. Flows around vehicles, buoyant force, flow resistance and side forces. Subsonic, transonic and supersonic flows. Gas dynamics. Aerodynamics. Numerical analysis of flows.

Literature:

Compulsory:

- Basics of Heat Transfer and Fluid Mechanics Debrecen, Magyarország: University of Debrecen (2014) ISBN: 9789634737988
- Pozrikidis: Fluid Dynamics. Springer Verlag, 2009.
- Clayton, Roberson, Elger. Engineering Fluid Mechanincs, 7th Edition, ISBN:0-471-38482-8

Schedule

1st week Registration week	
2nd week: **Lecture:** Definitions and Fundamental Ideas of Fluid mechanics and Hydrostatics. Theoretical fluid flow. Vector operators. Fluid mechanics. Introducing the concepts, principles, laws, observations, and models of fluids at rest. **Practice:** Solving hydrostatic and ideal flow problems.	**3rd week:** **Lecture:** Laws of the fluid flows (continuity and Euler equation). **Practice:** Solving continuity equation problems.
4th week: **Lecture:** Laws of the fluid flows (Bernoulli's principle).	**5th week:** **Lecture:** Law of pulse and momentum. **Practice:** Solving injector problems.

Practice: Solving Bernoulli's principle problems.	
6th week: **Lecture:** Laws of the fluid flows (Navier-stokes equation). **Practice:** Solving motion problems.	**7th week:** **Lecture:** Vortex, Helmholtz and Thomson laws. Real flows. **Practice:** Solving problems in the theme of the lecture.
8th week: 1st test	
9th week: **Lecture:** Real flows and real fluid phenomena and description (resistance, laminar and turbulent flow, boundary layers, separation) with applications to lift and drag on objects. **Practice:** Solving problems in the topic of the lecture.	**10th week:** **Lecture:** Diffuser and applications (pipes, vehicles) **Practice:** Solving problems in the topic of the lecture
11th week: **Lecture:** Friction and fitting losses in pipe flow. Modified Bernoulli. Open channel. **Practice:** Solving real flow and viscous flow problems.	**12th week:** **Lecture**: Subsonic, transonic and supersonic flows. Gas dynamics. Aerodynamics. **Practice:** Solving problems in the theme of the lecture
13th week: **Lecture:** Forces acting on the body merged in a fluid. Flows around vehicles, buoyant force, flow resistance and side forces. **Practice:** Solving problems in the theme of the lecture	**14th week:** **Lecture:** Numerical analysis of flows. **Practice:** Introduction to CFD and CFX applications.
15th week: 2nd test	

A, for signature:

Attendance at least on the half of **lectures** is compulsory.

Participation at **practice** is compulsory. Student must attend the practices and my not miss more than three practice during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student can't make up a practice with another group. The attendance on practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for

at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence due to the lack of active participation in class.

During the semester there are two tests: the mid-term test is in the 8th week and the end-term test in the 15th week from the seminar topics. Students have to sit for the tests.

B, for grade:

The course ends with exam grade, based on the average of the seminar test results x 0.3 + the exam grade from the theory x 0.7.

The minimum requirement for the mid-term, end-term tests and for the exam is 51%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-50	fail (1)
51-60	pass (2)
61-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

Subject group "Economics and Humanities" (for both specialisations)

Business Law

Code: MK3UZLJM03JX20-EN

ECTS Credit Points: 3

Evaluation: exam

Semester: 4th semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+0

Topics:

This course helps students understand the basics of a legal relationship. The course covers the concept and the rules of basic legal principals. Law, the function of law, branches of law, sources of law, provision of law, legal relationship, legal ability, legal capacity. The course also helps students understand the common rules of contract law, general rules of contracts and each significant contract according to the Civil Code: contracts for sale, contracts of exchange, contracts of agency, agency agreements, user agreements, escrow contracts. The law of compensation and contractual and delictual liability will also be elaborated on. It introduces common company rules and regulations. The rules of certain business associations: unlimited partnership, limited partnership, limited liability company, company limited by shares. Students will familiarize with the basic rules of labour law (employment relationship, the separation of business

relationship and contract of engagement, the subjects of employment relationship, its foundation, amendment, termination, rules referred to employees in manager positions, liability for damages.).

Literature:

Compulsory:

- Schaffer, Richard – Agusti, Filiberto – Dhooge, Lucien: International Business Law and Its Environment, Cengage, 2017. ISBN 978-1305972599
- Hartkamp, Arthur – Sieburgh, Carla – Devroe, Wouter: Cases, Materials and Text on European Law and Private Law, Hart, 2017, ISBN 978-1509911875
- Radley-Gardner, Oliver – Beale, Hugh – Zimmermann, Reinhard – Schulze, Reiner: Fundamental Texts on European Private Law, Hart, 2016. ISBN 978-1841133782

Schedule

1st week Registration week	
2nd week: Lecture: Basic definitions and principles of business law: functions of law, regulatory authorities, principles	3rd week: Lecture: Law of persons: legal capacity, capacity to act for private individuals.
4th week: Lecture: Company law: formation of companies, structure and corporate governance, cessation, bankruptcy and liquidation of companies	5th week: Lecture: Law of obligations: definition and nature of obligations, limitation period, basic principles
6th week: Lecture: Nature and formation of a contract. Performance. Nature and formation of a contract. Performance. Nature and formation of a contract. Performance.	7th week: Lecture: Breach of a contract and remedies: definition of breach, remedies available to the parties, calculation and assessment of damages. Basics of business torts: grounds for civil liability, defenses.
8th week: 1st drawing week	
9th week: Lecture: Product liability in the European Union: definition of a defective product, grounds for liability, defenses, limitation periods, cumulation of claims.	10th week: Lecture: Law of property: rights of the owner, enforcement, possession.
11th week: Lecture: International sales law: CISG rules on formation, breach and remedies.	12th week: Lecture: Contract for labour and services: specialities and case-law.

13th week: Lecture: Intellectual property law: patents, trademarks.	14th week: Lecture: Dispute resolution: diplomacy, international tribunals, arbitration, commercial arbitration.
15th week: 2nd drawing week	

Requirements

Attendance of lectures is compulsory. Students must attend lectures and may not miss more than three lectures during the semester. In case a student does so, the course will not be signed and the student must repeat the course. Attendance will be recorded by the lecturer. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.

During the semester there is one test: the end-term test on week 14. Students must sit for the test. The minimum requirement for the test is 60%. Based on the score of the test a grade is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

An offered grade: students might be offered a grade if the result of their test is at least good (4). If somebody fails or does not attend the test, he/she must take an exam.

B, for a grade:

The course ends in an examination. The minimum requirement for the examination is 60%. Based on the score of the examination a grade is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Micro- and Macroeconomics

Code: MK3MIMAM04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 2nd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week: 1+2

Topics:

This course aims to make students familiar with the basic concepts of microeconomic and macroeconomic analysis. In particular, the course will be focused on the analysis of how economic actors, consumers and firms choose between different alternatives. By the end of the course, the student should be able to use the basic tools and models of microeconomics and macroeconomics and apply them to solving problems. The course focuses on the theory and application of the following: Microeconomic processes, the basics of supply and demand. Market equilibrium. The elasticity of demand (supply). Consumer behaviour - Households' choices (Marginal utility theory). Firm's production (factors), costs of production, profit-maximizing behaviour. Market structures (perfect competition, imperfect competition: monopoly). Profit maximizing under perfect competition, and monopoly. Cost-benefit and Break-even analysis. Measuring macroeconomic output (real vs. nominal Gross Domestic Product, Gross output). Consumption and Investment. Household and firm sector. Investment multiplier. The economic role of government (externalities). Fiscal policy and output determination. The role of money in the economy, the evolution of money, the central bank, commercial banking, the supply and the demand for money. Monetary policy. Aggregate demand and supply. Labour market. Unemployment and inflation.

Literature:

Compulsory:

- Mankiw, Gregory (2015): Principles of Economics. Seventh Edition. Cengage Learning, USA, 2015. ISBN-10: 128516587X; ISBN-13: 978-1285165875.
- Mankiw, Gregory (2015): Principles of Economics. Study Guide. Seventh Edition. Cengage Learning, ISBN-13:978-1-285-86421-1.
- Judit T. Kiss (2014): Introduction to Macroeconomics for Engineers and Technical Managers. Debrecen University Press. ISBN: 978-963-318-416-5.
- Judit T. Kiss (2015): Introduction to Microeconomics for Engineers and Technical Managers. Debrecen University Press. ISBN: 978-963-318-469-1.

Recommended literature:

- K. E. Case – R. C. Fair – S. M. Oster (2012): Principles of Macroeconomics, Tenth Edition. Prentice-Hall, ISBN 13: 978-0-13-139140-6.
- Parkin, M., Powell, M. & Matthews, K. (2008) Economics. 7th ed. Harlow: Addison Wesley. ISBN-13: 9780132041225
- Besanko, David – Breautigam, Ronald R. (2014): Microeconomics. Fifth Edition (International Student version). John Wiley and Sons, Inc., New York. ISBN: 978-1-118-71638-0
- Besanko, David – Breautigam, Ronald R. (2008): Microeconomics. Study Guide. Third Edition. John Wiley and Sons, Inc., New York, 2008.

Schedule

1st week Registration week	
2nd week: Lecture: *Basic concepts of Micro- and Macroeconomics* Introduction to Microeconomics and Macroeconomics, models in Economics. Key analytical tools (Comparative statics, Equilibrium analysis, Constrained optimization). Efficiency and use of resources. The components of the Macroeconomics. The circular flow Diagram. Market sectors – commodity, money and labour market. Practice: Calculation/team problems: Main economic problems. Circular flow of income Case study examination.	3rd week: Lecture: *Measuring Macroeconomic Output* Output and Income. Price level, Consumer price index. Measuring macroeconomic output (Gross Output, Gross Domestic Product, calculating GDP, real versus nominal GDP, the components of the GDP). Practice: Calculation/team problems: measuring macroeconomic income and output. The difference between nominal and real GDP. GDP deflator and Produce price index.
4th week: Lecture: *The Keynesian Theory – Aggregate demand* Consumption function, marginal propensity to consume. Saving function, marginal propensity to saving. Economic role of investment, Mathematical and geometrical derivation of the equilibrium output. Investment multiplier, the main influencing factors of investment. Practice: Calculation/team problems: consumption and saving function, Investment multiplier. Investment-saving function.	5th week: Lecture: *Government in the economy* Government expenditures and revenues. Types of taxes, disposable income, government budget, fiscal policy, the tax multiplier. Average tax rate, tax wedge, and marginal tax rate. Practice: Calculation/team problems: The role of the government in the economy. Tax burden and tax multiplier.
6th week: Lecture: *Demand curves, Supply curves; Market equilibrium.* Calculation problems: equilibrium price and quantity; market demand and individual demand; shifts versus movements along the demand curve (supply curve)	7th week: Lecture: *Utility theory*, cardinal versus ordinal approach. Principle of the Marginal Utility. *Types of elasticity of demand* Price elasticity of demand, cross-price elasticity of demand, income elasticity of demand. The elasticity of supply. Total

Practice: Calculation/team problems: Market equilibrium. Surplus and shortage.	revenue and the price elasticity of demand. Increase in total revenue. **Practice:** Calculation/team problems: the relationship between marginal and total utility, total utility maximization.
8th week: Mid-term test	
9th week: Lecture: *Production* Factors of production. Production function. The marginal product of labour and the average product of labour. Law of diminishing marginal returns to labour (capital). *Costs of production* Total, fixed and variable costs, marginal and variable cost. The relationship between marginal and average cost. Total revenue, total profit curves. Calculating problems (types of cost, the relationship between cost and profit. opportunity cost). **Practice:** Calculation/team problems; (average product of labour (capital), the marginal product of labour (capital), the relationship between marginal product and average product. Marginal cost, total, variable and fixed cost, average costs.	10th week: Lecture: *Condition of profit maximization* The main condition of profit maximization under competitive market. Main characteristics of the competitive market. Marginal cost, average costs of production, profit-maximizing output, shut down and breakeven point, profit and loss. The competitive firm's supply curve. **Practice:** Calculation/team problems: marginal average revenue, total revenue, average and marginal profit, profit-maximizing output, marginal cost curve and supply curve. Determination of the shutdown and breakeven point.
11th week: Lecture: *Perfect and Imperfect competition* Monopoly (the profit-maximization condition); *Money market* **Practice:** Profit maximization condition (Monopoly), consumer and producer surplus.	12th week: Lecture: *The labour market* The demand for labour, the supply of labour. The labour force, working-age population, active and inactive population, labour participation rate. Supply curve and demand curve, equilibrium. Employed population. **Practice:** Calculation/team problems: Supply of labour function, and demand for labour function, equilibrium analysis.
13th week: Lecture: *Main macroeconomic problems – Unemployment and inflation I.*	14th week: Lecture: *Main macroeconomic problems – Unemployment and inflation II*

Measurement of Unemployment, the unemployment rate, the employment and activity rate. Types of unemployment (voluntarily and involuntarily unemployment; structural, frictional and cyclical unemployment), Okun law. **Practice:** Case study examination and team problems. Measurement of unemployment.	Inflation; (Price level, inflation rate, definition and measuring of inflation, types and causes of inflation, moderate, galloping and hyperinflation, demand side and supply side inflation, The relationship between the unemployment rate and inflation rate – Philips curve). **Practice:** Case study examination and team problems: Reasons for inflation, the Philips curve.
15th week: End-term test	

Requirements

A, for a signature:

Participation in practice classes is compulsory. Students must attend practice classes and may not miss more than three occasions during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent to an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test on the 8th week and the end-term test on the 15th week. Students must sit for the tests.

B, for a grade (ESE):

The course ends in an **examination.**

The minimum requirement of the mid-term, the end-term test and the teamwork is 50% separately. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

The grade is given according to the following table:

%	Grade
0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-89	good (4)
90-100	excellent (5)

If the score of any test is below 50%, the student once can take a retake test of the whole semester material.

An offered grade: It may be offered for the students if the average of the mid-term test, end-term tests and the teamwork is at least good (4). The offered grade is the average of them.

Management and Business Economics

Code: MK3MEN1M04JX20-EN
ECTS Credit Points: 4
Evaluation: exam
Semester: 4th semester
Its prerequisite(s): Micro- and Macroeconomics
Further courses are built on it: Yes/No
Number of teaching hours/week (lecture + practice): 1+2

Topics:

The purpose of the course is to give students an insight into the goals and tasks of management and applying its methodology in the industry and in other fields. Students familiarise with the role and place of management, its integrating function in economic activities, and, the complexity of the main management tasks, roles and competencies within managing an organisation. They learn the history of the discipline's development and the factors defining the most basic forms of company structure. Students learn the management trends and methods applied at enterprises and the get to know techniques of analysing macro and micro environment, and the methodology of applying them. They learn the importance of the factors defining the behaviour of different operators, and gain an insight into the general characteristics of the professional fields of management.

During the semester, students become acquainted with the types of enterprises, the processes of starting one, and the different fields of business economics. The course serves as a stable basis for the other economics-related subjects of the training programme. Apart from presenting the theory of management and business economics, the course includes calculation exercises and case studies as well.

Literature:

Required literature:

- Ramani, S. Improving business performance: a project portfolio management approach. Boca Raton, FL: CRC Press, Taylor & Francis Group, [2016]. 216 p. 658.4 ISBN 9781498741941
- Gupta, Sushil; Martin Starr: Production and operations management systems Boca Raton: CRC Press, Taylor & Francis Group, [2014]. 485 p. ISBN 9781466507333
- Reinert, Kenneth A.: Introduction to international economics: new perspectives on the world economy. Cambridge: Cambridge University Press, 2012. 474 p. ISBN 978-0-521-17710-8
- Stephen P. Robbins, Mary Coulter: Management. 13. ed., global ed. Boston, Mass. [u.a.] : Pearson, c2016! [2015]. 717 p. ISBN 978-1-292-09020-7
- Michael R. Baye: Managerial economics and business strategy. 7th ed. Boston: McGraw-Hill, cop. 2010. 621 p..2 ISBN 978 007 126744 1

Recommended literature:

- N. Gregory Mankiw, David R. Hakes: Principles of economics: study guide.7. ed. Stamford: Cengage Learning, 2015., 605 p.: ill.; 28 cm ISBN 978-1-285-86421-1
- Ricketts, Martin J.: The economics of business enterprise: an introduction to economic organisation and the theory of the firm. Northampton: Edward Elgar Publishing, [2019] 651 p. ISBN 978-1-78536-094-7
- Thomas, Christopher; Maurice, S. Charles: Managerial Economics Foundations of Business Analysis and Strategy. McGraw-Hill Education, 2015. 736. p. ISBN 9780078021909
- Gillespie, Andrew: Business Economics. OUP Oxford, 2013. p. 528. ISBN 9780199657995
- Economics Concepts, Methodologies, Tools, and Applications. IGI Global, 2015. 1800 p. ISBN 9781466684683

Schedule

1st week Registration week	
2nd week: Lecture: Business concept, Enterprises Practice: Stakeholders	3rd week: Lecture: Structure forms Practice: Establishing a company
4th week: Lecture: Strategy Practice: PEST and SWOT analysis	5th week: Lecture: Business Plan Practice: Study case
6th week: Lecture: Innovation and Investments Practice: Investment analysis	7th week: Lecture: Financial Strategies, Financial Plan Practice: How to make an efficient financial plan?
8th week: 1st drawing week TEST 1	
9th week: Lecture: Marketing Management Practice: How to develop an efficient marketing mix? (study case)	10th week: Lecture: Human Resource Management Practice: Study cases
11th week: Lecture: Logistics Practice: Exercises in the field of logistics	12th week: Lecture: Project Management Practice: Project Planning Techniques
13th week: Lecture: Crisis management Practice: Study case	14th week: Lecture: Organisational Development

Practice: Techniques used in organisational development

15th week: 2nd drawing week TEST 2

Requirements

A, for a signature:

Attending practices is compulsory. Students must attend practice classes and may not miss more than three occasions during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students cannot take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test on the 7th week and the end-term test on the 15th week. Students must sit for the tests.

B, for a grade:

The course ends in an **examination.**

The minimum requirement of the mid-term, the end-term test and the teamwork is 50% separately. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

The grade is given according to the following:

0-49 % = fail (1); 50-64 % = pass (2); 65-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5)

If the score of any test is below 50%, the student once can take a retake test of the whole semester material.

An offered grade: It may be offered for the students if the average of the mid-term test, end-term tests and the teamwork is at least good (4). The offered grade is the average of them.

Systems of Quality Management

Code: MK3MIMRM04JX20-EN

Evaluation: mid-semester grade

ECTS Credit Points: 4

Semester: 4th semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

The aim of the course is to provide students with a comprehensive picture of the organization's operations and the associated management and organizational roles and tasks. The aim of the course is to give students the opportunity to share with the company's quality management techniques, the application of which in the European Union, as well as in Hungary, is an essential element of market competitiveness.

Literature:

Compulsory:

- Nick Milton, Patrick Lambe: The Knowledge Manager's Handbook, Kogen Page, London, 2016
- Ranulfo P. Payos, Ernesto G. Espinosa, Orlando S. Zorilla: Organization and Management, K12, 2016
- Ramani S: Improving Business Performance: A Project Portfolio Management Approach, CRC Press, 2016

Schedule

1st week Registration week	
2nd week: Lecture: Basics of Quality management Practice: Analyze examples	3rd week: Lecture: The role of quality management in the industry Practice: PDCA project
4th week: Lecture: Process Management Practice: Create a flowchart	5th week: Lecture: Quality Planning Practice: Developing a Quality Plan
6th week: Lecture: Quality Management Methods I Practice: Ishikawa, Pareto Analysis, 5W	7th week: Lecture: Quality Management Methods II Practice: QFD, Kano model, 5s, 8D report
8th week: 1st drawing week	
9th week: Lecture: Engineering management Practice: Case study	10th week: Lecture: Company and its surroundings Practice: SWOT, Pestle analyzes
11th week: Lecture: Management functions, manager roles, tasks Practice: Situational tasks	12th week: Lecture: Organization Theory Practice: Process Development, Project Management
13th week: Lecture: Human Resource Management Practice: Recruitment, selection, work planning	14th week: Lecture: Innovation Management Practice: Business Plan
15th week: 2nd drawing week	

Requirements

A, for a signature:

Participation at lectures is compulsory. Students must attend lectures and may not miss more than three of them during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at lectures will be recorded by the lecturer. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed lectures must be made up for at a later date, being discussed with the tutor.

Students have to write two midterm tests during the semester. The first (40 points max) in the 8th, the second (40 points max) in the 14th week. At the end of the semester everybody will get a seminar grade on the basis of the following (score/grade): 0-39 = fail; 40-50 = pass (2); 51-60 = satisfactory (3); 61-70 = good (4); 71-80 = excellent (5).

If somebody fails, then he has to write both tests in the 1st week of the exam period again. If the result is 40 points (50%) or better, then he can take an exam. If somebody has to repeat his midterm tests, then his seminar grade can't be better than (2).

There will be homework from week to week. Only students who have handed in all their homework at the time of the midterm test will be allowed to write it. The problems in the midterm tests will be selected from the homework assignments.

B, for a grade:

Everybody will get an exam grade for their exam. The final grade will be the average of the seminar and exam grade. If it is for example (3.5) then the lecturer decides if it is (3) or (4).

Subject group "Professional Compulsory Subjects" (for both specialisations)

Programming

Code: MK3PROGR04JX20-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Semester: 3rd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice):0+4

Topics:

C programming language. Primitive data types: integer, float, double and character. Mathematical, comparative and logical operators and expressions. Complex or derived data types: array, structure, union and pointer. Relation between arrays and pointers. Concepts of the variable and the function. Types and roles of the different control statements, as the loops (while, do-while or for loop) and the decision-making statements (if-else, if-else if-else, nested if, switch, break, goto). Concept and types of the algorithm: recursive, divide and conquer, dynamic programming, greedy, brute-force, backtracking, searching and sorting. Input/Output, file operations. Clean code, basic rules of writing an effective and optimal code.

Literature:

Recommended:

- Kernighan, Brian W., and Dennis M. Ritchie. The C programming language. 2006.
- C.L. Tondo – S.E. Gimpel: C answer book
- Kelley, Al, and Ira Pohl. A book on C; Programming in C. Benjamin-Cummings Publishing Co., Inc., 1994.
- Perry, Greg M., and Dean Miller. C programming: absolute beginner's guide. Pearson

Schedule

1st week Registration week	
2nd week: **Practice:** C programming language.	3rd week: **Practice:** Primitive data types: integer, float, double and character.
4th week: **Practice:** Mathematical, comparative and logical operators and expressions.	5th week: **Practice:** Complex or derived data types: array, structure, union and pointer..
6th week: **Practice:** Relation between arrays and pointers.	7th week: **Practice:** Concepts of the variable and the function.
8th week: mid-term test	
9th week: **Practice:** Types and roles of the different control statements, as the loops (while, do-while or for loop).	10th week: **Practice:** Types and roles of the different control statements, as the decision-making statements (if-else, if-else if-else, nested if, switch, break, goto).
11th week: **Practice:** Concept and types of the algorithm: recursive, divide and conquer, dynamic programming, greedy.	12th week: **Practice:** Concept and types of the algorithm: brute-force, backtracking, searching and sorting.
13th week: **Practice:** Input/Output, file operations.	14th week: **Practice:** Clean code, basic rules of writing an effective and optimal code.
15th week: End-term test	

Requirements

A, for a signature:

Participation at practice classes is compulsory.

During the semester there are two written tests: the mid-term test on the 8th week and the end-term test on the 15th week. Students must sit for the tests.

B, for a grade:

The grade is based on the average grade of the two tests.

The minimum requirement of the mid-term and the end-term test is 50% separately. The grade for each test is given according to the following:

Score	Grade
0-49%	fail (1)
50-64%	pass (2)
65-79%	satisfactory (3)
80-89%	good (4)
90-100%	excellent (5)

If the score of a test is below 50%, the student can write a retake test once.

Basic Theory of Vehicle Engineering

Code: MK3ALJGJ04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 1st semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+1

Topics:

Physical quantities, systems of measurement. Basics of Measurement Technology. Concept of machines, their grouping. Physical quantities and their relationships. Types of machine operations. Mechanical work, power, efficiency concept. Friction and rolling resistance. Modification and transfer of mechanical work. Variable speed operation of machines with advanced and rotary motion. The work of changing forces. Variable machine losses, efficiency, optimal load. Periodic movements of vehicles and machines, damping of swinging movements, reduction of degree of inequality. Work of spring forces, spring characteristics. Crankshaft gear. Flywheel. Resting fluid balance, energy content and performance, hydrostatic lift. Swimming and stability of ships. Flowability of flowing fluid, flow in piping systems. Liquid transport by pump. Fluid impulse change machines, simple turbines. Operational processes in gas engines, gas compression and expansion, circuits in thermal power plants, efficiency. Machine Characteristics, Collaboration, Operating Point and Stability. Basic concepts of vehicle and machine control, control and regulation.

Literature:

Compulsory:

- Tiba Zs.: Basic constructions of machine design DUPRESS 2017.
- Tiba Zs.: Drivetrain optimization. DUPRESS 2017.
- Kutz, M.: Mechanical Engineers' Handbook, 4 Volume Set, 4th Edition, ISBN: 978-1-118-11899-3, 2015.

- Sanny, J.; Ling, S.: University Physics Volume 1, ISBN 13: 9781938168277, 2016.
- Lindeburg, M.R.: Mechanical Engineering Reference Manual for the PE Exam, 13th Ed, ISBN: 978-1591264149, 2013.

Schedule

1st week Registration week	
2nd week: **Lecture:** SI units, basic and derived quantities, prefixes. Translational and rotational motion, moment of inertia, torque, work, power **Practice:** Overview of The International System of Units (SI). Elaboration of kinetic and kinematic exercises. Elaborating exercises in the following topics: losses of machines, efficiency, specific consumption, economical efficiency.	3rd week: **Lecture:** Efficiency, power loss of machines **Practice:** Elaborating exercises in the topic of flywheels and hydrostatics. Utilization of Bernoulli's principle.
4th week: **Lecture:** Bernoulli's equation, law of continuity, Venturi tube, water jet force. **Practice:** Elaborating calculation exercises in the field of hydrodynamics.	5th week: Entropy, specific heat capacity, latent heat, temperature-entropy diagram for steam. **Practice:** Elaborating calculation exercises: the air as energy source.
6th week: **Lecture:** Classification of machines, power drives **Practice:** Elaborating calculation exercises: machines transmitting fluid and the water vapor as energy source.	7th week: **Lecture**: Drive gears, flywheels, breaks, springs **Practice:** Elaborating calculation exercises in connection with water vapor elements.
8th week: Mid-term test	
9th week: **Lecture:** Otto engines, Diesel engines I. **Practice:** Elaborating calculation exercises in connection with water vapor	10th week: **Lecture:** Otto engines, Diesel engines II. **Practice:** Elaborating calculation exercises: machines transmitting gas.
11th week: **Lecture** Positive displacement pumps, centrifugal pumps and gear pumps. **Practice:** Elaborating calculation exercises: steam-engines, steam-boilers	12th week: **Lecture:** Fans, compressors. **Practice:** Elaborating calculation exercises: internal combustion engines.
13th week: **Lecture:** Steam boilers, steam turbines, steam power plants **Practice:** Elaborating	14th week:

calculation exercises: water turbines, topics of hydraulic and pneumatic machines.	**Lecture:** Water turbines, wind power plants, swimming and stability of ships Adaptation of prime movers and driven machines **Practice:** Elaborating calculation exercises in the field of machine groups.
15th week: End-term Test	

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. Students must attend the practice classes and may not miss more than three of the during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students cannot make up practice classes with another group. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments for the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence because of the lack of active participation in class.

Students have to **take part in laboratory measures** and submit the measuring reports minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for a grade:

The course ends in an **examination**. Based on the average of the grades of the measuring reports and the examination, the exam grade is calculated as an average of them:

- the average grade of the measuring reports
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

An offered grade: it may be offered for the students if the average grade of the two designing tasks is at least good (4) and the average of the mid-term and end-term tests is at least good (4). The offered grade is the average of them.

Vehicles and Mobile Machinery

Code: MK3JAMGJ04JX20-EN
ECTS Credit Points: 4
Evaluation: exam
Semester: 2nd semester
Its prerequisite(s): -
Further courses are built on it: Yes/No
Number of teaching hours/week (lecture + practice): 2+1

Topics:

The role of vehicles and mobile machinery in the transportation, classification of the vehicles. The main processes of the vehicle motion. Energetics fundamentals of the longitudinal motion of vehicles, energy sources applied for vehicle propulsion, processes of the energy conversation in case of the several vehicle types. Active and passive forces acting on the vehicles, equations of motion, dynamics, stability and control of vehicle motion. Different kinds of vehicle propulsion systems, direct drive, wheel-drive, caterpillar drive, propeller drive. The typical elements of the drive system, constructional and operation analysis of clutches, gearboxes, shafts, suspension systems and brake systems. Dynamics of the vehicle cornering, constructional requirements and principles of steering systems, typical configurations of steering systems. Role, constructional and operation analysis of end-gearboxes and differentials. Basics of vehicle suspension systems, fundamental constructions of the suspension and shock-absorber systems. Dynamics of the braking of vehicles, constructional requirements of braking systems, constructional and operation analysis of the advanced braking systems. Main aspects of the construction of vehicle bodies, their auxiliary accessories, main trends of the development. Fundamental types of the earth moving machines. Operation principles, characteristics and powertrain systems of the machinery. Types, operation principles and characteristics of road construction machinery. The machinery of industrial material flow. Classification of material handling machines. Construction and operational properties of forklifts, stacker cranes and monorail systems. Construction and operational properties of conveyors.

Literature:

Compulsory:

- Victor Albert Walter Hillier (1991): Fundamentals of Motor Vehicle Technology, Nelson Thornes, 1991. ISBN-10: 0748705317.
- Tom Denton (2002): Motor Vehicle Engineering, Cengage Learning EMEA, 2002, ISBN-10: 1861528922.

- Julian Happian-Smith (2001): An Introduction to Modern Vehicle Design, Elsevier, 2001, ISBN-10: 0750650443.

Schedule

1st week Registration week	
2nd week: **Lecture:** The role of vehicles and mobile machinery in the transportation, classification of the vehicles. The main processes of the vehicle motion. **Practice:** Calculation problems.	3rd week: **Lecture:** Energetics fundamentals of the longitudinal motion of vehicles, energy sources applied for vehicle propulsion, processes of the energy conversation in case of the several vehicle types. **Practice:** Calculation problems.
4th week: **Lecture:** Active and passive forces acting on the vehicles, equations of motion, dynamics, stability and control of vehicle motion. **Practice:** Calculation problems	5th week: **Lecture:** Different kinds of vehicle propulsion systems, direct drive, wheel-drive, caterpillar drive, propeller drive. The typical elements of the drive system, constructional and operation analysis of clutches, gearboxes, shafts, suspension systems and brake systems. **Practice:** Calculation problems.
6th week: **Lecture:** Dynamics of the vehicle cornering, constructional requirements and principles of steering systems, typical configurations of steering systems. Role, constructional and operation analysis of end-gearboxes and differentials. **Practice:** Calculation problems.	7th week: **Lecture**: Basics of vehicle suspension systems, fundamental constructions of the suspension and shock-absorber systems. Dynamics of the braking of vehicles, constructional requirements of braking systems, constructional and operation analysis of the advanced braking systems **Practice:** Calculation problems.
8th week: Mid-term test	
9th week: **Lecture:** Main aspects of the construction of vehicle bodies, their auxiliary accessories, main trends of the development. **Practice:** Calculation problems.	10th week: **Lecture:** Fundamental types of the earth moving machines. Operation principles, characteristics and powertrain systems of the machinery. **Practice:** Calculation problems.
11th week:	12th week:

Lecture: Types, operation principles and characteristics of road construction machinery. **Practice:** Calculation problems.	**Lecture:** The machinery of industrial material flow. Classification of material handling machines. **Practice:** Calculation problems.
13th week: **Lecture:** Construction and operational properties of forklifts, stacker cranes and monorail systems. **Practice:** Calculation problems.	**14th week:** **Lecture:** Construction and operational properties of conveyors. **Practice:** Calculation problems.
15th week: End-term test	

Requirements

A, for a signature:

Participation in practice classes is compulsory. Students must attend practice classes and may not miss more than three occasions during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent to an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test on the 8th week and the end-term test on the 15th week. Students must sit for the tests.

B, for a grade (ESE):

The course ends in an **examination.**

The minimum requirement of the mid-term test and the end-term test is 50% separately. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

The grade is given according to the following table:

%	Grade
0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-89	good (4)
90-100	excellent (5)

If the score of any test is below 50%, the student once can take a retake test of the whole semester material.

An offered grade: It may be offered for the students if the average of the mid-term test, end-term tests and the teamwork is at least good (4). The offered grade is the average of them.

Technical Drawing I

Code: MK3MAB1A04JX20-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Semester: 1st semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+1

Topics:

Basis of axonometry and perspective. **Projection drawing.** Monge's method of projection. Point, line in a plane and intersection tasks (intersection of line with plane, intersection of two planes). Visibility of 3D objects. Method of the replacing image-planes (transformation of views). Rotation of plane. Representation of a polyhedrons, intersection of the polyhedrons with lines and planes. Intersection of two polyhedrons. Surfaces of revolution. Techniques of 3D representation in computer-aided modelling: representation of solids, sizing, geometric constructions, representation of polyhedrons, solid modelling, 3D constructions.

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Literature:

Compulsory:

- Church, A. E.: Elements of Descriptive Geometry, American Book Company, University of Michigan
- Fuller, A., - Ramirez, A. – Smith, D.: Technical Drawing 101 with AutoCAD 2020, SDC Publications
- Ledneczky, P.: Descriptive Geometry I., BUTE

Recommended:

- Pare, E. G.,- Loving, R. O. - Hill, I. L. - Pare, R. C.: Descriptive Geometry, Amazon
- Yamaguchi, F.: Computer-Aided Geometric Design, Springer Verlag

Schedule

1st week Registration week	
2nd week: **Lecture, Practice:** Axonometry, perspective. Introduction to multiview projection.	**3rd week:** **Lecture, Practice: Introduction to the Monge's method of projecting** Projection of the space-elements (points, lines, segments, planes). Relative position of two straight lines. Special positions of a straight line to image planes. Special positions of the planes to the image planes.
4th week:	**5th week:**

Lecture, Practice: Points and lines in the plane Line in a plane, point in a plane. First mainline and second mainline in a plane. Point in a first/second projecting plane.	**Lecture, Practice: Intersection of a line with the plane** Intersection of a line with the projecting plane. Intersection of a line with the plane (in general position). Visibility.
6th week:	**7th week:**
Lecture, Practice: Intersection of two planes The intersection line of projecting planes. The intersection line of planes, if one of them is in projecting position. Intersection line of two planes.	**Lecture, Practice: Method of the replacing image-planes** (transformation of views) Introduction of new image planes, the method of the replacing of an image plane with a new plane. Rotation of the plane.
8th week: 1st drawing week	
9th week:	**10th week:**
Lecture, Practice: Metric tasks. Determining distances and angles of the objects Distance between two points. Lenght of the line-segment. Distance from a point to a plane. Distance from a point to a line. Angle of inclination of a line to the image-planes. Angle formed by two planes. Perpendicularity. Distance between two parallel lines. Distance between two skew lines. Distance between two parallel planes. Angle formed by two lines. Rotation of plane	**Lecture, Practice: Intersection of the polyhedrons with lines and planes** Intersection of prisms and pyramids with lines. Intersection of prisms and pyramids with planes.
11th week:	**12th week:**
Lecture, Practice: Intersection of two polyhedrons I. Intersection of prisms and pyramids.	**Lecture, Practice: Intersection of two polyhedrons II. Curved surfaces** Intersection of prisms and pyramids. Surfaces of revolution.
13th week:	**14th week:**
Lecture, Practice: Computer-aided geometric constructions I. Representation of solids and polyhedrons, sizing, 3D constructions.	**Lecture, Practice: Computer-aided geometric constructions II.** Representation of solids and polyhedrons, sizing, 3D constructions.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Regular attendance (Minimum 70 %). Successful accomplishment of three drawings.

B, for grade:

Grades will be a composite of homework (drawing) (30%), mid-term test (35%), end-term test (35%). The homework will be issued five times in the semester. Minimum requirements to pass the semester: successful accomplishment of the drawings and tests (minimum 50%).

Technical Drawing II

Code: MK3MAB2A04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 2nd semester

Its prerequisite(s): Technical Drawing I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Students get acquainted with basic rules of preparation of technical documentation. They acquire the specifications and get routine in preparation and application of technical drawings. They get acquainted with CAD systems, and get routine in the use of AutoCAD software.

Drawing standards, formal requirements of machine drawings. Drawing sheet dimensions, line types and thickness groups. Projection views, sections and sectional views, revolved- and removed sections. Drawings of standardized machine elements: threads and thread symbols, bolted joint, gears, sprocket-wheel, splined shaft, bearings. Representation of welded joints. General prescriptions for dimensioning. Conventional dimensioning methods. Tolerance system. Defining fits: clearance, transition and interference fit. ISO Tolerance system. Form and position tolerances. Defining the surface roughness.

General properties of AutoCAD. Utilization of commands, menu bar options and icons. The layer-system of the AutoCAD, operations with layers. Use of outer references and blocks. Dimensioning possibilities, building up dimensional chains, representation of tolerances.

Literature:

Compulsory:

- Tiba Zsolt, Machine drawing, Debreceni Egyetemi Kiadó – Debrecen University Press, 2013
- Learning AutoCAD 2010, Autodesk Official Training Guide Edition, 2010

Recommended:

- Flender, Technical Handbook

Schedule

1st week Registration week	
2nd week: **Lecture:** Drawing standards, formal requirements of machine drawings. Drawing sheet dimensions, title block, defining the line types and thickness groups. Standardized letter and figure shape and sizes, scales, full size, reduction scales, enlarged scales. **Practice:** issuing the task 1: Lettering	**3rd week:** **Lecture:** Defining the surfaces of a part. Views, auxiliary view, local view, sectional views and sections. Complex sectional views, removed sections, specific sectional views and sections. **Practice:** issuing the task 2: Drawing Machine Parts. Introduction of CAD systems, general properties of AutoCAD.
4th week: **Lecture:** General prescriptions for dimensioning, choosing basis surfaces. Conventional dimensioning methods. Specific dimensioning, defining and giving conical taper and flat taper **Practice:** submitting the task 1 and 2, issuing the task 3: Shaft drawing. User interface of AutoCAD. Utilization of commands, menu bar options and icons.	**5th week:** **Lecture:** ISO Tolerance system. Basic size, actual size, limits, deviations, fundamental deviation. Defining the tolerance IT grades. **Practice:** Applying the dimensioning methods to dimensioning parts. "Modify" commands in AutoCAD. Effect of constructional commands on efficiency.
6th week: **Lecture:** Hole-base system, shaft base system. Defining fits: clearance, transition and interference fit. **Practice:** submitting the task 3, issuing the task 4: Designing Fitting Pieces. Applying the cutting plane and the cutting sphere method to construct the intersection lines of interpenetrating surfaces. The layer-system of the AutoCAD, operations with layers.	**7th week:** **Lecture:** ISO Tolerance system. Form and position tolerances. Free dimensional tolerance. **Practice:** Designing Fitting Pieces. Applying the triangulation and parallel line methods to develop fitting pieces. Representing tolerances and calculating its dimensions. Insertion of texts in AutoCAD. Loading and modification of letter types.
8th week: 1st drawing week	
9th week: **Mid-term test**	**10th week:** **Lecture:** Standardized Thread forms and its main features. Threads and thread symbols

Lecture: Defining the surface roughness. Feasible roughness with different processing methods. Correlation between the surface roughness and the IT grade of dimension. **Practice:** elaborating the shop drawing of pattern development of fitting pieces. Hatching, loading of styles, indication of areas to hatch in AutoCAD.	in drawing. Threaded joints: bolted joint, studded joint, screw fastening. **Practice:** submitting the task 4, issuing the task 5: Screw Fastening and Joints. Presentation of tolerances and fits in drawing. Presentation of surface roughness in drawing. Use of outer references and blocks in AutoCAD.
11th week: **Lecture:** springs: standardized representation of helical spring, Belleville spring, buffer spring, annular spring, multi-leaf spring. Keyed joints with saddle keys, sunk keys, parallel keys and woodruff keys. Splined shaft joint. **Practice:** elaborating the task 5, Drawing threaded joints in section and on view. Dimensioning possibilities in AutoCAD, building up dimensional chains, representation of tolerances.	**12th week:** **Lecture:** Gears and toothed parts. Spur and helical gears, bevel gears, worms, rack and pinion gears, sprockets. **Practice:** issuing the task 6: Gearing. Drawing keyed joints and splined shaft joint in section and on view. Drawing in AutoCAD.
13th week: **Lecture:** rolling bearings: ball and roller bearings. Riveted joints. Welding symbols and welded joints: butt joint, lap joint, tee joint, corner joint. **Practice:** submitting the task 5, elaborating task 6. Drawing in AutoCAD.	**14th week:** **Lecture: End-term test** **Practice:** submitting the task 6. Drawing bearings, riveted and welded joints in section and on view. Drawing in AutoCAD.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Attendance on the **lectures** is recommended, but not compulsory.

Participation at **practice** is compulsory. Student must attend the practices and my not miss more than three practice during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student can't make up a practice with another group. The

attendance on practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments for the course with them to each practice. Active participation is evaluated by the teacher in every class. If student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence due to the lack of active participation in class.

Students have to **submit all the six drawing tasks** made manually as well as with AutoCAD as scheduled minimum on a sufficient level.

B, for grade:

The course ends in **exam**. Based on the average of the marks of the drawings and the exam result, the final grade is calculated as an average of them.

Electronics and Electrotechnics

Code: MK3ELTTR04JX20-EN
Evaluation: mid-semester grade
ECTS Credit Points: 4
Semester: 2nd semester
Its prerequisite(s): Engineering Physics
Further courses are built on it: Yes/No
Number of teaching hours/week (lecture + practice): 2+2

Topics:

Introduction to DC circuits: voltage, current, basic components. Network analysis: Ohm's Law, Kirchhoff's Law, current and voltage divider, superposition, Thevenin and Norton's Law. Alternating current circuits: sinusoidal wave, calculation on the complex plane, power and effective values. Transient signals in the AC circuits: series and parallel RLC circuits. 3 phases circuit.

Introduction to electronics: features of electronic circuits, solid state devices. Transistors, unipolar and bipolar transistors. Operation, characteristics, and basic circuits. Amplifiers: 4 port theory, transfer functions, feedback: positive and negative. Semiconductors, diode, special diode. Common emitter amplifier. Differential amplifier: operational modes, circuit. Class A and AB amplifiers. Power amplifiers. Operational amplifiers: inverting and non-inverting type. Filters: Low and high pass filter, band pass filter.

Literature:

Compulsory:

- Electronic Circuits: Handbook for Design and Application, U. Tietze, Ch. Schenk, 2nd edition, 2008, ISBN-10: 3540004297

Recommended:

- A.P. Godse, U.A. Bakshi: Basic Electronics, 5th revised edition, Technical Publications Pune 2005, ISBN 81-89411-26-8

Schedule

1st week Registration week	
2nd week: Lecture: Electrostatics, DC networks: basic electrical concepts of electric charge, electric current (amperage), electric field, electric field work, electric voltage (potential), electric circuit Practice: General description, laboratory regulations, Safety regulations and safety instruction	3rd week: Lecture: Power source (ideal real), Power Source (ideal for real), Consumer, Ohm's Law, Resistance - design, characteristic data, division, marking according to IEC standard. Passive resistance of bipolar networks, Star-delta, delta-star conversion, Electrical work, electric power, efficiency Practice: introduction to measurements and instrumentation (measuring error, power supply, digital multimeter, signal generator)
4th week: Lecture: Network analysis: Kirchhoff's laws, Voltage divider, potentiometer, extending measuring range of a Volt meter current divider, extending measuring range of an Amp meter, Wheatstone bridge. Nodal analysis, Mesh analysis. Practice: 1st measurement: measuring the characteristics of DC voltage (U, I, RB, P) using Ohm's Law. Measuring the values of DC circuit. Using Kirchhoff's lows. Report writing.	5th week: Lecture: Network analysis: superposition theory, Northon and Thevenin theory. Practice: Perform a complex DC measurement and calculation task. Report writing.
6th week: Lecture: AC circuit, complex number, AC circuit mean value (RMS). Behavior of a resistance in AC circuit, inductance behavior in AC circuit, capacitance behavior in AC circuit. Practice: introduction to AC measurements and instrumentation (AC type digital multimeter, signal generator, oscilloscope, LRC meter). Report writing.	7th week: Lecture: Performance of AC circuits, power factor correction, Three-phase systems Practice: measurements of AC power. Report writing.
8th week: 1st drawing week	
9th week:	10th week:

Lecture: Pure and doped semiconductor characteristics, PN junction behavior at forward and reverse bias conditions. **Practice:** Silicon diode opening and closing characteristics measurements. Analysis of rectifier circuits. Report writing.	**Lecture:** Characteristics and applications of semiconductor diodes, the rectifier circuit operation, the one-way, two-way rectifier circuits operation. **Practice:** Analysis of rectifier circuits. Report writing.
11th week: **Lecture:** Bipolar transistor structure, gain, transistor parameters and characteristics, the FE connection, adjusting the set point. Areas of application of bipolar transistor, circuits transistor basic (CB, CC circuits), **Practice:** Analysis of common emitter basic circuit. Report writing.	**12th week:** **Lecture:** Principles of operation of field-effect transistors. **Practice:** Analysis of common source basic circuit. Report writing.
13th week: **Lecture:** Operation and characteristics of basic operational amplifier circuits (inverting, non-inverting, follower, summing, differential, differentiator and integrator basic circuit) **Practice:** Analysis of summing operational amplifier basic circuit. Report writing.	**14th week:** **Lecture:** Filters: Low and high pass filter, band pass filter. **Practice:** Analysis of filters basic circuit. Report writing.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory. Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. Missed practice classes must be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as absence because of the lack of active participation in class. During the semester there are one test. Students have to sit for these tests.

Preparing measurement reports until deadline.

B, for grade:

At the end of the course a test must be taken. The minimum requirement for end-term test is 41%. Score Grade 0-40 fail (1) 41-55 pass (2) 56-70 satisfactory (3) 71-85 good (4) 86-100 excellent (5)

Vehicle and Drive Elements I

Code: MK3JAH1J05JX20-EN

ECTS Credit Points: 5

Evaluation: exam

Semester: 3rd semester

Its prerequisite(s): Statics and Strength of Materials

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

The series of lectures are based on the topics of technical drawing and mechanics. It reviews the recurrent construction elements of vehicles, their grouping and analysing. The phenomenon of the fatigue and its importance in the vehicle constructions. The fundamental relations of the sizing procedure of machineries (stress analysis for static combined loads; dimensioning on strength at harmonically varying loads, fatigue and life of members) and the concept of manufacturing tolerance and fitting. After that it deals with connections between components (connection with force transmission by friction, positive connections, bolted joints, weldings), gaskets, elastic connections (metal springs, rubber springs) beds for machine eg. rolling bearings, plain journal bearings.

In the laboratory, being connected with the lectures machine elements are studied and tests of them are carried out. In seminars there are two design tasks to elaborate: a welded machinery base, and a hydraulic cylinder.

Literature:

Compulsory:

- TIBA ZS.: Machine Drawing, ISBN 978-963-318-066-2, Debrecen University Press 2010.
- Joseph Shigley, Charles Mischke, Richard Budynas: Mechanical Engineering Design, 7th Edition Hardcover with access card, 1056 pages©2004, ISBN-13 9780072921939
- Ansel Ugural, NEW JERSEY INSTITUTE TECH: Mechanical Design: An Integrated Approach, 1st Edition Hardcover with access card, ©2004, ISBN-13 9780072921854

Schedule

1st week Registration week	
2nd week: **Lecture:** Requirements against components, stressing theories. Theory of a fatigue failure, designing a simple and a	**3rd week:** **Lecture:** Power screws and fasteners. Free body diagrams of power screws, wrench torques. Fastener materials and stress. Lap

combined fluctuating load. Goodman diagram, Smith diagram. **Practice:** issuing task 1: Designing a welded machinery base. Scathing different constructions for a welded base. Measuring the dimension of parts, calculating the tolerance and fit dimensions.	joints from bolted joints. Bolt tightening of pressure vessel caps. **Practice:** Design of welded constructions. Dimensioning a welded base. Determining the friction coefficient in a bolted joint by measurement.
4th week: **Lecture:** Riveted joints. Welded joints, strength of a butt and lap joint subjected to a constant load, a fatigue load and an eccentric load. **Practice:** Constructing a welded base.	**5th week:** **Lecture:** Positive and frictional torque transmitting connections. Torque capacity of keyed joints, spline joints, clamped joints. **Practice:** Submitting a welded base design. Issuing a hydraulic cylinder designing task.
6th week: **Lecture:** Seals, operation principles. Contacting and non -contacting seals and their application fields. **Practice:** Studying the operation method of a hydraulic cylinder, determining its main dimensions.	**7th week:** **Lecture:** Springs, tasks and operation principles of springs. Stressing of bar springs, leaf springs, multi-leaf springs, Belleville springs. Helical springs, designing and stressing for a fatigue load. **Practice:** Sketching different constructions for a piston, a cap and a cover regarding sealing, studying similar constructions.
8th week: Mid-term test	
9th week: **Lecture:** Rubber springs, features and spring diagrams. Designing and stressing block and cylindrical rubber springs for compression, shear and torsion load. **Practice:** Constructing the assembly drawing of a hydraulic cylinder.	**10th week:** **Lecture:** Bearings, lubrication principles and methods. Heat balance and application fields of journal bearings. **Practice:** Constructing the assembly drawing of the hydraulic cylinder.
11th week: **Lecture:** Rolling bearings, features of different types of bearings. Separable, non-separable bearings, bearing clearances (initial, mounting, working).	**12th week:** **Lecture:** Bearing arrangements. Locating, non-locating bearing arrangement. **Practice:** Elaborating the shop drawings of the parts: a piston, a piston rod, a head, a cover.

Practice: Elaborating the shop drawings of the parts: a piston, a piston rod, a head, and a cover.	
13th week: **Lecture:** Cross located bearing arrangements with adjusted or floating bearings **Practice:** Elaborating the records of stressing and design.	**14th week:** **Lecture:** Selection of ball and roller bearings for service life. **Practice:** Submitting a hydraulic cylinder task..
15th week: End-term test	

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for a grade:

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)

80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

An offered grade: it may be offered for students if the average grade of the two designing tasks is at least good (4) and the average of the mid-term and end-term tests is at least good (4). The offered grade is the average of them.

Vehicle and Drive Elements II

Code: MK3JAH2J05JX20-EN

Evaluation: exam

ECTS Credit Points: 5

Semester: 4th semester

Its prerequisite(s): Vehicle and Drive Elements I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Types of couplings, clutches and breaks and their sizing. Classification and sizing of shafts, components of drive chains and transmissions with special read to them applied in mobile machines. Mechanical drives, positive and frictional connection operation principles. Operation methods and the sizing procedure of a belt and a chain drive. Types of gearing, geometry and basic principles of involute gear pair: standard basic rack tooth profile, generating the involute profile, undercut, contact ratio, crest width. Gear's material and manufacturing technology. Tooth force of meshing gear pair, load capacity of gears, reasons for failures. Basics of bevel; worm; and internal gear drive. Seizing methods of meshing gear pair. Special mechanical gearing. Task and construction of the crank mechanism, its kinematic and dynamic analysis. The task of the flywheel and its seizing.

In the laboratory, connected to the lecture the vehicle–and drive elements are studied and tests of them are conducted. In seminars there are two design tasks to elaborate: an external long-shoes drum break, and a counterdrive containing a V-belt drive and a chain drive.

Literature:

Compulsory:

- TIBA ZS.: Machine Drawing, ISBN 978-963-318-066-2, Debrecen University Press 2010.
- Joseph Shigley, Charles Mischke, Richard Budynas: Mechanical Engineering Design, 7th Edition Hardcover with access card, 1056 pages©2004, ISBN-13 9780072921939
- Ansel Ugural, NEW JERSEY INSTITUTE TECH: Mechanical Design: An Integrated Approach, 1st Edition Hardcover with access card, ©2004, ISBN-13 9780072921854

Schedule

1st week Registration week	
2nd week: **Lecture:** Energy equilibrium of braking processes. A mechanical model of a winch crane. Calculation of an external shoe drum brake, a serviceable diagram. Designing a brake spring and choosing its thruster. **Practice:** Issuing task 1: Designing an external double-shoe thruster released a drum brake. Scathing different constructions for brake actuation.	3rd week: **Lecture:** Derivation of the braking moment capacity of an internal shoe drum brake, band brakes and disc brakes and clutches. A uniform wear model, a uniform pressure model. **Practice:** A service diagram of a brake: maximum brake moment, maximum drum speed, checking for heat generation. Designing the brake spring, selecting the brake thruster.
4th week: **Lecture:** Designing steps of an external shoe thruster released drum brake. **Practice:** Constructing a brake assembly drawing.	5th week: **Lecture:** Couplings, rigid couplings, flexible couplings, universal joints. Supplementary loads on shafts having misalignment. **Practice:** Submitting a brake design. Issuing a counter drive designing task.
6th week: **Lecture:** Belt drives. Flat, round, V and timing belts. Forces on a belt, optimal belt speed. Belt drive arrangements, selection procedure of a belt profile, designing a belt drive. A chain drive. Types and application fields of chains, chordal action. Designing a chain drive, selecting a chain from brand catalogue. **Practice:** Designing the layout of a counter drive. Dividing the total speed ratio for a belt drive and for a chain drive. Designing a belt and a chain drive of a counter drive.	7th week: **Lecture:** A shaft and its associate parts. Designing a shaft and stressing against fatigue, plastic deformation, elastic deflection and critical speed. **Practice:** Designing a counter shaft and its keyed joints. Stressing a shaft and checking against fatigue and plastic deformation.
8th week: Mid-term Test	
9th week: **Lecture:** Gears, types of gears. Nomenclature of a spur gear. Involving gears. A standard basic rack tooth profile.	10th week: **Lecture:** Unmodified, modified gear pairs, addendum modification. **Practice:** Constructing an assembly drawing of a counter drive.

Practice: Designing a counter shaft bearing. Selecting ball bearings.	
11th week: **Lecture:** The modified gear's dimensions. Checking gears for crest width, contact ratio and undercut. Load bearing capacity of a gear. **Practice:** Elaborating an assembly drawing. Designing a chain drive chasing.	**12th week:** **Lecture:** **Practice:** Elaborating the shop drawing of the parts: a shaft, a pulley, a sprocket, a bearing house.
13th week: **Lecture:** the crank mechanism, its kinematic and dynamic analysis **Practice:** Elaborating the shop drawing of the parts: a shaft, a pulley, a sprocket, a bearing house.	**14th week:** **Lecture:** The flywheel and its seizing. **Practice:** Submitting the Counter Drive task.
15th week: End-term Test	

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments for the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for a grade:

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

An offered grade: it may be offered for the students if the average grade of the two designing tasks is at least good (4) and the average of the mid-term and end-term tests is at least good (4). The offered grade is the average of them.

Vehicle Materials and Technologies

Code: MK3JAATJ06JX20-EN

Evaluation: exam

ECTS Credit Points: 6

Semester: 3rd semester

Its prerequisite(s): Materials Engineering

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 4+4

Topics:

Properties of vehicle structure materials and technologies which influence of materials properties (heat treatment, metal forming, surface treatment). Basic concepts of metal forming processes. Flow conditions. Formable sheets. Classification of sheet metal forming technologies. Sheet metal forming processes and its technology (volume shaping, material separation processes, blanking and punching). Steps of designing of sheet metal forming tool. The theory of bending, V-shaped, U-shaped bending technology, tools. The theory of deep drawing and theoretical arrangement of deep drawing. The maximum force and power calculation to deep drawing. Designing of deep drawing tools. Special metal forming technologies. Forming of car body panels. Weldability of metals and its alloys. Classification of welding technologies. Flame welding processes, arc welding processes, shielded gas welding technologies, construction of welding equipment. Arc and machine characteristic curves. Automotive welding technologies. The role of machining in vehicle manufacturing. Classification of machining processes. Basic concepts of cutting. Cutting with a single-edged tool. Tool design, edge geometry, chip removal, chip formation, chip breaking, cutting force-, heat conditions, tool wear, tool life, quality of cutted surface. Machining processes, turning, milling, drilling, planning, chipping, abrasive processes, gearing, and thread cutting technology and their tools. Machining with irregular edges, grinding tools, grinding processes. Basic rules of gear manufacturing. Special machining, electrochemical, laser-, and water-jet cutting.

Literature:

Compulsory:

- Mikell P. Groover: Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley, 2006, ISBN: 9780471744856
- Fritz Klocke: Manufacturing Processes 1: Cutting, Springer-Verlag Berlin Heidelberg, 2011, ISBN 9783642119781
- Fritz Klocke: Manufacturing Processes 2: Grinding, Honing, Lapping Springer-Verlag Berlin Heidelberg, 2009, ISBN 9783540922599,

Recommended:

- J. T. Black, Ronald A. Kohser: DeGarmo's Materials and Processes in Manufacturing, 11th Edition, 2011, ISBN: 9780470924679

Schedule

1st week Registration week	
2nd week: **Lecture:** Overview of plastic deformation of sheet metals. Stresses and shape modification during plastic deformation. **Practice:** Stress tensor, calculation methods, scalar and vector methods.	3rd week: **Lecture:** Classification of sheet metal forming technologies. Sheet metal forming processes and its technology (volume shaping, material separation processes, blanking and punching). **Practice:** Calculation of the minimal force to metal forming, and average stress calculation in different forming types.
4th week: **Lecture:** The theory of bending, V-shaped, U-shaped bending technology, tools. **Practice:** Designing of bending tools.	5th week: **Lecture**: The theory of deep drawing and theoretical arrangement of deep drawing. The maximum force and power calculation to deep drawing. Forming of car body panels **Practice:** Designing of deep drawing tools
6th week: **Lecture:** Overview of Welding Technology. The Weld Joint. Physics of Welding. Features of a Fusion-Welded Joint. Types of Arc welding **Practice:** Arc welding	7th week: **Lecture:** Energy Beam welding. (laser, electron beam, plasma) Oxyfuel gas welding. Solid state welding. Resistance Welding **Practice:** Oxyfuel gas welding.
8th week: 1st drawing week	
9th week: **Lecture:** Other Fusion-Welding Processes. Solid-State Welding. Weld Quality.	10th week: **Lecture:** Surface heat treating process: carburizing, nitriding, carbonitriding. hot

Weldability. Machines of welding technology **Practice:** Gas tungsten arc welding (GTAW).	metal spray fusing. Equipment for heat treating operations. **Practice:** Heat treatment and surface treatment of automotive steels..
11th week: **Lecture:** Types of manufacturing methods, chip generation process, chip types. Cutting force and cutting tool geometries. Factors of the cutting force. **Practice:** Tool-geometry practice (dimensional analysis of different cutting tools)	**12th week:** **Lecture:** Classification of turning machines. Classification of milling machines. **Practice:** Machining Practice (on a turning machine).
13th week: **Lecture:** Threading tools, gear manufacturing tools, grinding tools. Classification of grinding and gear production machines. Design and components analysis. **Practice:** Methods to design a production technology. Calculation of basic technological parameters.	**14th week:** **Lecture:** Special technologies. Electric arc cutting, ultrasonic milling, water-jet cutting, electro-polishing. **Practice:** Dimensional measuring practice.
15th week: 2nd drawing week	

Requirements

Attendance on the lectures is recommended, but not compulsory. Participation at practice is compulsory. Student must attend the practices and not miss more than three practice during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student can't make up a practice with another group. The attendance on practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor.

During the semester there are two tests: the mid-term test is in the first drawing week and the end-term test in the 2nd drawing week. Students have to sit for the tests. If the score of any test is below 60%, the student once can take a retake test covering the whole semester material.

B, for grade:

The course ends with an exam, the grade is calculated as:

- 60% from the exam
- 20%-20% from the two tests

The minimum requirement for passing is 60%, the grade for the final mark is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Vehicle Manufacturing and Repair

Code: MK3JAGJJ05JX20-EN

ECTS Credit Points: 5

Evaluation: exam

Semester: 4th semester

Its prerequisite(s): Vehicles and Mobile Machinery

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Internal hierarchy and construction of part manufacturing systems. The basic theorem of CNC programming, classification of coordinate systems to the machines. Interpretation of simple and complex cycles. Drilling cycles, thread cutting cycles, manufacturing and measurement of 2D, 3D and 5D surfaces by CNC machines and devices. Application possibilities of special transformation techniques during the manufacturing. The process of mechanical designing. Designing based on features, CIM interpretation of life section and product models. Basic methods and implementation of competing product designing. Manufacturing of statue surfaces. Finishing techniques considering the part's shape. Overview of rapid prototyping and reverse engineering techniques. Manufacturing analysis of typical parts of the vehicles. Basic definitions, systems and strategies of vehicle maintenance and reparation. Reparation technologies of typical surfaces. Laboratory practice and measurement: manufacturing of 2D, 3D, and 5D surfaces by CNC machines. Application and demonstration of the Reverse Engineering process. Application of designing and manufacturing of shape features by a CAM software.

Literature:

- Klocke, F.: Manufacturing Processes I., Cutting, Springer, RWTH edition, 2011, ISBN 978-3-642-11978-1, p. 524.
- Halderman, J. D.: Automotive Technology, Fourth edition, Pearson New International Edition, 2014, ISBN 10: 1-292-04218-4, p. 1831
- Gupta, H. N., Gupta, R. C., Mittal, A.: Manufacturing Processes, Second Edition, New Edge International Publishers, 2009, ISBN (13) : 978-81-224-2844-5, p. 194.
- Kief, H. B., Roschiwal H. A.: CNC Handbook, The McGraw-Hill Companies, 2011, ISBN 978-0-07-179948-5, p. 451
- Tom DentonTechnique\\Transportation: Cars, motorcycles Butterworth-Heinemann, 2011

  ISBN 10: 0080969461; ISBN 13: 9780080969466

- Auto Repair and Maintenance ISBN 13: 9781615647620
- Robert L. Mott, Edward M. Vavrek, Jyhwen Wang Machine Elements in Mechanical Design Technology\\Mechanical Engineering 2018, ISBN 13: 978-0134441184

Schedule

1st week Registration week	
2nd week: Lecture: Basic theorem of working machines. The manufacturing opportunities of classical machines. Practice: Determination of allowances for different parts	3rd week: Lecture: The theorem of turning technology. The main manufacturing opportunities by this process. Practice: Task solution for turning technology.
4th week: Lecture: Drilling methods. The types of drilling and counterbore tools. Practice: Task solution for drilling technology.	5th week: Lecture: Analysis of milling technologies. The milling strategies. Practice: Task solution for plain milling technology.
6th week: Lecture: The construction of CNC machines. Overview of rapid prototyping and reverse engineering techniques. Practice: Task solution for face milling technologies.	7th week: Lecture: Manufacturing analysis of typical parts of the vehicles. Analysis of the vehicle production process. Practice: Manufacturing of complex parts by cutting technology
8th week: 1st drawing week	
9th week: Lecture: The basic definitions of machine reparation. The relation of the maintenance and machine reparation. The causes of vehicle's attrition. Recording error, error findings. The types of wearing. The basic theorem of tribology. Practice: Analysis of disassembled and faulty workpieces. Wearing measurement methods in the Practice (length and weight measurement, impressive method).	10th week: Lecture: Reparation method of typical vehicle parts. Different cleaning methods. Practice: Wearing measurement of worn parts. Creation of troubleshooting instruction of defective parts.
11th week: Lecture: Restoration of machine parts by welding technology. Knitting welding and fill welding of steel parts. Corrective welding of cast iron and aluminium parts. Thermal dispersion methods, spraying technologies and typical applications of	12th week: Lecture: Increasing methods of deadweight. Surface hardener methods. Restoration of shafts and bore parts. Malfunction of toothed gears. Sticking and plastic coating technologies in case of reparation of vehicle parts.

them. Creation of various thermal dispersion methods. Part preparation, methods and properties of the coating. Methods of plastic application, occurring technological errors **Practice**: Restoration of worn parts by traditional methods. Half-year presentation of the task.	**Practice**: Restoration of faulty shaft-like part by thermal dispersion. Task consultation.
13th week: **Lecture**: Malfunction of rolling and sliding bearings. Working analysis of bearings. Reparation and restoration of bodies and chassis. **Practice**: Task consultation.	**14th week:** **Lecture**: Malfunction, reparation and restoration of elements of hydraulic systems. Malfunction and reparation of elements of pneumatic systems. **Practice**: Task consultation
15th week: 2nd drawing week	

Requirements

two test: manufacturing field and reparation field

two designing task solution: manufacturing field and reparation field

Thermodynamics and Fluid Machines of Vehicles

Code: MK3JAHBJ06JX20-EN

ECTS Credit Points: 6

Evaluation: exam

Semester: 5th semester

Its prerequisite(s): Fluid Mechanics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 4+1

Topics:

Basics of thermodynamics and fluid mechanics, processes, efficiencies. Classification of the caloric engines and fluid machines. Typical constructions. Theoretical basics: fundamental equations, delivery- and friction-head, efficiencies, velocity triangles.

Operation, construction, and characteristic curves of the radial- and axial machinery (compressors and turbines). The turbocharger. Basics of the gas turbine and jet engine.

Basics of the fluid mechanics of hydrodynamic clutch and torque converter.

Fundamentals, operation and characteristic curves of the positive displacement compressors, fans and pumps. Fundamentals of the internal combustion engines.

Classification of refrigerators. Processes of the vapour-compression refrigerators. Multistage refrigerators.

Laboratory practice, measurements:

Measurements of centrifugal compressors, radial turbines and turbochargers. Measuring the characteristic diagrams of internal combustion engines. Measurements of vapor-compression refrigerators.

Literature:

Compulsory:

- Dixon S.L. (1978): Fluid Mechanics, Thermodynamics of Turbomachinery (Third ed.), Pergamon Press, ISBN 0-08-022722-8
- Bloch, H.P. and Hoefner, J.J. (1996). Reciprocating Compressors, Operation and Maintenance. Gulf Professional Publishing. ISBN 0-88415-525-0
- Y.V.C. Rao (2003). An Introduction to Thermodynamics (2nd ed.). Universities Press. ISBN 978-81-7371-461-0

Schedule

1st week Registration week	
2nd week: **Lecture:** Basics of thermodynamics and fluid mechanics, processes, efficiencies. Classification of the caloric engines and fluid machines. Typical constructions. **Practice:** Calculation problems. Laboratory measurements.	3rd week: **Lecture:** Theoretical basics of fluid machines: fundamental equations, delivery- and friction-head, efficiencies, velocity triangles I. **Practice:** Calculation problems. Laboratory measurements.
4th week: **Lecture:** Theoretical basics of fluid machines: fundamental equations, delivery- and friction-head, efficiencies, velocity triangles II. **Practice:** Calculation problems. Laboratory measurements.	5th week: **Lecture:** Operation, construction, and characteristic curves of the radial- and axial machinery (compressors and turbines) I. **Practice:** Calculation problems. Laboratory measurements.
6th week: **Lecture:** Operation, construction, and characteristic curves of the radial- and axial machinery (compressors and turbines) **Practice:** Calculation problems. Laboratory measurements.	7th week: **Lecture**: Construction, and characteristic curves of the turbocharger. Basics of the gas turbine and jet engine. **Practice:** Calculation problems. Laboratory measurements.
8th week: Midterm Test I.	
9th week:	10th week:

Lecture: Operation and constructions of gas turbines and jet engines.	**Lecture:** Basics of the fluid mechanics of hydrodynamic clutch and torque converter.
Practice: Calculation problems. Laboratory measurements	**Practice:** Calculation problems. Laboratory measurements.
11th week:	**12th week:**
Lecture: Fundamentals, operation and characteristic curves of the positive displacement compressors, fans and pumps I.	**Lecture:** Fundamentals, operation and characteristic curves of the positive displacement compressors, fans and pumps II.
Practice: Calculation problems. Laboratory measurements.	**Practice:** Calculation problems. Laboratory measurements.
13th week:	**14th week:**
Lecture: Fundamentals of the internal combustion engines.	**Lecture:** Classification of refrigerators. Processes of the vapour-compression refrigerators. Multistage refrigerators.
Practice: Calculation problems. Laboratory measurements.	**Practice:** Calculation problems. Laboratory measurements.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Participation in practice classes is compulsory. Students must attend practice classes and may not miss more than three occasions during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent to an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test on the 8th week and the end-term test on the 15th week. Students must sit for the tests.

B, for a grade (ESE):

The course ends in an **examination.**

The minimum requirement of the mid-term test and the end-term test is 50% separately. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

The grade is given according to the following table:

%	Grade
0-49	fail (1)
50-62	pass (2)

63-75	satisfactory (3)
76-89	good (4)
90-100	excellent (5)

If the score of any test is below 50%, the student once can take a retake test of the whole semester material.

An offered grade: It may be offered for the students if the average of the mid-term test, end-term tests and the teamwork is at least good (4). The offered grade is the average of them.

Vehicle Design and Diagnostics

Code: MK3JATVJ04JX20-EN

Evaluation: exam

ECTS Credit Points: 4

Semester: 6th semester

Its prerequisite(s): Vehicle and Drive Elements I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Basics of the reliability theory and its role in the vehicle industry. Qualitative and quantitative methods of the reliability analysis. Definition of the failure probability and the theoretical and experimental basics of its estimation. Definition of the load spectrum, its fundamental types, standards. Definition of the S-N curve and its connection to the Haigh-diagram. The Palmgren-Miner methods. The probability theory approach to the safety factor.

Fundamental definitions of the tribology. Friction states, dry friction, friction in the presence of lubrication. The elastohydrodynamic lubrication state. Mechanisms of wearing, types of wearing. Influencing factors of the wearing resistance.

Definition of the numerical structural analysis, generating numeric models based on geometric models. Practical applications of the finite element method in the vehicle industry. Practical role of the numerical simulation in the vehicle industry.

Laboratory practice:

Solving of numerical simulation problems during seminars.

Literature:

Compulsory:

- Lewis, E.E.: Introduction to Reliability Engineering. Second Edition. John Wiley & Sons, Inc. New York1996.
- O'Connor, P.D.T.: Practical Reliability Engineering. Third Edition. John Wiley & Sons Chichester…1997.

- Stephens, R. I., Fatemi, A., Stephens, R. R., Fuchs, H.O.: Metal Fatigue in Engineering. Second Edition. John Wiley & Sons Inc. New York, 2001.
- G.R. Liu, S. S. Quek: Finite Element Method: A Practical Course. Elsevier, 2003. ISBN 0080472761

Schedule

1st week Registration week	
2nd week: **Lecture:** Basics of the reliability theory and its role in the vehicle industry. Qualitative and quantitative methods of the reliability analysis. **Practice:** Calculation problems.	3rd week: **Lecture:** Definition of the failure probability and the theoretical and experimental basics of its estimation. **Practice:** Calculation problems.
4th week: **Lecture:** Definition of the load spectrum, its fundamental types, standards **Practice:** Calculation problems.	5th week: **Lecture:** Definition of the S-N curve and its connection to the Haigh-diagram. **Practice:** Calculation problems.
6th week: **Lecture:** The Palmgren-Miner methods. **Practice:** Calculation problems.	7th week: **Lecture**: The probability theory approach to the safety factor. Fundamental definitions of the tribology. **Practice:** Calculation problems.
8th week: Mid-term test	
9th week: **Lecture:** Friction states, dry friction, friction in the presence of lubrication. **Practice:** Calculation problems.	10th week: **Lecture:** The elastohydrodynamic lubrication state. **Practice:** Calculation problems.
11th week: **Lecture:** Mechanisms of wearing, types of wearing. **Practice:** Calculation problems.	12th week: **Lecture:** Influencing factors of the wearing resistance. **Practice:** Calculation problems.
13th week: **Lecture:** Definition of the numerical structural analysis, generating numeric models based on geometric models. **Practice:** Calculation problems.	14th week: **Lecture:** Practical applications of the finite element method in the vehicle industry. Practical role of the numerical simulation in the vehicle industry. **Practice:** Calculation problems.

15th week: End-term test

Requirements

A, for a signature:

Participation in practice classes is compulsory. Students must attend practice classes and may not miss more than three occasions during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent to an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test on the 8th week and the end-term test on the 15th week. Students must sit for the tests.

B, for a grade (ESE):

The course ends with an **examination.**

The minimum requirement of the mid-term test and the end-term test is 50% separately. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

The grade is given according to the following table:

%	Grade
0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-89	good (4)
90-100	excellent (5)

If the score of any test is below 50%, the student once can take a retake test of the whole semester material.

An offered grade: It may be offered for the students if the average of the mid-term test, end-term tests and the teamwork is at least good (4). The offered grade is the average of them.

Measurement Technology

Code: MK3MERTR04JX20-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade, measurement report

Semester: 3rd semester

Its prerequisite(s): Electrotechnics and Electronics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Detectors (sensors) and transducers. Grouping the sensors. The measuring device structure and characteristics. Unit of measurement systems. Measurement error. Measurement methods. Electro-mechanical - and electronic instruments. Digital instruments. Microelectronic sensors. Elastic deformation measuring devices. Temperature, light and radiation detectors. Thermocouples, thermometers metal, semiconductor thermometers-; Optical gates-; Capacitive proximity switches-; Ultrasonic sensors-; structure, operating principles and properties. Foil Version strain gauges, semiconductor strain gauges, strain sensor wire, one, two and four-sensor bridge circuit. Fiber optic sensors. Signal processing systems. Pressure, temperature, strain and measurement of rotary motion using National Instruments LabVIEW software.

Literature:

Compulsory:

- Aciatore, David G.: Introduction to mechatronics and measurement systems, Boston, 2007, ISBN:007 125407 2
- Ed. Robert H. Bishop: The Mechatronics Handbook, Section III: Sensors and actuators, CRC Press; 2nd edition 2007, ISBN: 978-0849392573

Recommended:

- David G. Alciatore, Michael B. Histand: Introduction to mechatronics and measurement systems 1st. McGraw-Hill, 2013. ISBN: 978-0073380230
- Uday A. Bakshi, Varsha U. Bakshi:: Electronic Measurement and Instrumentation 1st. Technical Publications Pune, 2009. ISBN: 9788184315295

Schedule

1st week Registration week	
2nd week: Lecture: Basic concepts of measurement. Sensors (sensors) and transducers. The sensors are grouped. The structure and characteristics of the measuring apparatus. Measurement Systems. Measurement errors. Measurement methods. Practice: General description about laboratory regulations. Accident prevention and safety education.	3rd week: Lecture: Theoretical basis of Light electric effect sensors. The photodiode and photovoltaic structure, modes of operation and application. Multi-colour LEDs. The structure and characteristics of optical interfaces. The scanner structure and characteristics of CCD sensors. Practice: Examination of solar cell.
4th week: Lecture: Types of photo resist and application. The structure and features of a phototransistor. The structure and use of a light pencil. The structure, characterization and application of a liquid crystal display.	5th week: Lecture: Measuring elastic deformation instruments. Piezoelectric and piezoresistive sensors. Elastic deformation measuring instruments. Bellows. Microelectronic capacitive pressure

Practice: Measurement of LED characteristics.	sensors. PN-gradient sensors and the MOSFET structure. **Practice:** Measurement of elastic deformation
6th week: **Lecture:** Thermoelectric sensors. The operating principles, construction and characteristics of an infrared motion sensor. Thermoelectric transducer coupling, the PVDF film. Thermocouples, semiconductor structure, function and features of metal thermometers and other thermometers. **Practice:** Measurement of temperature.	**7th week:** **Lecture:** An optical gate. Its structure, working principle and characteristics and application areas. **Practice:** Measurement of an optical gate.
8th week: 1st drawing week	**Mid-term test**
9th week: **Lecture:** A capacitive proximity switch. Its structure, working principle, characteristics and application areas. **Practice:** Measuring of capacitive proximity switch.	**10th week:** **Lecture:** Ultrasonic sensors. Their structures, working principles, characteristics, and application areas. **Practice:** Measuring of an ultrasonic distance sensor.
11th week: **Lecture:** Strain gages. Foil strain gauges, semiconductor strain gauge, strain sensor wires, one, two and four-sensing bridge circuits. **Practice:** Measuring of strain gages.	**12th week:** **Lecture:** The Reed switch and magneto inductive sensors. Their structures, working principles, characteristics and Application areas. **Practice:** Measuring of reed switch.
13th week: **Lecture:** Description of the main features of the NI LabVIEW software. **Practice:** National Instruments with hardware and software. Edit VI. Measuring system construction, Troubleshooting practice	**14th week:** **Lecture:** Structure of the NI data acquisition systems. DAQ connecting to your computer. **Practice:** Recording and evaluation of data measured by National Instruments Hardware
15th week: 2nd drawing week: End-term test	

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory. Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student cannot make up a practice class with another group. Attendance at practice classes will be recorded by the practice

leader. Being late is equivalent with absence. Missed practices should be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his or her participation as an absence because of the lack of active participation in the class. Students have to submit all the twelve reports as scheduled minimum at a sufficient level. During the semester there are two tests: the mid-term test is in the 8th week and the end-term test in the 15th week.

B, for grade:

Based on the average of the grades of the reports and the test results, the mid-semester grade is calculated as an average of them: - the average grade of the twelve reports (50 %) - the grade of the tests (50 %). The minimum requirement for end-term test is 60%. Based on the score of the test separately, the grade for the test is given according to the following table: Score Grade 0-59 fail (1) 60-69 pass (2) 70-79 satisfactory (3) 80-89 good (4) 90-100 excellent (5)

Applied Automatization

Code: MK3AAUTR04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 6th semester

Its prerequisite(s): Control Theory II

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Control engineering of funds and core control technology, feedback (closed-loop) control knowledge acquisition. Theoretical Foundations Control Technology. Control (open-loop) and application control functions. Programmable Logic Controllers. Timers, counters, sequential controls. Tags of the control loop. Examination of the tags of the control loop steady state. linear transition state regulations. a description of the transitional state of the linear members. Examination of the closed-loop control. Stability and quality features. Selection and setting regulators. Control and feedback systems practical exercises using the PLC programming.

Literature:

Compulsory:

- Ed. Robert H. Bishop: The Mechatronics Handbook, Section IV: Systems and Controls, CRC Press; 2nd edition 2007, ISBN: 978-0849392573
- Uday A.Bakshi, S.C.Goyal: Feedback Control Systems,Technical Publications Pune, 2nd edition 2008, ISBN: 978-8189411077

Recommended:

- Uday.A.Bakshi,Varsha.U.Bakshi: Control System Engineering, Technical Publications Pune, 1th edition 2008, ISBN: 978-8184314632

Schedule

1st week Registration week	
2nd week: **Lecture:** The theoretical bases of control technology. Basic concepts, symbols and allocation. Comparison of control and feedback control. Subdivision of control and feedback control. **Practice:** Realization of logic functions "AND, OR, NAND, NOR, XOR, XNOR" with relays.	3rd week: **Lecture:** Feedback control. Signs and characteristics of a control loop. Loop tags (a sensor, a signal generator, subtraction, signal processing, an amplifier, an actuator). **Practice:** Realization of logic functions "AND, OR, NAND, NOR, XOR, XNOR" with digital circuits.
4th week: **Lecture:** Control systems. Boolean algebra, basic operations (And, Or, Not). Basic identity of Boolean algebra. **Practice:** Digital circuits realization of Flip-Flop circuits, RS-JK storage, MUX-DEMUX.	5th week: **Lecture:** De Morgan's theorems. Two-variable logic functions (Nor, Inhibition, Antivalency, Equivalency, Implication). **Practice:** Digital circuits realization of flip-flop circuits, RS-JK storage, MUX-DEMUX.
6th week: **Lecture:** Functions to simplify algebraic and graphical way. Operation and programming of freely programmable logic controllers (PLCs). **Practice:** Operation of programmable logic controllers. Basic programming tasks with PLC.	7th week: **Lecture:** Linear Control Systems. Test methods (time domain, frequency domain, and transfer functions method). **Practice:** Operation of programmable logic controllers. Basic programming tasks with PLC. Measuring internal timers and counters.
8th week: 1st drawing week: Self-control Test	
9th week: **Lecture:** Linear control steady-state operation. Linear terms (P, I, D) and transmission coefficient. Linear coupling of tags (serial, parallel, feedback). **Practice:** Application of different programming languages for programmable logic controllers Medium programming tasks with PLC.	10th week: **Lecture:** A proportional tag, negative feedback through a proportional tag. Examination of feedback. **Practice:** Medium level programming exercises with PLC.
11th week: **Lecture:** Analysis of proportional (type 0) control. Examination of integral (type 1) control. Gaining and measuring a concept loop.	12th week: **Lecture:** Linear feedback control transition state. Typical testing functions. Linear tags differential equations. Transfer function preparation about transmission function.

Practice: Determine and analysis the transfer function of one-two variable proportional tag. Analyze the transition function of two storage proportional tags with MULTISIM software. **13th week:** **Lecture:** Transition, transfer function and differential equations of a proportional and integral tag. Transition, transfer function and differential equations of a derivate and dead time tag. **Practice:** Proportional Differential (PD) tags transfer function analysis of the function using MULTISIM software.	**Practice:** Conditions and analysis of a variable storage differentiator tag and its transfer function. Proportional Integral (PI) tags transfer function analysis of the function using MULTISIM software. **14th week:** **Lecture:** Continuous (P, PI, PD, PID) controllers. Non-electrical quantities electrical measuring. Control loops stability criterion with Routh-Hurwitz and high-quality specifics. **Practice:** The Proportional-Integral-Derivative (PID) tag recording its transfer function and function analyzing. Optimization of measurement of different types of controllers.
15th week: 2nd drawing week: End-term Test	

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory. Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student cannot make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. Missed practice classes must be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as absence because of the lack of active participation in class. Students have to submit all the twelve reports as scheduled minimum on a sufficient level. During the semester there are one test: the end-term test in the 15th week. Students have to sit for these tests.

B, for grade:

At the end of the course an oral exam must be taken. Based on the average of the grades of the reports and the test results, the mid-semester grade is calculated as an average of them: - the average grade of the twelve reports (30 %) - the grade of the tests (20 %) - the oral exam (50 %) The minimum requirement for end-term test is 60%. Based on the score of the test separately, the grade for the test is given according to the following: 0-59 % = fail (1); 60-69 % = pass (2); 70-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5)

Control Theory I

Code: MK3IRA1R04JX20-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Semester: 4th semester

Its prerequisite(s): Electronics and Electrotechnics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+1

Topics:

Control theory fundamentals. System analysis in time and frequency domain. Stability of systems: definition and analysis. Stability of open and closed loop systems. Design of serial compensator. Quality properties of closed loop systems. Robustness in stability. Introduction to state space theory. Analysis of state space system. Controller design with state variable feedback. Vehicle Dynamics applications.

Literature:

Compulsory:

- Richard C. Dorf and Robert H. Bishop "Modern Control Systems" 13 ed. ISBN: 978-0134407623
- Zhai Wanming, "Vehicle–Track Coupled Dynamics", Springer, 2020, ISBN 978-981-329-282-6
- Rajesh Rajamani "Vehicle Dynamics and Control", Springer, 2012, ISBN 978-1-4614-1432-2
- Massimo Guiggiani "The Science of Vehicle Dynamics", Springer, 2018, ISBN 978-3-319-73220-6

Schedule

1st week Registration week	
2nd week: Lecture: Introduction to control theory. Practice: Introduction to Computer Aided Control System Design software.	3rd week: Lecture: System modelling in time domain. Practice: Practice on time domain modelling.
4th week: Lecture: System modelling in frequency domain. Practice: Practice on frequency domain modelling.	5th week: Lecture: System dynamic property analysis in time domain Practice: Practice on time domain dynamic behaviour analysis.
6th week: Lecture: System dynamic property analysis in frequency domain. Practice: Practice in frequency domain dynamic behaviour analysis.	7th week: Lecture: Stability of systems. Practice: Practice on system stability.
8th week: 1st drawing week	
9th week:	10th week:

Lecture: Stability and dynamics behaviour of open loop system. **Practice:** Practice on open loop system stability.	**Lecture:** Stability and dynamics behaviour of closed loop system. **Practice:** Practice on closed loop system stability.
11th week: **Lecture:** Quality properties of closed loop systems. **Practice:** Practice on closed loop systems quality properties.	**12th week:** **Lecture**: Robustness in stability. **Practice:** Practice on robustness in time domain modelling
13th week: **Lecture:** State space systems: modelling and behaviour. **Practice:** Practice on state space system modelling.	**14th week:** **Lecture:** Vehicle dynamics control. **Practice:** Practice on vehicle dynamics control.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Attendance on the lectures is recommended, but not compulsory.

Participation at practice is compulsory. Student must attend the practices and may not miss more than three practices during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student cannot make up a practice with another group. The attendance on practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments for the course with them to each practice. Active participation is evaluated by the teacher in every class. If student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence due to the lack of active participation in class.

During the semester there are two tests: the mid-term test is in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for grade:

The course ends with exam grade. Based on the average of the test results x 0.3 + the exam grade from the theory x 076 the mid-semester grade is calculated as an average of them:

The minimum requirement for the mid-term, end-term tests and for the exam is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following:

0-50 % = fail (1); 51-60 % = pass (2); 61-74 % = satisfactory (3); 75-89 % = good (4); 90-100 % = excellent (5)

Control Theory II

Code: MK3IRA2R04JX20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 5th semester

Its prerequisite(s): Control Theory I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+1

Topics:

Real engineering system, signal, input and outputs, abstract system, linear and non-linear systems, deterministic, stochastic, and chaotic systems, causality, system parameter and state variable, concentrated and distributed parameter modelling, wave effect. Deterministic systems with concentrated parameters, time-invariant and autonomous systems, steady state and dynamics systems, smoothness of systems, general properties of dynamics system, phase, general state, state variable, state space equations. Discrete and continuous models in time and frequency domain, digital (discrete state) systems, stochastic system with discrete state variable.

Literature:

Compulsory:

- Richard C. Dorf and Robert H. Bishop "Modern Control Systems" 13 ed. ISBN: 978-0134407623
- Peter Lugner, "Vehicle Dynamics of Modern Passenger Car", Springer, 2019, ISBN 978-3-319-79008-4
- Massimo Guiggiani "The Science of Vehicle Dynamics", Springer, 2018, ISBN 978-3-319-73220-6
- Dieter Schramm, Manfred Hiller, Roberto Bardini "Vehicle Dynamics", Springer, 2018, ISBN 978-3-662-54482-2

Schedule

1st week Registration week	
2nd week: Lecture: Modelling of real engineering systems, inputs, outputs, time and frequency domain. Practice: Introduction on Computer Aided Control System Design software.	3rd week: Lecture: Concentrated and distributed parameter modelling. Practice: Practice on engineering modelling.
4th week: Lecture: State variables and state space, (continuous) time domain models. Practice: Practice on state space and time domain systems.	5th week: Lecture: Deterministic systems with concentrated parameter modelling. Practice: Practice on deterministic systems with concentrated parameter models
6th week: Lecture: Deterministic systems with distributed parameter modelling. Practice: Practice on deterministic systems with distributed parameter models.	7th week: Lecture: Time invariant and autonomous systems. Practice: Practice on time invariant systems: dynamic behaviour analysis

8th week: 1st drawing week	
9th week: **Lecture:** General properties of dynamics systems, time and frequency domain modelling. **Practice:** Analysis of dynamic properties of state space systems.	10th week: **Lecture:** State variables, phase space and state space modelling. **Practice:** Practice on state space modelling of engineering systems.
11th week: **Lecture:** Discrete systems, properties of discrete systems. **Practice:** Modelling of discrete systems.	12th week: **Lecture**: Properties of discrete and continuous models in time domain. **Practice:** Modelling and analysis of dynamic behaviour in time domain.
13th week: **Lecture:** Properties of discrete and continuous models in frequency domain. **Practice:** Modelling and analysis of dynamic behaviour in frequency domain.	14th week: **Lecture:** Stochastic systems with discrete state variable. **Practice:** Practice on stochastic systems.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Attendance on the lectures is recommended, but not compulsory.

Participation at practice is compulsory. Student must attend the practices and may not miss more than three practices during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student cannot make up a practice with another group. The attendance on practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments for the course with them to each practice. Active participation is evaluated by the teacher in every class. If student's behaviour or conduct does not meet the requirements of active participation, the teacher may evaluate their participation as an absence due to the lack of active participation in class.

During the semester two tests from the practice will be written: the first practice test is in the 6th week and the second test in the 12th week. Students have to sit for the tests.

B, for grade:

The course ends with midterm grade. From the theory mid-term test will be written too. Based on the 2 practice test results and the theory test the mid-semester grade is calculated as an average of them.

The minimum requirement for all the tests is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following:

0-50 % = fail (1); 51-60 % = pass (2); 61-74 % = satisfactory (3); 75-89 % = good (4); 90-100 % = excellent (5)

Electric Machines and Drives

Code: MK3VHAJR06JX20-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Semester: 6th semester

Its prerequisite(s): Electronics and Electrotechnics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Fundamentals and classification of electrical machines. Direct Current machines: structure, theory of operation, mechanical and electrical commutation, theory of operation modes. Fundamentals of transformers: theory, operation under different load conditions: open and short circuit, resistive and inductive loads. Tri-phase transformers. Theory and operation of rotating magnetic field. Synchronous machines: theory and operation of helical synchronous machine. Stepper motor and drives. Special electrical machines and its applications. Rectifier bridge circuits. Summary of drive circuits for AC machines. VSD: variable speed drives.

Literature:

Compulsory:

- Austin Hughes "Electric Motors and Drives", Elsevier, 3rd ed. 2006, ISBN-13: 978-0-7506-4718-2
- Muhammad H. Rashid, "Power Electronics Handbook", Elsevier, 3rd ed. 2011, ISBN 978-0-12-382036-5
- Jan A. Melkebeek "Electrical Machines and Drives", Sringer 2018, ISBN 978-3-319-72729-5
- V. Rakini, V. S. Nagarajan "Electrical Machine Design" Pearson, 2018, ISBN 978-93-325-8557-7

Schedule

1st week Registration week	
2nd week: **Lecture:** Classification of electrical energy converters. **Practice:** Laboratory introduction and safety issues.	**3rd week:** **Lecture:** Direct Current electrical machines: structure, electrical and mechanical commutator **Practice:** DC motor start circuits.
4th week: **Lecture:** DC Machines: operating conditions.	**5th week:** **Lecture:** Transformers: Theory of operation, induced voltage, open, short cut, and load conditions.

Practice: DC Machines: operating conditions.	**Practice:** Measurement of DC machines: mechanical and electrical variables and power.
6th week: **Lecture:** Tri-phase transformers. **Practice:** Measurement of transformers: open and short cut conditions.	**7th week:** **Lecture:** Theory and application of rotating fields. **Practice:** Transformers: calculation of iron core and copper losses.
8th week: 1st drawing week	
9th week: **Lecture:** Synchronous machines: theory and operation of tri-phase, with cylindrical rotor. **Practice:** Synchronous motor starter circuits.	**10th week:** **Lecture:** Tri-phase induction motors: theory and operational conditions. **Practice:** Induction motor starter circuits.
11th week: **Lecture:** Tri-phase induction motors: load conditions and operations. **Practice:** Smooth starter circuit commissioning.	**12th week:** **Lecture:** Stepping motors: theory and operational conditions. **Practice:** VSD: Variable speed drive practice. Commissioning
13th week: **Lecture:** Special motors: EC and BLDC. Theory and operation **Practice:** VSD: Variable speed drive practice. Control.	**14th week:** **Lecture:** Rectifier circuits. One and tri-phase. **Practice:** VSD: Variable speed drive practice. Monitoring.
15th week: 2nd drawing week	

Requirements

A, for signature:

Attendance on the lectures is recommended, but not compulsory.

Participation at practice is compulsory. Student must attend the practices and may not miss more than three practice during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. The attendance on practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor.

The correct solution of the project and submission before deadline.

B, for grade:

The practical grade is the evaluation of the project.

Vehicle Engineering Comprehensive Exam

Code: MK3JASZJ00JG20-EN/MK3JASZJ00JJ20-EN

ECTS Credit Points: 0

Evaluation: comprehensive exam

Semester: 6th semester

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+0

Its prerequisite(s): Subjects of the chosen specialisation:

Vehicle Manufacturing Specialsation:

Materials of Vehicles, Vehicle Manufacturing II, Quality Assurance in Manufacturing Processes, Manufacturing Planning and Lean Management, Vehicle Diagnostics

Automotive Vehicle Engineering Specialisation:

Vehicle Powertrain Systems, Vehicle Suspensions, Automative Engines, Automative Electronics and Mechatronics, Automative Operation System

Materials of Vehicles

Code: MK3GEPAJ06JJ20-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Semester: 5th semester

Its prerequisite(s): Vehicle Materials and Technologies

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

Topics:

Deepening the scientific content of the most important topics of materials engineering. Understanding in convenient depth the automotive materials bulk and surface modification.

Main areas:

- thermodynamic principles of solid consistency,

- solid phase transformations and their thermodynamics (homogeneous and heterogeneous transformations),

- non-equilibrium systems,

- opportunities for increase of strength,

- metal-gas systems,

- interface energies,

- types, purposes and methods of surface modification processes.

Conventional and advanced materials used in the automotive industry, their properties and modifications:

- alloys: iron-based (non-alloy, low-alloy and high-alloy), advanced high-strength steels, aluminium-based (castable and formable alloys), Mg-based, Cu-based and special alloys (high-strength, super-alloys, Ti-based alloys)

- ferromagnetic materials,

- associated and composite materials and structures,

- types and production of traditionally manufactured technical ceramics.

The main issues of quality assurance in the production of raw materials.

Laboratory practice, measurement. Material testing. Destructive testing methods Introduction to non-destructive testing (NDT) methods (visual, radiographic, ultrasonic, magnetic, eddy current, dye penetrant, acoustic emission, etc.). Physical principles and areas of application. Flaw detection and sizing. Automation of NDT processes. The performance and evaluation of various laboratory tests (tensile, fracture mechanics, hardness). Metallography and relevant testing methods.

Literature:

Compulsory:

- Mikell P. Groover: Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley, 2006, ISBN: 9780471744856
- William D. Callister, David G. Rethwisch: Fundamentals of materials science and engineering: SI version, John Wiley and Sons, 2013., ISBN 978 1 118 32269 7

Recommended:

- Mikell P. Groover: Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley, 2006, ISBN: 9780471744856

Schedule

1st week Registration week	
2nd week: **Lecture:** Overview the solid state phase transformations and their thermodynamic background. **Practice:** Introduction to safety laboratory work. Introduction to basic heat treatment processes.	3rd week: **Lecture:** Conventional and advanced materials used in the automotive industry, their properties and modifications **Practice:** Heat treatment process of applied steels for automotive industry.
4th week: **Lecture:** Magnesium alloys for lightweight powertrains and automotive structures **Practice:** Magnesium alloys for lightweight powertrains and automotive structures	5th week: **Lecture:** Magnesium alloys for lightweight powertrains and automotive structures **Practice:** International designation systems for aluminium alloys. Casting of Al-alloy in laboratory.
6th week: **Lecture:** Thermoplastic-matrix and thermoset–matrix composites for lightweight automotive structures **Practice:** Produce of carbon fiber reinforced thermoset–matrix composites	7th week: **Lecture:** Direct Hardening: Annealing methods: full annealing, stress relief annealing. Austenitization and quench, selective hardening. **Practice:** TTT diagrams in case of isothermal and continuous cooling.
8th week: 1st drawing week	
9th week: **Lecture:** Destructive testing methods: Mechanical properties of metals. Concepts of stress and strain. Elastic, plastic deformation **Practice:** Tensile test. Determination of proof stress.	10th week: **Lecture:** Destructive testing methods: Comparison of materials harnesses. The difference between the theoretical and practical strength of the materials and their reason. **Practice:** Micro hardness testing.
11th week:	12th week:

Lecture: Charpy impact test. Crack theory: Fracture mechanism, Failures. **Practice:** Charpy impact test.	**Lecture:** Metallographic analysis of metals. Interpretation of metals microstructure. Specimen preparation process. **Practice:** Optical microscopy investigations.
13th week: **Lecture:** Non-destructive testing methods: visual, radiographic, ultrasonic, magnetic, eddy current, dye penetrant, acoustic emission. **Practice:** Non-destructive testing	**14th week:** **Lecture:** Microscopic Examinations: Scanning electron microscopy, EDS-Energy Dispersive Spectroscopy **Practice:** SEM examination
15th week: 2nd drawing week	

Requirements

A, for a signature:

1. Students have to visit the lectures and seminars. Three misses are permissive for the seminar.
2. Students have to write a two tests from the two parts of the lecture and seminar. They have to write them for minimum sufficient marks. Based on these result they will get the final practice mark.

B, for grade:

The course ends with a **mid-semester grade**. Based on the average of the marks of the planning task and the average of the test results, the mid-semester grade is calculated as an average of them:

- grade of the planning task
- average grade of the two tests

The minimum requirement for the mid-term and end-term tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, the student once can take a retake test covering the whole semester material.

Vehicle Manufacturing I

Code: MK3JGY1J08JJ20-EN

ECTS Credit Points: 8

Evaluation: exam

Semester: 5th semester

Its prerequisite(s): Vehicle Materials and Technologies

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+6

Topics:

Structure and kinematic analysis of machine tools in vehicle manufacturing. Application of CNC machining centres in production planning. Analysis of mechanical properties of different vehicle materials. Production of various vehicle profiles (cutting, punching, bending, deep drawing, etc.). Design of technological parameters and machining tool geometries. Manufacturing technologies for body parts. Assembling parts made by different technologies into parts by welding, riveting and gluing. Welding technology during the assembly of body elements (gas welding, arc welding). Thermal cuts. Metal spraying, plasma spraying. Adhesives used in the construction of vehicles. General introduction to robotics. Theoretical background of robotics. Conceptual definition and classification of robots. Robot Architecture, Coordinate Systems, Robot Workspaces, and Restriction of Workspaces. Structure of robots, operation of robots. Mechanical structure of robots, characteristics of mechanical structure, kinetic chains, forced equations. Manual control of robots, demonstration of basic forms of motion. Robot gripping structures, relation between gripping safety and robot kinetic characteristics. Robot programming and information processing, principles of robot programming, basic concepts of programming. Basics of Robot Programming. Description of Robot Movements in Program Languages General Principles of Path Generation, Questions of Linear and Curved Paths, Linear Interpolation, Circular Interpolation. Determination of robot position and orientation, position movements and orientation movements. Application and design of robots. Material handling applications, combined application of technology and material handling systems, synchronization tasks. Introducing the Smart Space concept: robots in human spaces. Robot simulation.

Literature:

Compulsory:

- Shaqe, E.: Machining and CNC Technology, The McGraw-Hill, 2014., ISBN 978-0-07-337378-2
- Taylan, A., Tekkaya, E.: Sheet Metal Forming: Fundamentals, The Ohio State University, USA, Technical Univeristy Dortmund, Germany, 2012., ISBN: 978-1-61503-842-8
- Taylan, A., Tekkaya, E.: Sheet Metal Forming: Processes and Applications, The Ohio State University, USA, Technical Univeristy Dortmund, Germany, ISBN: 978-1-61503-844-2
- Groover, M. P.: Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson; 4th edition (January 8, 2015), ISBN: 978-0133499612
- Altintas, Y.: Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design, Cambridge University Press; 2nd edition (January 16, 2012), ISBN: 978-1107001480

Schedule

1st week Registration week	
2nd week: Lecture: Introduction to Machining, Layout Skills and Tools, Cutting Tool Geometry, Drilling and Operations and, Turning Operations, Mills and Milling Operations, Precision Grinding Operations and, Screw	3rd week: Lecture: Design and Analysis of CNC Systems, Machine Tool Drives, Mechanical Component and Torque Requirements,

Thread Technology, Computer Numerical, Coordinates, Axes, and Motion, CNC Systems, CNC Controls, operating a CNC Machine, Program Planning, Setting Up a CNC Machine **Practice:** Laboratory practice, shopfloor, drilling, turning, milling, basics of CNC operations	Feedback devices, Electrical Drives, Position Control Loop **Practice:** Laboratory practice, shopfloor, drilling, turning, milling, basics of CNC operationsclutches; transmission actuators. Special transmissions: CVT, DCT, toroid.
4th week: **Lecture:** Metal Forming Processes in Manufacturing, Classification of Manufacturing Processes, Characteristics of Manufacturing Processes, Metal Forming Processes in Manufacturing, Classification of Metal Forming Processes **Practice:** Laboratory practice, Metal Forming Processes in Manufacturing, Classification of Metal Forming Processes	**5th week:** **Lecture:** Classification and Description of Sheet Metal Forming Operations, Sticking and welding Process Variables, Sheet Metal Forming as a System, Brief Description of Sheet Metal Forming Operations **Practice:** Laboratory practice, Process Variables, Sheet Metal Forming as a System, Classification of Geometries
6th week: **Lecture:** Mechanical Presses, Electro Mechanical Servo Drive Presses for Sheet Forming, Hydraulic Presses **Practice:** Mechanical Press Designs, Characteristic of Mechanical Presses, Other Features of Mechanical Presses, Servo Press Drives, Applications	**7th week:** **Lecture:** Blanking, Bending, Flanging and Hemming, Warm Forming, Hot Stamping, Sheet Hydroforming, Tube Hydroforming, Roll Forming **Practice:** Blanking Process, Tool Materials, Mechanics of Bending, Other Industrial Bending Processes, Bending Machines, Roll Forming Lines, Roll Design, Materials for THF
8th week: Mid-term test	
9th week: **Lecture:** Introduction to robotics, Basic Elements of an Automated System, Levels of Automation **Practice:** Laboratory practice, basics of robotics, main parts of robot manipulators	**10th week:** **Lecture:** Hardware components for automation and process control, Industrial Robotics **Practice:** Laboratory practice, basics of robotics, main parts of robot manipulators
11th week: **Lecture:** Discrete Control and Programmable Logic Controllers **Practice:** Laboratory practice, basics of PLC programming, robot programming	**12th week:** **Lecture:** Material Handling and Identification, Material Transport system **Practice:** Overview of Material Handling, Material Transport Equipment, Analysis of Material Transport Systems.
13th week:	**14th week:**

Lecture: Storage Systems and automatic identification data capture **Practice:** Definition of Storage Systems, Conventional Storage Systems, Automated Storage Systems	**Lecture:** Inspection principles and practice, Artificial Vision in manufacturing, Industry 4.0 principles. **Practice:** Automated inspection with robotics and AI, Analysis of inspection system, Case Studies
15th week: End-term test	

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. Students must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't make up a practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence due to the lack of active participation in class.

During the semester there is some homework related to each topic and there are two tests: the mid-term test is in the 7th week and the end-term test in the 15th week. Conditions for the signature:

- to reach the 50 % score on both tests.
- to hand the homework in time.

B, for a grade:

The course ends with a **mid-semester grade (AW5)**. During the exam period there is another test on all the topics of the semester. This test is accepted with minimum 50 % score. The total score of the semester is the sum of the scores of all tests (mid-term, end-term, exam) and the homework tasks, and the grade is given according to the following table:

Score	Grade
0-99	fail (1)
100-129	pass (2)
130-159	satisfactory (3)
160-179	good (4)
180-200	excellent (5)

Vehicle Manufacturing II

Code: MK3JGY1J04JJ20-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Semester: 6th semester

Its prerequisite(s): Vehicle Manufacturing I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

Topics:

Analysis of dimension chains in aspect of manufacturability. Construction, technological and measuring locating elements. Calculation of total and operation allowances. Analysis of cutting technologies (turning, drilling, milling, grinding, planning and slotting technologies). Determination of the technological parameters for the production of vehicle elements. Geometric establishment of cutting tools. Special manufacturing methods. Manufacturing of toothed elements. Electric discharge machining, ultrasonic manufacturing, electrochemical milling, thermal material separation. Laser, plasma and waterjet cutting technologies. Manufacturing designing of typical vehicle elements. Device designing on the vehicle production: typical device constructions, collision, orientation, clamping methods of workpieces and tools. Designing of assembly systems. Quality assurance of the assembly processes. CAD and CAM systems on the total manufacturing processes. Types and structures of manufacturing systems.

Literature:

Compulsory:

- Klocke, F.: Manufacturing Processes I., Cutting, Springer, RWTH edition, 2011, ISBN 978-3-642-11978-1, p. 524.
- Halderman, J. D.: Automotive Technology, Fourth edition, Pearson New International Edition, 2014, ISBN 10: 1-292-04218-4, p. 1831
- Gupta, H. N., Gupta, R. C., Mittal, A.: Manufacturing Processes, Second Edition, New Edge International Publishers, 2009, ISBN (13): 978-81-224-2844-5, p. 194.
- Kief, H. B., Roschiwal H. A.: CNC Handbook, The McGraw-Hill Companies, 2011, ISBN 978-0-07-179948-5, p. 451
- Liker, J.: The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, 2004. McGraw-Hill Education, ISBN: 978-0071392310

Schedule

1st week Registration week	
2nd week: Lecture: Analysis of dimension chains in aspect of manufacturability. Construction, technological and measuring locating elements. Calculation of total and operation allowances. Practice: Task solutions for dimension chains and allowances for different technologies	3rd week: Lecture: Analysis of turning technologies. Practice: Task solutions for designing of turning technologies of vehicle elements
4th week:	5th week:

Lecture: Analysis of drilling technologies. **Practice:** Task solutions for designing of drilling technologies of vehicle elements.	**Lecture:** Analysis of different milling technologies. **Practice:** Task solutions for designing of different milling technologies of vehicle elements.
6th week: **Lecture:** Analysis of different grinding technologies **Practice:** Task solutions for designing of different grinding technologies of vehicle elements.	**7th week:** **Lecture**: Analysis of planning and slotting technologies. Geometric establishment of cutting tools. **Practice:** Task solutions for designing of planning and slotting technologies of vehicle elements. Special manufacturing methods. Manufacturing of toothed elements
8th week: 1st drawing week	**1st Mid-term test**
9th week: **Lecture:** Electric discharge machining, ultrasonic manufacturing, electrochemical milling, thermal material separation. **Practice:** Manufacturing designing of typical vehicle elements.	**10th week:** **Lecture:** Device designing on the vehicle production: typical device constructions, collision, orientation, clamping methods of workpieces and tools. **Practice:** Designing of assembly systems. Quality assurance of the assembly processes.
11th week: **Lecture:** CAD and CAM systems on the total manufacturing processes. **Practice:** Technological designing by EdgeCAM software	**12th week:** **Lecture:** Types and structures of manufacturing systems. **Practice:** Vehicle assembly designing by SolidWorks software.
13th week: **Lecture:** LEAN methods of vehicle systems. I. **Practice:** Laboratory visiting. Manufacturing of special vehicle elements.	**14th week:** **Lecture:** Basics of automotive quality principles **Practice:** Quality complaints, basics of process development in manufacturing, case studies
15th week: End-term test	

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. Students must attend the practice classes and may not miss more than three of the during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students cannot make up practice classes with another group. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments for the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence because of the lack of active participation in class.

Students have to **take part in laboratory measures** and submit the measuring reports minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for a grade:

The course ends with an **examination**. Based on the average of the grades of the measuring reports and the examination, the exam grade is calculated as an average of them:

- the average grade of the measuring reports
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Quality Assurance in Manufacturing Processes

Code: MK3GYFMJ04JJ20-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Semester: 5th semester

Its prerequisite(s): Systems of Quality Management

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

This course is an introduction to automotive quality assurance (IATF 16949). The students learn about PFMEA, DFMEA, CP, CPK, CMK, Gage R and R, SPC and the first sample approval process. The lectures describe the main properties of APQP processes, control plans, flow charts and 8D documentation (quality complaint handling) like problem solving techniques and measuring methods. One of the goals is to deepen the students' understanding of brainstorming, 5 why and pareto analysis by the middle of the semester. The focus of the course is on how to create the quality management handbook and how to review the management handbook processes and documentation. By the end of the semester the students will acquire and will be able to use these kinds of methods.

Literature:

- *Compulsory:* Roland Mader, Eric Armengaud, Gerhard Griessnig, Christian Kreiner, Christian Steger, Reinhold Weiss: Reliability Engineering & System Safety, December 2013. ISSN 0951-8320
- Hervé Ressencourt, Louise Trave-Massuyes, Jérome Thomes: Fault Detection, Supervision and Safety of Technical Processes 2006, Volume 1, 2007. ISBN 978-0080-0444-857
- Salman Taghizadegan: Essentials of Lean Six Sigma, 2006, Pages 107-174. ISBN 978-0080-4623-325

Recommended:

- Ali Jahan, Kevin L. Edwards: Multi-criteria Decision Analysis for Supporting the Selection of Engineering Materials In Product Design, 2013. ISBN 978-0081-0053-61
- Radley M. Smith, Roderick A. Munro, Ronald J. Bowen: The ISO/TS 16949 Answer Book: A Step-by-step Guide for Automotive Suppliers, Paton Professional, 2004. ISBN 1-932828-00-1

Schedule

1st week Registration week	
2nd week:	3rd week:
Lecture: Lean Manufacturing, Wates, Lean Terminology and Metrics	Lecture: TQM, Definition of Quality, Elements for Success, History of QM
Practice: KPI numbers of Quality, Supplier Evaluation	Practice: Case studies about different quality systems
4th week:	5th week:
Lecture: 5S method, 5+1S, Plant Layouts	Lecture: Continuous Improvement, Kaizen
Practice: 7 wastes	Practice: PDCA, Idea Management System
6th week:	7th week:
Lecture: ISO system, Definition of Standards, ISO 9000, ISO 9001	Lecture: IATF 16949, Certification, VDA 6.3
Practice: General Management Systems	Practice: Comparing IATF 16949 with ISO 9001
8th week: 1st drawing week	
9th week:	10th week:

Lecture: Techniques to Support IATF 16949, Statistical Analysis, SPC, Measurement System Analysis, MSA	**Lecture:** Techniques to Support IATF 16949, Failure Modes & Effects Analysis, FMEA, Control Plans
Practice: SPC and MSA Calculation	**Practice:** FMEA example, Control Plan example
11th week:	**12th week:**
Lecture: Problem Solving Techniques, Fishbone (Ishikawa) diagram, 5W2H	**Lecture:** Quality Complaints, 3D and 8D documents
Practice: Problem Solving Techniques case studies	**Practice:** Quality Complaint process, 8D report
13th week:	**14th week:**
Lecture: Production Part Approval Process, PPAP	**Lecture:** Capability indices, CP, CPK, PPK
Practice: Production Part Approval Process documentations	**Practice:** CP, CPK, PPK calculation
15th week: 2nd drawing week	

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory.

Participation at practice is compulsory. Students must attend the practice classes and may not miss more than three occasions during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students cannot make up a practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class. During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for grade:

The course ends in an exam grade. The grade for the test is given according to the following: 0-59 % = fail (1); 60-69 % = pass (2); 70-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5)

Manufacturing Planning and Lean Management

Code: MK3GYLMJ04JJ20-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Semester: 6th semester

Its prerequisite(s): Vehicle Manufacturing and Repair

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

The goal and the task of the course is to introduce students to the value-added and non-value-added activities of either manufacturing or service providing companies. The course material introduces the planning phase of the companies' strategies from the production management's point of view. Both theoretical and practical courses - complemented with real life problems - help the students understand the following fields of study: Modelling of operations management, Production planning based on the available capacities, Organization as a system, Types and comparison of production systems, Future planning – forecasting models as a support of decision making, Inventory management and the application of practical models, ABC analysis, Material Requirement Planning (MRP), Process management, Production philosophies: Lean and its methods: waste hunting, value streams, process mapping, Jidoka tools, Heijunka, 5S, 5W, JIT.

Literature:

Compulsory:

William J. Stevenson: Operations management, 13th ed. McGraw-Hill Education - New York, 2018, ISBN 978-125-9921-81-0

Stephen N. Chapman, J. R. Tony Arnold, Ann K. Gatewood, Lloyd M. Clive: Introduction to Materials Management, 8th. global ed., Pearson New - Jersey, 2016, ISBN: 978-1-292-16235-5

Recommended:

Steven Nahmias, Tava Lennon Olsen: Production and Operations Analysis, 7th ed. Waveland press, Inc. - Long Grove Illinois, 2015, ISBN 978-1-4786-2306-9

Schedule

1st week Registration week	
2nd week:	**3rd week:**
Lecture: Introduction to production and service operations. Competitiveness, productivity, model of manufacturing systems	**Lecture:** Introduction to Forecasting. Elements, steps in the forecasting process. Qualitative Forecasts. Components of demand.
Practice: Determination of manufacturing system's components. Productivity – problem solving.	**Practice:** Forecast based on time series data.
4th week:	**5th week:**
	Lecture: Capacity planning for products, waste in the manufacturing.

Lecture: Monitoring forecast error. Choosing a forecasting technique, using forecast information. **Practice:** Associative forecasting technique.	**Practice:** Determination of real and theoretical capacity. Bottleneck in process – developing capacity strategies.
6th week:	**7th week:**
Lecture: Service level improving. Capacity planning for services. **Practice:** Developing capacity strategies for services.	**Lecture:** Define the term of Inventory, functions of inventories. **Practice:** Inventory (stock) control.
8th week: 1st drawing week	
9th week:	**10th week:**
Lecture: MRP - Inputs of MRP, steps of MRP Basic Economic Order Quantity. MRP I-II, ERP. **Practice:** MRP processing, Deterministic Inventory Models.	**Lecture:** Introduction to Aggregate planning. **Practice:** Techniques for Aggregate planning. Technics of optimizing the number of workers.
11th week:	**12th week:**
Lecture: JIT comparison of push and pull systems, MTO-MTS dilemma. **Practice:** Examples, case studies JIT comparison of push and pull systems.	**Lecture:** Waiting Lines Management – Implications, goals characteristics. **Practice:** Service pool line model, Queuing models.
13th week:	**14th week:**
Lecture: Jidoka Problem Solving and material flow scheduling. **Practice:** Jidoka tools - case studies.	**Lecture:** Service and production development by Six Sigma method. **Practice:** Application of Six Sigma method for process quality control.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Participation at practice is compulsory. Students must attend lectures and may not miss more than three of them during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at lectures will be recorded by the lecturer. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed lectures must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test is on the 8th week and the end-term test is on the 14th week. Students must sit for the tests. The minimum requirement of the mid-term and the end-term test is 60% separately. If the score of any test is below 60%, the students once can take a retake test

of the whole semester material. If somebody fails, then he/she has to write both tests in the 1st week of the exam period again. If the result is 60 % or better the retake test is success.

B, for grade:

The grade is given according to the following (score/grade): 0-59 % = fail (1); 60-69 % = pass (2); 70-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5).

Vehicle Diagnostics

Code: MK3JDIAJ04JJ20-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Semester: 6th semester

Its prerequisite(s): Measurement Technology

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+4

Topics:

Theoretical foundations of Technical Diagnostics. Methods and equipment of Technical Diagnostics. Automobile systems condition monitoring, fields of application. The role of Technical Diagnostics in quality assurance.

Chassis dynamometers, performance test of automobile power, simulation of the road surface and the vehicle working conditions. Duty cycles, load simulation. Brake diagnostics, brake certification procedures. Vehicle undercarriage diagnostics. Gas emission measurement systems. On-board diagnostics, data-management, protocols and functions.

Laboratory measurements: vibration measurement, vehicle undercarriage measurement, shock absorber measurement, brake measurement. Investigation of the injection systems: petrol and diesel engines, common rail diagnostics. Emission measurement. Official vehicle tests.

Literature:

Compulsory:

- Tom Denton, Advanced Automotive Fault Diagnosis (4th edition), Routledge, 2012
- Tracy Martin, How to use automotive diagnostic scanners, Quarto Publishing Group USA Inc., 2015
- Allan Bonnick, Derek Newbold, A Practical Approach to Motor Vehicle Engineering and Maintenance (2nd edition), Elsevier, 2005

Schedule

1st week Registration week	
2nd week:	3rd week:

Practice: Role of the technical vehicle diagnostics in the vehicle-industry

Derivation of the vehicle-diagnostics history

Vehicle, like a mechatronic system

Electrotechnics basic-knowledge

Types of the vehicle-diagnostics

Practice: Type of the diagnostics's information

Source,handle and store of the diagnostics's information

Wired and wire-less data-connection

Informatics basic-knowledge

Methods of the vehicle-diagnostics

4th week:

Practice: Technical and status diagnostics of ICE

Measurement, diagnostics and analysis of operating characteristics

Different cylinder measurements

Case study

5th week:

Practice: Measurement and analysis of vehicle with chasiss-dynamometer

Structure and operating method of the dynamometer

Procedure of the performance measuring

Determination and analysis of losses using dynamometer measurements

6th week:

Practice: Technical diagnostic analysis of controlled systems

Features of serial and parallel diagnostics

Interventional, active operation tests

7th week:

Practice: Ignition diagnostics

Analysis of the vehicle's ignition system, examination of parameters

Oscilloscopic examinations

8th week: 1st drawing week

9th week:

Practice: Technical diagnostic testing of the power supply and starting system of motor vehicles; Battery diagnostics, software integration with the vehicle; Conventional and Smart Generator Diagnostics

10th week:

Practice: Brake system diagnostics

Types of brake measurement, measurable values; Brake measurement on a roller dynamometer; Method of official brake measurement; Technical diagnostics of the braking system of vehicles equipped with air brakes

11th week:

Practice: Examination and diagnostics of vehicle lighting systems; Official measurements of lighting equipment; Inspection and operation of LED headlights

12th week:

Practice: Noise load of motor vehicles; Measurement of vehicle noise; EMC measurement methods, possibilities; Thermographic, endoscopic, ultrasound and vibration diagnostic devices

13th week:

Practice: OBD, EOBD on-board diagnostics; Exhaust after-treatment system diagnostics ; OBD connector design, communication channels; Guided troubleshooting

14th week:

Practice: Expert systems in vehicle diagnostics; Remote diagnostic methods and options; Application of expert systems in practice

15th week: 2nd drawing week

Requirements

Students have to visit the practices. Three misses are permissive for the practice

On the first and second drawing week they have to write a test from the lecture extended with practical diagnostics tasks. Based on these result they will get the final practice mark.

Group Project for Vehicle Engineers

Code: MK3JPROJ15JJ20-EN

ECTS Credit Points: 15

Evaluation: mid-semester grade

Semester: 7th semester

Its prerequisite(s): all subjects of the Vehicle Manufacturing Specialisation

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+20

Topics:

Students have to solve an own technological designing task relating to vehicle parts manufacturing. After checking and analysing the chosen vehicle part, based on the completed professional compulsory and the field specific vocational subjects, they have to design the manufacturing, assembling, control and checking processes. Students work on the project during the seminar under the supervision of the instructor, using CAD, CAM, and finite elements software.

Literature:

Recommended:

The literature of the professional and the field specific vocational subjects

Schedule

1st week Registration week	
2nd week: **Practice:** Analysing the chosen part, its operation, and requirements.	3rd week: **Practice:** Analysing the chosen part, its operation, and requirements.
4th week: **Practice:** Design of the part (stressing, construction, required technology) in different versions	5th week: **Practice:** Design of the part (stressing, construction, required technology) in different versions
6th week:	7th week:

Practice: Design of the part (stressing, construction, required technology) in different versions	**Practice:** Design of the part (stressing, construction, required technology), in different versions
8th week: 1st drawing week	
9th week:	10th week:
Practice: Design of the part (stressing, construction, required technology), analysing the different solutions.	**Practice:** Design of the part (stressing, construction, required technology), analysing the different solutions.
11th week:	12th week:
Practice: Giving presentation about the optimized design and its required technology and defending it.	**Practice:** Elaborating the eventual design, construction, and technology.
13th week:	14th week:
Practice: Elaborating the eventual design, construction, and technology.	**Practice:** Completing the design report, defending the eventual design, construction, and technology.
15th week: 2nd drawing week	

Requirements

A, for the practice mark:

- Students have to take part in the project seminars. Three misses are permitted.
- They have to solve an own technological designing task.
- Students have to write two reports about the different stages of the design project and results and defend them in front of project group and instructors during the semester.

Vehicle Powertrain Systems

Code: MK3GEPEJ06JG20-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Semester: 5th semester

Its prerequisite(s): Vehicle and Drive Elements II

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 4+2

Topics:

Review of the elements of the different power train systems from the engine to the driven wheels. The task of the drive train systems and their effects on the drive dynamic. The power need of the vehicle and power train concepts.

Clutches and couplings: construction of the mechanical and hydrodynamic clutches. Actuating and controlling the clutch; calculating forces and torques; force diagram; dual-mass flywheel.

Transmissions: tasks and main types of them, grouping. Manual transmission, planetary gear. Hydrodynamic torque transformer; continuous variable transmissions. Automatic transmissions, kinematic relationship. Retarders; external synchronous clutches; transmission actuators. Special transmissions: CVT, DCT, toroid.

Drive of wheels: cardan shaft; transfer case; differentials. Four wheel and all-wheel drive systems.

Modelling and calculating procedures, set up of vehicle model: gear assignment, static characteristics. Modelling the power transmission, related vehicle dynamic model.

Synchronous clutches, switching process and its forces (forced synchronous clutch). Heavy commercial vehicle’s AMT inspection. Modelling the pneumatic transmission actuator. Calculation of the hydrodynamic coupling and torque transformer. Kinematic and dynamic correlations of planetary gears. AT switching schemas, torque distribution, diagnostic methods of the mechatronics components. Selection, and seizing of electric motors and batteries. Energy management of hybrid drive systems. Set up of the control circuit (charging-control, recuperation, energy release).

Laboratory and measuring:

Disassemble and assemble of power transmission units. Measuring clutches and transmissions on test bench.

Vehicle test stand measuring: recording tractive force diagram, power utilization, testing the effects of modifying the differential parameters. Writing measuring report of the tests.

Literature:

Compulsory:

- David Crolla, Behrooz Mashadi: Vehicle Powertrain Systems. 2011. ISBN-13: 978-0470666029
- Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi: Modern Electric, Hybrid Electric, and Fuel Cell Vehicles. 2004. ISBN-0-8493-3154-4
- Ferit Küçükay, Burkhard Pollak, Gunter Jürgens, Rolf Najork, Robert Fischer: The Automotive Transmission Book. 2015. ISBN 978-3-319-05263-2

Recommended:

- Naunheimer, H., Bertsche, B., Ryborz, J., Novak, W.: Automotive Transmissions. 2011. ISBN 978-3-642-16214-5

Schedule

1st week Registration week	
2nd week: Lecture: elements of the different power train systems from the engine to the driven wheels. Clutches and couplings: construction of the mechanical and hydrodynamic clutches. Practice: The power need of the vehicle and power train concepts. Actuating and controlling the clutch; calculating forces and torques; force diagram; dual-mass flywheel.	3rd week: Lecture: Transmissions: tasks and main types of them, grouping. Manual transmission, planetary gear. Hydrodynamic torque transformer; continuous variable transmissions. Practice: Automatic transmissions, kinematic relationship. Retarders; external synchronous clutches; transmission actuators. Special transmissions: CVT, DCT, toroid.
4th week: Lecture: Drive of wheels: cardan shaft; transfer case; differentials. Four wheel and all-wheel drive systems. Practice: Modelling and calculating procedures, set up of vehicle model: gear assignment, static characteristics. Modeling the power transmission, related vehicle dynamic model.	5th week: Lecture: Synchronous clutches, switching process and its forces (forced synchronous clutch). Practice: Assembling different types of synchronous clutches
6th week: Lecture: Heavy commercial vehicle's AMT inspection. Modeling the pneumatic transmission actuator.	7th week: Lecture: Kinematic and dynamic correlations of planetary gears I.

Practice: Calculation of the hydrodynamic coupling and torque transformer.	**Practice:** Calculating the kinematic ratios of planetary gears.
8th week: Mid-term test	
9th week: **Lecture:** AT switching schemas, torque distribution, diagnostic methods of the mechatronics components. **Practice:**	**10th week:** **Lecture:** Set up of the control circuit (charging-control, recuperation, energy release). **Practice:** Charging-control, recuperation, energy release.
11th week: **Lecture:** Kinematic and dynamic correlations of planetary gears. **Practice:** Disassemble and assemble of power transmission units.	**12th week:** **Lecture:** Selection, and seizing of electric motors and batteries. **Practice:** Measuring clutches and transmissions on test bench
13th week: **Lecture:** Energy management of hybrid drive systems I. **Practice:** Vehicle test stand measuring: recording tractive force diagram, power utilization, testing the effects of modifying the differential parameters.	**14th week:** **Lecture:** Energy management of hybrid drive systems II. **Practice:** Writing measuring report of the tests.
15th week: End-term test	

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. Students must attend the practice classes and may not miss more than three of the during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students cannot make up practice classes with another group. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments for the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence because of the lack of active participation in class.

Students have to **take part in laboratory measures** and submit the measuring reports minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for a grade:

The course ends with an **examination**. Based on the average of the grades of the measuring reports and the examination, the exam grade is calculated as an average of them:

- the average grade of the measuring reports
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

An offered grade: it may be offered for the students if the average grade of the two designing tasks is at least good (4) and the average of the mid-term and end-term tests is at least good (4). The offered grade is the average of them.

Vehicle Suspensions

Code: MK3GEPFJ08JG20-EN
ECTS Credit Points: 8
Evaluation: exam
Semester: 5th semester
Its prerequisite(s): Vehicle Suspensions
Further courses are built on it: Yes/No
Number of teaching hours/week (lecture + practice): 4+4

Topics:
Vehicle dynamic requirements against the suspension; types of wheel geometry and their typical values; wheel suspension geometry; motion analysis of the different types of suspensions. Structural elements of the suspension: wheel, axle stub, suspending rods, spring elements; construction analysing of the connecting points of the body; analysing the active and semi-active wheel suspensions. Structural and

construction analysing of intelligent suspensions, their operation principal, research and developing directions.

Vehicle dynamic requirements against the steering; geometrical analysis of different steering systems; steering linkage; analysing the pole point. Structural elements of the steering system; axle stub and arm, connecting rods, push rods, joints, steering gear, steering column; construction analysis of the steering wheel; geometric and construction analysis of power steering units and all wheel steering systems; Structural and construction analysing of intelligent steering systems, their operation principal, research and developing directions.

Vehicle brake systems and the requirements against them; the most important correlation of seizing the hydraulic and pneumatic brake systems; ideal effective specific braking force distribution and adhesion diagram of twin-axes vehicle. The ideal and effective specific braking force characteristics of hydraulic and pneumatic brake systems. The construction and critical analysis of hydraulic brake systems and assembly units with special regard to the braking force controller. The construction and critical analysis of pneumatic brake systems and assembly units with special regard to the braking force controller. The ABS. Special brake systems, steady brake systems. Determining the brake testing parameters.

Laboratory and measuring:

Test-bench measuring: testing steering units, testing hydraulic and pneumatic brake systems.

Vehicle test-bench measuring: ABS, ESP systems, braking force distribution, checking the effects of changing brake parameters.

Writing measuring report of the tests.

Literature:

- John J. Dixon: Tires, Suspension and Handling (Second edition). SAE International, 1996.
- Don Knowles: Automobile Suspension System and Steering Classroom Manual, Publisher: Cengage Learning 2010.
- Sergio Savaresi Charles Poussot-Vassal Cristiano Spelta Olivier Sename Luc Dugard: Semi-Active Suspension Control Design for Vehicles, 2010. Hardcover ISBN: 9780080966786.
- Schnubel, Mark: Automotive Suspension & Steering Systems Shop Manual 2014. ISBN-13: 978-1285438122
- James D. Halderman: Automotive Brake Systems 1995. ISBN-13: 978-0134063126

Schedule

1st week Registration week	
2nd week: **Lecture:** Vehicle dynamic requirements against the suspension; types of wheel geometry and their typical values; structural elements of the suspension: wheel, axle stub, suspending rods	3rd week: **Lecture:** analyzing the active and semi-active wheel suspensions. **Practice:** analyzing the active and semi-active wheel suspensions.

Practice: wheel suspension geometry; motion analysis of the different types of suspensions. Structural elements of the suspension: spring elements; construction analyzing of the connecting points of the body;	
4th week: **Lecture:** Structural and construction analyzing of intelligent suspensions **Practice:** Intelligent suspensions, research and developing directions.	**5th week:** **Lecture:** Vehicle dynamic requirements against the steering **Practice:** geometrical analysis of different steering systems; steering linkage; analyzing the pole point.
6th week: **Lecture:** Structural elements of the steering system; axle stub and arm, connecting rods, push rods, **Practice:** Structural elements of the steering system; joints, steering gear, steering column; construction analysis of the steering wheel; geometric and construction analysis of power steering units and all wheel steering systems	**7th week:** **Lecture:** Structural and construction analysing of intelligent steering systems. Vehicle brake systems and the requirements against them. **Practice:** Operation principal of intelligent steering systems, research and developing directions. Correlations of seizing the hydraulic and pneumatic brake systems
8th week: Mid-term test	
9th week: **Lecture:** The ideal effective specific braking force distribution and adhesion diagram of twin-axes vehicle **Practice:** The ideal and effective specific braking force characteristics of hydraulic and pneumatic brake systems.	**10th week:** **Lecture:** The construction and critical analysis of hydraulic brake systems and assembly units with special regard to the braking force controller. **Practice:** The construction and critical analysis of pneumatic brake systems and assembly units with special regard to the braking force controller.
11th week: **Lecture:** The ABS. **Practice:** Test-bench measuring: testing steering units.	**12th week:** **Lecture:** Special brake systems, steady brake systems. Determining the brake testing parameters. **Practice:** Test-bench measuring: testing hydraulic and pneumatic brake systems.
13th week: **Lecture:** Energy management of hybrid drive systems I.	**14th week:** **Lecture:** Energy management of hybrid drive systems II.

Practice: Vehicle test-bench measuring: ABS, ESP systems.	**Practice:** Vehicle test-bench measuring: braking force distribution, checking the effects of changing brake parameters.

15th week: 2nd drawing week

Requirements

A, for a signature:

Attending **lectures** is recommended, but attending the **practices** is compulsory. Students must attend practice classes and may not miss more than three practice classes during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students cannot take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments for the course with them to each practice class. Active participation is evaluated by the instructor in every class. If a student's behavior or conduct does not meet the requirements of active participation, the teacher may evaluate their participation as an absence because of the lack of active participation in class.

Students have to **take part in laboratory measures** and submit the measuring reports minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for a grade:

The course ends in an **examination**. Based on the average of the grades of the measuring reports and the examination, the exam grade is calculated as an average of them:

- the average grade of the measuring reports
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

An offered grade: it may be offered for the students if the average grade of the two designing tasks is at least good (4) and the average of the mid-term and end-term tests is at least good (4). The offered grade is the average of them.

Automotive Engines

Code: MK3GEPMJ08JG20-EN

ECTS Credit Points: 8

Evaluation: mid-semester grade

Semester: 6th semester

Its prerequisite(s): Thermodynamics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 6+4

Topics:

Notion definitions and classifications of internal combustion engines. Historical overview of automotive engines. Systematization of internal combustion and heat engines. Operation of two-stroke and four-stroke, gasoline and diesel engines, valve timing pie chart. Application of Stirling- and Rankine-engines for vehicle drive. Operation of Wankel-engines.

Thermodynamics of internal combustion engines, comparative cycle-processes. Notion of ideal engine and its cycle-process. Main characteristics of engines: indicated and effective mean pressure, power, specific fuel consumption, torque, mean piston speed. Influencing factors of indicated parameters and losses. Mechanical losses of engines, their starters and starting systems. Notion of torque- and speed elasticity. Characteristics and heat balance of engines. Effects of environmental conditions to engine power, normal power.

Main dimensions and geometrical features of engines. Constructions, crank case and cylinder head. Construction, kinematics, dynamics of crank drive, equation of motion, mass balance and torsional vibration. Timing of charge exchange: solutions of valves and slots.

Cooling of engines, construction, components and control of cooling systems. Needs of lubrication, classification of lubrication systems. Wet and dry sump lubrication systems, oil filters. Monitoring of lubrication systems.

Fuels and lubricating oils of engines, gasoline and diesel fuels, alternative fuels.

Mixture generation systems of gasoline and diesel engines. Operation of carburetors. Multi-point and central injection systems. Fuel injection pumps of diesel engines, modern pump injection and common-rail injection systems. Energy transformation in internal combustion engines. Ignition and combustion in spark and compression ignition engines. Combustion procedures of gasoline and diesel engines, combustion chamber design and comparison. Abnormal combustion processes. Recording of indicator diagram, analysis of combustion processes. Generation of emissions from engines to the environment. Influencing factors of engine emissions. Emission reduction and after-treatment options.

Charge exchange processes of internal combustion engines. Valve timing, aerodynamic and acoustic design of intake and exhaust system. Air filtering in intake system. Rotation generation. Engine brake systems. Purpose and characteristics of charging. The interaction of chargers and engine. Turbocharging, mechanical and Comprex charging systems.

Laboratory and measuring:

Measuring of gasoline and diesel internal combustion engines on dynamic engine test bench: static characteristics, recording of shell curves, dynamic measurements, testing of standard vehicle cycles, fuel consumption and emission measurements. Investigation of injection systems: gasoline, diesel and common-rail systems. Practice of disassembly and assembly of internal combustion engines.

Writing measuring report of the tests.

Literature:

Compulsory:

- Richard Van Basshuysen (Editor), Fred Schafer (Editor): Internal Combustion Engine Handbook: Basics, Components, Systems, and Perspectives, SAE International, 2004. ISBN-13: 978-0768011395
- Hermann Hiereth, Peter Prenninger: Charging the Internal Combustion Engine, Springer, ISBN 978-3211471135
- Baumgarten, Carsten: Mixture Formation in Internal Combustion Engines, Springer, ISBN 978-3540308362
- D. Winterbone Ali Turan: Advanced Thermodynamics for Engineers, 2nd edition, Elsevier, **ISBN:** 9780444633736

Schedule

1st week Registration week	
2nd week: **Lecture:** Notion definitions and classifications of internal combustion engines. Historical overview of automotive engines. Systematization of internal combustion and heat engines. Operation of two-stroke and four-stroke, gasoline and diesel engines, valve timing pie chart. Application of Stirling- and Rankine-engines for vehicle drive. Operation of Wankel-engines. Thermodynamics of internal combustion engines, comparative cycle-processes. Notion of ideal engine and its cycle-process. Main characteristics of engines: indicated and effective mean	**3rd week:** **Lecture:** Influencing factors of indicated parameters and losses. Mechanical losses of engines, their starters and starting systems. Notion of torque- and speed elasticity. Characteristics and heat balance of engines. Effects of environmental conditions to engine power, normal power. **Practice:** Practice of disassembly and assembly of internal combustion engines.

pressure, power, specific fuel consumption, torque, mean piston speed.

Practice: Practice of disassembly and assembly of internal combustion engines.

4th week:

Lecture: Main dimensions and geometrical features of engines. Constructions, crank case and cylinder head.

Practice: Practice of disassembly and assembly of internal combustion engines.

5th week:

Lecture: Construction, kinematics, dynamics of crank drive, equation of motion, mass balance and torsional vibration. Timing of charge exchange: solutions of valves and slots.

Practice: Measuring of gasoline and diesel internal combustion engines on dynamic engine test bench: static characteristics, recording of shell curves.

6th week:

Lecture: Cooling of engines, construction, components and control of cooling systems. Needs of lubrication, classification of lubrication systems. Wet and dry sump lubrication systems, oil filters. Monitoring of lubrication systems.

Practice: Measuring of gasoline and diesel internal combustion engines on dynamic engine test bench: static characteristics, recording of shell curves.

7th week:

Lecture: Fuels and lubricating oils of engines, gasoline and diesel fuels, alternative fuels.

Practice: Measuring of gasoline and diesel internal combustion engines on dynamic engine test bench: dynamic measurements.

8th week: Mid-term test

9th week:

Lecture: Mixture generation systems of gasoline and diesel engines. Operation of carburetors. Multi-point and central injection systems.

Practice: Measuring of gasoline and diesel internal combustion engines on dynamic engine test bench: fuel consumption and emission measurements.

10th week:

Lecture: Fuel injection pumps of diesel engines, modern pump injection and common-rail injection systems. Energy transformation in internal combustion engines. Ignition and combustion in spark and compression ignition engines.

Practice: Measuring of gasoline and diesel internal combustion engines on dynamic engine test bench: fuel consumption and emission measurements.

11th week:

Lecture: Combustion procedures of gasoline and diesel engines, combustion

12th week:

Lecture: Generation of emissions from engines to the environment. Influencing

chamber design and comparison. Abnormal combustion processes. Recording of indicator diagram, analysis of combustion processes. **Practice:** Measuring of gasoline and diesel internal combustion engines on dynamic engine test bench: testing of standard vehicle cycles.	factors of engine emissions. Emission reduction and after-treatment options. **Practice:** Investigation of injection systems: gasoline engine systems.
13th week: **Lecture:** Charge exchange processes of internal combustion engines. Valve timing, aerodynamic and acoustic design of intake and exhaust system. Air filtering in intake system. Rotation generation. Engine brake systems. **Practice:** Investigation of injection systems: diesel engine systems.	**14th week:** **Lecture:** Purpose and characteristics of charging. The interaction of chargers and engine. Turbocharging, mechanical and Comprex charging systems. **Practice:** Investigation of injection systems: common-rail systems.
15th week: End-term test	

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct does not meet the requirements of active participation, the teacher may evaluate their participation as an absence because of the lack of active participation in class.

Students have to **take part in laboratory measures** a submit the measuring reports minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for a grade:

The course ends with an **examination**. The exam grade is the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 50%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-69	satisfactory (3)
70-79	good (4)
80-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Automotive Electronics and Mechatronics

Code: MK3GEELJ04JG20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 5th semester

Its prerequisite(s): Electronics and Electrotechnics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Basics of electronics: DC resistive networks and their calculation; periodic signals and their description, modulation methods. Passive electronic components (resistors, capacitors, inductive components) and their technology. Other electrical components (switches, push buttons, connectors, cables) and their manufacturing technology. Simplest semiconductors and manufacturing technologies. Construction, operation and application of diodes and bipolar transistors. Basic connections with semiconductors: diode switches, switching operation of transistors. Integrated circuits and their manufacturing technology. Electronic sensors, electric actuators (relays, electromagnets, motors). Wired communication protocols. Structure, operation and adaptation of memories and mass storage. Construction and operation of microprocessors and microcontrollers. Construction of control units, wiring diagrams with application examples. Electrology: warming of direct current networks, transients of RLC circuits, alternating current networks, basics of signal processing. Semiconductors (FET, IGBT, Thyristor, Triac). Electronic circuits: operational amplifiers, filters, timers, frequency generators. References, power supplies, stabilizers, inverters. Combination and sequence networks, FPGAs: basic elements of logical networks, application technology. Sensors: thermocouples, piezo sensors, magnetostatic, magneto resistive, optical, surface physics, MEMS. Actuators: piezo-electric, pyrotechnic, thermodynamic, magnetostrictive, electrostatic, MEMS. Programming languages, software development. Construction and programming of PLCs. Displays, touch screens. Elements, batteries, super capacities, fuel cells design, construction, main properties. Automotive electronic measuring instruments.

Literature:

Compulsory:

- B.T. Fijalkowsi: Automotie Mechatronics: Operational and Practical Issues, Springer, 2011., ISBN 978-94-007-0408-4
- Robert Bosch GmbH: Autoelektrik/Autoelektronik, Springer, 2007., ISBN 978-3-322-91560-3
- Allan W. M. Bonnick: Automotive Computer Controlled Systems. Elsevier, 2001.
- Cetinkunt: Mechatronics. Wiley, 2005.
- R., Konrad: Automotive Mechatronics: Automotive Networking, Driving Stability Systems, Electronics, Springer, 2015., ISBN 978-3-658-03974-5

Schedule

1st week Registration week	
2nd week:	3rd week:

Lecture: The vehicle as a complex mechatronic system. Development, trends. SAE J1850 Protocol, IEEE 1394 Protocol, switches, buttons. Vehicle overview. Basics of Vehicle Dynamics. **Practice:** General description about laboratory regulations. Accident prevention and safety education. Transients in DC circuits. Voltage boosting and lowering switching and application. (Ignition of petrol vehicles).	**Lecture:** Structure of vehicle drive chains. Controller Area Networking, CAN Arbitration, CAN Error Detection, CAN Architecture, FPGA **Practice:** Main parts of engine controller unit, actuators, controllers
4th week: **Lecture:** Electricity supply to vehicles on board. Electricity network construction. Protections. Actuators **Practice:** Vehicle diagnostics, Bus systems.	5th week: **Lecture:** Fundamentals of bus systems, Construction in vehicles. Types, their main characteristics. EMC and ESD in vehicles. **Practice:** EMC Simulation elements.
6th week: **Lecture:** Vehicle actuators and controls. **Practice:** Actuator and control simulation in software environment	7th week: **Lecture**: Sensor and actuator elements for motor controllers. Fuel pumps, Semiconductors (FET, IGBT, Thyristor, Triac) Transmission systems. Automotive Vehicle Driving Performance **Practice:** Fuel pumps simulation, errors, error detection. Analysis of intelligent shifting, simulations
8th week: Mid-term test	
9th week: **Lecture:** Vehicle braking systems as mechatronic systems. (ABS / ESP / ESR), OBD systems and self-diagnostic systems **Practice:** Operation of ABS/ESC	10th week: **Lecture:** Monitoring of vehicle length and transverse dynamics, stability. Suspensions. Half active and active damping. Power steering. Governance strategies. Global body control. **Practice:** Vehicle dynamics calculations and simulations
11th week: **Lecture:** Examples of driver assistance systems. Information about the external environment. Radar, ultrasound, laser and camera in vehicles. Parking and parking	12th week: **Lecture:** Examples of passenger and driver safety. Tire pressure check Airbag. Automatic belt tensioners.

assist system. Automatic speed and distance control (ACC). **Practice:** Measurement of LED characteristics, Measurement of an optical gate, Measuring of an ultrasonic distance sensor, Ultrasonic sensors. Their structures, working principles, characteristics, and application areas.	**Practice:** Pressure calculation, type of sensors, safety regulations.
13th week: **Lecture:** Examples of mechatronics for comfort and security systems. Air-conditioning. Main elements of cooling / heating / ventilation system. Central locking. **Practice:** Basics of comfort theorem, ergonomy, calculations	**14th week:** **Lecture:** Examples of mechatronics for comfort and security systems. Window and headlight washers. Windows. Active lighting system - Automatic adjustment. Fleet management, self-driving and autonomous vehicles, levels of autonomous systems **Practice:** Demonstrate on intelligent lighting table, Case studies
15th week: End-term test	

Requirements

A, for signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. Students must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't make up a practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence due to the lack of active participation in class.

During the semester there is some homework related to each topic and there are two tests: the mid-term test is in the 7th week and the end-term test in the 15th week. Conditions for the signature:

- to reach the 50 % score on both tests.
- to hand in the home assignments in time.

B, for a grade:

The course ends with a **mid-semester grade (AW5)**. During the exam period there is another test on all the topics of the semester. This test is accepted with minimum 50 % score. The total score of the semester is the sum of the scores of all tests (mid-term, end-term, exam) and the homework tasks, and the grade is given according to the following table:

Score	Grade
0-99	fail (1)
100-129	pass (2)
130-159	satisfactory (3)
160-179	good (4)
180-200	excellent (5)

Automotive Operation Systems

Code: MK3GEPUJ04JG20-EN
ECTS Credit Points: 4
Evaluation: mid-semester grade
Semester: 6th semester
Its prerequisite(s): Vehicles and Mobile Machinery
Further courses are built on it: Yes/No
Number of teaching hours/week (lecture + practice): 2+2

Topics:

In the lectures we deal with the different vehicle maintenance systems and focus on the reasons of malfunction of car parts and main units arising during operation. We deal with the vehicle diagnostics in detail which is a special field of the technical diagnostics. Because of the special operation features of the vehicle units, the application of many particular condition inspection methods is needed.

In the lecture the followings are discussed: vehicle diagnostics systems; failure detection diagnostics methods; failure repair methods detected on bench test; technical reliability and probability; rules of accident analysing; vehicle accident analysing measures; technical evaluation; recycling processes of car parts, units: relevant domestic and EU rules and measures; specific constructions in terms of recycling (special materials, modality of components connections)

Laboratory measurements:

Brake test; suspension inspection and adjustment; wheel balancing; shock absorbers test; diagnostics of ICE; periodic technical inspection (identification; checking the accessories; checking the towing conditions; brake and emission tests; applied diagnostics tests necessary for keeping the usage permission).

Literature:

Compulsory:

- Alternative Propulsion for Automobiles. Springer 2018
- Seiffert, Wech: Automotive Safety Handbook, SAE International. 2003.
- Menyhárt J.: Basics of Maintenance Engineering. DUPRESS 2019

- Mohamed Ben-Daya: Handbook of maintenance management and engineering. Dordrecht; New York: Springer, cop. 2009 9781848824713

Schedule

1st week Registration week	
2nd week: Lecture: Vehicle maintenance systems Practice: Brake test	3rd week: Lecture: Reasons of malfunction of car parts and main units Practice: Suspension inspection and adjustment
4th week: Lecture: Reasons of malfunction of car parts and main units Practice: Suspension inspection and adjustment. Electricity supply to vehicles on board. Electricity network construction. Protections. Actuators Practice: Vehicle diagnostic, Bus systems	5th week: Lecture: Failure detection diagnostics methods Practice: Shock absorbers test
6th week: Lecture: Failure detection diagnostics methods Practice: Diagnostics of ICE	7th week: Lecture: Vehicle and ICE diagnostics, failure repair methods Practice: Diagnostics of ICE
8th week: Mid-term test	
9th week: Lecture: Failure repair methods Practice: Diagnostics of ICE	10th week: Lecture: Technical reliability and probability Practice: Periodic technical inspection
11th week: Lecture: Rules of accident analysing; vehicle accident analysing measures Practice: Checking the towing conditions	12th week: Lecture: Rules of accident analysing; vehicle accident analysing measures Practice: Emission test
13th week: Lecture: Recycling processes of car parts, units: relevant domestic and EU rules and measures	14th week: Lecture: Recycling processes of car parts, units: relevant domestic and EU rules and measures

Practice: Applied diagnostics tests necessary for keeping the usage permission	**Practice:** Applied diagnostics tests necessary for keeping the usage permission

15th week: End-term test

Requirements

A, for signature:

Attendance at **lecture** is recommended, but not compulsory. Attendance at the **practice classes** is compulsory.

Students must attend practices and may not miss more than three lectures during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Being late counts as an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation in the class and the laboratory is evaluated by the teacher. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to **submit all the measuring reports** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

B, for a grade:

The course ends with a **mid-term grade**. Based on the average of the grades of the measuring tasks and the midterm tests, the midterm grade is calculated as an average of them:

- the average grade of the measuring tasks
- the result of the midterm tests

The minimum requirement for the mid-term and end-term tests respectively is 60%. Based on the score of the tests separately, the grade is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Group Project for Vehicle Engineers

Code: MK3JPROJ15JG20-EN

ECTS Credit Points: 15

Evaluation: mid-semester grade

Semester: 7th semester

Its prerequisite(s): all subjects of the Automotive Vehicle Engineering Specialisation

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+20

Topics:

Students have to solve an own designing task relating to vehicle parts. After checking and analysing the chosen vehicle part, based on the completed professional compulsory and the field specific vocational subjects, they have to design the part, assembling, control and checking processes. Students work on the project during the seminar under the supervision of the instructor, using CAD, CAM, and finite elements software.

Literature:

Recommended:

The literature of the professional and the field specific vocational subjects

Schedule

1st week Registration week	
2nd week: Practice: Analysing the chosen part, system and its operation, and requirements.	3rd week: Practice: Analysing the chosen part, system and its operation, and requirements.
4th week: Practice: Design of the part, system (stressing, construction, required technology) in different versions.	5th week: Practice: Design of the part, system (stressing, construction, required technology) in different versions.
6th week: Practice: Design of the part, system (stressing, construction, required technology) in different versions.	7th week: Practice: Design of the part, system (stressing, construction, required technology) in different versions.
8th week: 1st drawing week	
9th week: Practice: Design of the part, system (stressing, construction, required technology), analysing the different solutions.	10th week: Practice: Design of the part, system (stressing, construction, required technology), analysing the different solutions.
11th week:	12th week:

Practice: Giving presentation about the optimized design and its required technology and defending it.	**Practice:** Elaborating the eventual design, construction, and technology.
13th week:	14th week:
Practice: Elaborating the eventual design, construction, and technology.	**Practice:** Completing the design report, defending the eventual design, construction, and technology.
15th week: 2nd drawing week	

Requirements

A, for the practice mark:

- Students have to take part in the project seminars. Three misses are permitted.
- They have to solve an own technological designing task.
- Students have to write two reports about the different stages of the design project and results and defend them in front of project group and instructors during the semester.

Within 30 days of the successful final exam the diploma is issued and given out by the Faculty at the graduate's special request. Otherwise, the diploma will be awarded to him/her at the graduation ceremony of the Faculty.

The diploma is an official document decorated with the coat of arms of Hungary which verifies the successful completion of studies in the Vehicle Engineering undergraduate programme. The diploma contains the following data: name of HEI (higher education institution); institutional identification number; serial number of diploma; name of diploma holder; date and place of his/her birth; level of qualification; training program; specialisation; mode of attendance; place, day, month and year issued. Furthermore, it has to contain the original signature of the Dean (or in case of his/her indisposition the Vice-Dean) original signature and the seal of HEI. The University keeps a record of the diplomas issued.

At the graduate's special request, a certificate on the completion of studies is issued. The document does not contain any reference to qualification, it merely proves that the candidate has taken a successful final exam. The Faculty keeps a record of the certificates issued.

Calculating diploma grade

Grade = 0,3×A + 0,2×B + 0,5×C, where

A: Oral exam

B: Grade for defending thesis

C: Average of comprehensive exams (C = 0,3×Mathematics Comprehensive Exam + 0,7×Vehicle Engineering Comprehensive Exam)

Classification of the award

Outstanding	4,81 – 5,00
Excellent	4,51 – 4,80
Good	3,51 – 4,50
Satisfactory	2,51 – 3,50
Pass	2,00 – 2,50

Diploma with honours

Diploma with honours is awarded to students who get grade 5 in the oral exam and the thesis defence. Moreover, they do not have a grade worse than grade 4 during their studies.

MODEL CURRICULUM OF VEHICLE ENGINEERING BSC – VEHICLE MANUFACTURING SPECIALISATION

The curriculum of the program is available in excel format on the webpage of the Faculty of Engineering (www.eng.unideb.hu/en).

University of Debrecen | **Faculty of Engineering** | **Curriculum** | **Full-Time**

Vehicle Engineering (BSc) - Vehicle Manufacturing Specialisation

Nr.	Subject groups	Subject	Code	1st semester				2nd semester				3rd semester				4th semester				5th semester				6th semester				7th semester				Prerequisite
				L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	
1	Basics of Natural Sciences	Mathematics I	MK3MAT1A08JX20-EN	4	4	m	8																									
2		Mathematics II	MK3MAT2A06JX20-EN					2	4	m	6																					Mathematics I
3		Mathematics Comprehensive Exam	MK3MATSA00JX20-EN					0	0	c	0																					Matematika II (parallel)
4		Mathematics III	MK3MAT3A04JX20-EN									2	2	m	4																	Mathematics II
5		Engineering Physics	MK3MFIZA04JX20-EN	2	2	e	4																									
6		Technical Chemistry	MK3MKEMK04JX20-EN	2	1	e	4																									
7		Statics and Strenght of Materials	MK3STSZG04JX20-EN					2	2	m	4																					
8		Dynamics and Vibration	MK3MREZG04JX20-EN									2	2	e	4																	
9		Materials Engineering	MK3ANISG06JX20-EN	3	2	m	6																									
10		Thermodynamics	MK3HOTAL04JX20-EN									2	2	m	4																	Mathematics II
11		Fluid Mechanics	MK3ARATL04JX20-EN													2	2	e	4													Thermodynamics
12	Economics and Humanities	Business Law	MK3UZLJM03JX20-EN													2	0	e	3													
13		Micro- and Macroeconomics	MK3MIMAM04JX20-EN					1	2	e	4																					
14		Management and Business Economics	MK3MEN1M04JX20-EN													1	2	m	4													Micro- and Macroeconomics
15		Systems of Quality Management	MK3MIMRM04JX20-EN													2	2	m	4													
16	Professional Compulsory Subjects	Programming	MK3PROGR04JX20-EN					0	4	m	4																					
17		Basic Theory of Vehicle Engineering	MK3ALJGJ04JX20-EN	2	1	e	4																									
18		Vehicles and Mobile Machinery	MK3JAMGJ04JX20-EN					2	1	e	4																					
19		Technical Drawing I	MK3MAB1A04JX20-EN	2	1	m	4																									
20		Technical Drawing II	MK3MAB2A04JX20-EN					2	2	e	4																					Technical Drawing I
21		Electronics and Electrotechnics	MK3ELTTR04JX20-EN					2	2	m	4																					Engineering Physics
22		Vehicle and Drive Elements I	MK3JAH1J05JX20-EN									2	2	e	5																	Statics and Strenght of Materials
23		Vehicle and Drive Elements II	MK3JAH2J05JX20-EN													2	2	e	5													Vehicle and Drive Elements I
24		Vehicle Materials and Technologies	MK3JAATJ06JX20-EN									4	4	e	6																	Materials Engineering
25		Vehicle Manufacturing and Repair	MK3JAGJJ05JX20-EN													2	2	e	5													Vehicles and Mobile Machinery
26		Thermodynamics and Fluid Machines of Vehicles	MK3JAHBJ06JX20-EN																	4	1	e	6									Fluid Mechanics
27		Vehicle Design and Diagnostics	MK3JATVJ04JX20-EN																					2	2	e	4					Vehicle and Drive Elements I
28		Measurement Technology	MK3MERTR04JX20-EN									2	2	m	4																	Electronics and Electrotechnics
29		Applied Automation	MK3AAUTR04JX20-EN																					2	2	e	4					Control Theory II
30		Control Theory I	MK3IRA1R04JX20-EN													2	1	m	4													Electronics and Electrotechnics
31		Control Theory II	MK3IRA2R04JX20-EN																	2	1	e	4									Control Theory I
32		Electric Machines and Drives	MK3VHAJR06JX20-EN																					2	4	m	6					Electronics and Electrotechnics
33		Vehicle Engineering Comprehensive Exam	MK3JASZJ00JJ20-EN																					0	0	c	0					Prerequisite: Materials of Vehicles, Vehicle Manufacturing I, Quality Assurance in Manufacturing Proceses Parallel: Vehicle Manufacturing II, Manufacturing Planning and Lean Management, Vehicle Diagnostics
34	Field-specific Vocational Subjects	Materials of Vehicles	MK3GEPAJ06JJ20-EN																	2	4	m	6									Vehicle Materials and Technologies
35		Vehicle Manufacturing I	MK3JGY1J08JJ20-EN																	2	6	e	8									Vehicle Materials and Technologies
36		Vehicle Manufacturing II	MK3JGY2J04JJ20-EN																					2	4	m	4					Vehicle Manufacturing I
37		Quality Assurance in Manufacturing Proceses	MK3GYFMJ04JJ20-EN																	2	2	m	4									Systems of Quality Management
		Manufacturing Planning and Lean Management	MK3GYLMJ04JJ20-EN																					2	2	m	4					Vehicle Manufacturing and Repair
38		Vehicle Diagnostics	MK3JDIAJ04JJ20-EN																					0	4	m	4					Measurement Technology
39		Group Project for Vehicle Engineers	MK3JPROJ15JJ20-EN																									0	20	m	15	Materials of Vehicles, Vehicle Manufacturing II, Quality Assurance in Manufacturing Proceses, Manufacturing Planning and Lean Management, Vehicle Diagnostics
41		Thesis	MK3SZDGJ15JJ20-EN																									0	15	m	15	Group Project for Vehicle Engineers (parallel)
42	Optional Subjects*	Optional Subject I												3																		
43		Optional Subject II																2														
44		Optional Subject III																					2									
45		Optional Subject IV																									3					
46		Internship**	MK3SZGYJ00JX20-EN																					6 weeks		s	0					

	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	
Total / semester:	15	11		30	11	17		30	14	14		30	13	11		31	12	14		30	10	18		29	0	35		30	**Total:**
number of exam subjects			3				3				3				4				3				2				0		number of exam subjects 18
number of mid-semester grade subjects			3				4				3				3				2				4				2		number of mid-semester grade subjects 21
number of comprehensive exam subjects			0				1				0				0				0				1				0		number of comprehensive exam subjects 2
number of subjects			6				8				6				7				5				7				2		number of subjects 41
number of teaching hours / semester	26				28				28				24				26				28				35				number of teaching hours 195
																													number of optional credits 10
																													total number of credits 210

Abbreviations:
L = Number of Lectures / week
P = Number of Practices / week
E = Evaluation
c = comprehensive exam
e = exam
m = mid-semester grade
s = signature
C = Credits

Criterion subjects:
*Optional Subjects (Rules and Regulations XIII. Faculty of Engineering 10. § (2)). Minimum of credits assigned to optional subjects: 10 credits. The suggedted order and credit number in the curriculum is only a recommendation.
**Internship (requirement: signature, lenght: 6 weeks after the 6th semester; students must register for the subject in the 6th semester)
Work and Fire Safety (requirement: signature, students must register for the subject in the 1st semester based on Rules and Regulations XIII. Faculty of Engineering 5. § (6))
Physical Education (requirement: signature, Rules and Regulations 10. §)

MODEL CURRICULUM OF VEHICLE ENGINEERING BSC – AUTOMOTIVE VEHICLE ENGINEERING SPECIALISATION

the curriculum of the program is available in excel format on the webpage of the Faculty of Engineering (www.eng.unideb.hu/en)

University of Debrecen | **Faculty of Engineering** | **Curriculum** | **Full-Time**

Vehicle Engineering (BSc) - Automotive Vehicle Engineering Specialisation

Nr.	Subject groups	Subject	Code	1st semester				2nd semester				3rd semester				4th semester				5th semester				6th semester				7th semester				Prerequisite
				L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	
1	Basics of Natural Sciences	Mathematics I	MK3MAT1A08JX20-EN	4	4	m	8																									
2		Mathematics II	MK3MAT2A06JX20-EN					2	4	m	6																					Mathematics I
3		Mathematics Comprehensive Exam	MK3MATSA00JX20-EN					0	0	c	0																					Matematika II (parallel)
4		Mathematics III	MK3MAT3A04JX20-EN									2	2	m	4																	Mathematics II
5		Engineering Physics	MK3MFIZA04JX20-EN	2	2	e	4																									
6		Technical Chemistry	MK3MKEMK04JX20-EN	2	1	e	4																									
7		Statics and Strenght of Materials	MK3STSZG04JX20-EN					2	2	m	4																					
8		Dynamics and Vibration	MK3MREZG04JX20-EN									2	2	e	4																	
9		Materials Engineering	MK3ANISG06JX20-EN	3	2	m	6																									
10		Thermodynamics	MK3HOTAL04JX20-EN									2	2	m	4																	Mathematics II
11		Fluid Mechanics	MK3ARATL04JX20-EN													2	2	e	4													Thermodynamics
12	Economics and Humanities	Business Law	MK3UZLJM03JX20-EN													2	0	e	3													
13		Micro- and Macroeconomics	MK3MIMAM04JX20-EN					1	2	e	4																					
14		Management and Business Economics	MK3MEN1M04JX20-EN													1	2	m	4													Micro- and Macroeconomics
15		Systems of Quality Management	MK3MIMRM04JX20-EN													2	2	m	4													
16	Professional Compulsory Subjects	Programming	MK3PROGR04JX20-EN					0	4	m	4																					
17		Basic Theory of Vehicle Engineering	MK3ALJGJ04JX20-EN	2	1	e	4																									
18		Vehicles and Mobile Machinery	MK3JAMGJ04JX20-EN					2	1	e	4																					
19		Technical Drawing I	MK3MAB1A04JX20-EN	2	1	m	4																									
20		Technical Drawing II	MK3MAB2A04JX20-EN					2	2	e	4																					Technical Drawing I
21		Electronics and Electrotechnics	MK3ELTTR04JX20-EN					2	2	m	4																					Engineering Physics
22		Vehicle and Drive Elements I	MK3JAH1J05JX20-EN									2	2	e	5																	Statics and Strenght of Materials
23		Vehicle and Drive Elements II	MK3JAH2J05JX20-EN													2	2	e	5													Vehicle and Drive Elements I
24		Vehicle Materials and Technologies	MK3JAATJ06JX20-EN									4	4	e	6																	Materials Engineering
25		Vehicle Manufacturing and Repair	MK3JAGJJ05JX20-EN													2	2	e	5													Vehicles and Mobile Machinery
26		Thermodynamics and Fluid Machines of Vehicles	MK3JAHBJ06JX20-EN																	4	1	e	6									Fluid Mechanics
27		Vehicle Design and Diagnostics	MK3JATVJ04JX20-EN																					2	2	e	4					Vehicle and Drive Elements I
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29		Applied Automation	MK3AAUTR04JX20-EN																					2	2	e	4					Control Theory II
30		Control Theory I	MK3IRA1R04JX20-EN													2	1	m	4													Electronics and Electrotechnics
31		Control Theory II	MK3IRA2R04JX20-EN																	2	1	e	4									Control Theory I
32		Electric Machines and Drives	MK3VHAJR06JX20-EN																					2	4	m	6					Electronics and Electrotechnics
33		Vehicle Engineering Comprehensive Exam	MK3JASZJ00JG20-EN																					0	0	c	0					Prerequisite: Vehicle Powertrain Systems, Vehicle Suspensions, Automotive Electronics and Mechatronics Parallel: Automotive Engines, Automotive Operation Systems
34	Field-specific Vocational Subjects	Vehicle Powertrain Systems	MK3GEPEJ06JG20-EN																	4	2	m	6									Vehicle and Drive Elements II
35		Vehicle Suspensions	MK3GEPFJ08JG20-EN																	4	4	e	8									Vehicles and Mobile Machinery
36		Automotive Engines	MK3GEPMJ08JG20-EN																					6	4	m	8					Thermodynamics
37		Automotive Electronics and Mechatronics	MK3GEELJ04JG20-EN																	2	2	e	4									Electronics and Electrotechnics
38		Automotive Operation Systems	MK3GEPUJ04JG20-EN																					2	2	m	4					Vehicles and Mobile Machinery
39		Group Project for Vehicle Engineers	MK3JPROJ15JG20-EN																									0	20	m	15	Vehicle Powertrain Systems, Vehicle Suspensions, Automotive Engines, Automotive Electronics and Mechatronics, Automotive Operation Systems
41		Thesis	MK3SZDGJ15JG20-EN																									0	15	m	15	Group Project for Vehicle Engineers (parallel)
42	Optional Subjects*	Optional Subject I												3																		
43		Optional Subject II																2														
44		Optional Subject III																					2									
45		Optional Subject IV																									3					
46		Internship**	MK3SZGYJ00JX20-EN																					6 weeks		s	0					
				L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	
		Total / semester:		15	11		30	11	17		30	14	14		30	13	11		31	16	10		30	14	14		29	0	35		30	**Total:**
		number of exam subjects				3				3				3				4				4				2				0		number of exam subjects 19
		number of mid-semester grade subjects				3				4				3				3				1				3				2		number of mid-semester grade subjects 19
		number of comprehensive exam subjects				0				1				0				0				0				1				0		number of comprehensive exam subjects 2
		number of subjects				6				8				6				7				5				6				2		number of subjects 40
		number of teaching hours / semester		26				28				28				24				26				28				35				number of teaching hours 195
																																number of optional credits 10
																																total number of credits 210

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