University of Debrecen

Faculty of Engineering

Mechanical Engineering MSc Program

2020

TABLE OF CONTENTS

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 2020/2021

Opening ceremony of the academic year	6 September 2020 (Sunday)
Registration week	31 August - 4 September 2020
Revision week (exams in Exam coursess may be scheduled during this week)	31 August - 4 September 2020
1st semester study period in MSc and BSc programs	7 September - 11 December 2020 (14 weeks) In case of finalist courses: 7 September 2020 - 6 November 2020 (9 weeks)
Reporting period I (Drawing week I)	19 - 22 October 2020 (4 working days without scheduled lessons, consultation schedule announced previously)
Faculty Conference of Scientific Students' Association	12 November 2020
Reporting period II (Drawing week II)	7-11 December 2020 (5 working days without scheduled lessons, consultation schedule announced previously)
1st semester examination period	14 December 2020 - 29 January 2021 (7 weeks) In case of finalist courses: 9 November - 11 December 2020 (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 14 December 2020 and 29 January 2021. The departments shall announce the date of the final examination until 15 September 2020.
Registration week	1 - 5 February 2021
2nd semester study period in MSc and BSc programs	8 February - 14 May 2021 (14 weeks) In case of finalist courses: 8 February - 9 April 2021 (9 weeks)
Conferences	
Reporting period I (Drawing week I)	22 - 26 March 2021 (5 working days without scheduled lessons, consultation schedule announced previously)
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)	31 March - 2 April 2021
10th "Árkádia" Conference (organised by the Department of Architectural Engineering)	31 March - 2 April 2021
Career Days in Civil Engineering (organised by the Department of Civil Engineering)	31 March - 2 April 2021
8th ISCAME (International Scientific Conference on Advances in Mechanical Engineering) *VIII. Exhibition on Mechanical Engineering* (organised by the Department of Mechanical Engineering)	31 March - 2 April 2021
Career Days in Environmental Engineering (organised by the Department of Environmental Engineering)	31 March - 2 April 2021

*Career Days in Mechatronics (exhibition, company presentations) (*organised by the Department of Mechatronics)	31 March - 2 April 2021
International conference entitle *"Electrical Engineering and Mechatronics Conference EEMC'21"* (organised by the Department of Mechatronics)	31 March - 2 April 2021
"Challenges and Opportunities in the Field of Management" Conference (organised by the Department of Enginering Management and Enterprise)	31 March - 2 April 2021
"Problem-Based Learning in Engineering Education" Conference (organised by the Department of Basic Technical Studies)	1 April 2021
Career Days in and Exhibition on Building Services Engineering	6-7 May 2021
Reporting period II (Drawing week II)	10 – 14 May 2021 (5 working days without scheduled lessons, consultation schedule announced previously).
2nd semester examination period	17 May - 2 July 2021 (7 weeks) In case of finalist courses: 12 April - 14 May 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 17 May and 25 June 2021. The departments shall announce the date of the final examination until 15 February 2021.

THE MECHANICAL ENGINEERING MASTER'S PROGRAM

INFORMATION ABOUT THE PROGRAM

Name of master's program:	Mechanical Engineering Master's Program
Specialization available:	Production Engineering Specialization
Field, branch:	Engineering
Level:	MSc
Qualification:	Mechanical Engineer
Mode of attendance:	Full-time
Faculty:	Faculty of Engineering
Program coordinator:	Tamás Mankovits Ph.D, Associate Professor
Program length:	4 semesters
Credits total:	120 (thesis: 30, optional subjects: 6)

Aim of the degree program is to train mechanical engineers who are able to work out, model, design, operate, control and maintain mechanical systems and processes; develop engineering technologies and processes, new materials and manufacturing technologies, apply them in an energy-efficient and environmentally conscious way; complete leadership, control and organisational tasks; complete tasks of engineering development, research, design and innovation; participate in and control national and international engineering projects. The degree offers the opportunity to further study at PhD level.

Professional competencies to be acquired

a) knowledge

- He/she knows the general and specific principles, rules, relations and procedures pertaining to mathematics, natural- and social sciences necessary to work in the field of engineering.
- He/she has an in-depth understanding of global social and economic processes.
- He/she knows theories, relations, terminology of fundamental importance in the engineering field.
- He/she knows and understands basic principles, borderlines of the epistemic and functional system of the engineering field and the expected directions of development, innovation.
- He/she knows terminology, main regulations and aspects of other areas of vital importance (primarily that of logistics, management, environmental protection,

quality assurance, information technology, law, economics, work- and fire safety, industrial safety) relating to the engineering field.

- He/she has a detailed knowledge and understanding of mechanisms of knowledge acquisition and methods for data collection, their ethical barriers and problem-solving techniques.
- He/she has an in-depth knowledge of the main characteristics and application areas of structural materials used in the field of mechanical engineering.
- He/she has a detailed knowledge of the rules of preparing engineering documentation.
- He/she knows the organisational devices and methods pertaining to leadership, legal regulations in the professional field.
- He/she has knowledge of measurement techniques and theory relating to mechanical engineering.
- He/she knows information and communication technologies relating to the field of mechanical engineering.
- He/she knows devices and methods of computer modelling and simulation in relation to the field of mechanical engineering.
- He/she has an in-depth theoretical and practical knowledge including knowledge in methodology to design, manufacture, operate and control complex mechanical systems and processes.
- He/she has an in-depth knowledge of the methods used in machine, system and process design in the field of mechanical engineering.

b) abilities

- He/she is capable of the practical application of the acquired general and specific principles, rules, relations, processes relating to mathematics and natural- and social sciences in order to solve problems emerging in the engineering field.
- By problem-solving he/she is able to use theories and terminology of the engineering field in an innovative way.
- He/she is capable of approaching and solving specific problems emerging in the professional field in manifold interdisciplinary ways.
- By problem-solving he/she is able to promote cooperation between representatives of the related fields.
- By applying modern knowledge acquisition and data collection methods he/she is able to innovatively solve specific engineering problems emerging in the professional field
- He/she is able to apply information and communication technologies and methods to solve engineering problems.
- He/she is ready to publish, make presentations and hold discussions in his/her professional field in his/her mother tongue and at least one foreign language.
- He/she is able to complete leadership tasks followed by the required practical experience.
- He/she is capable of the laboratory study and analysis of the materials used in the field of mechanical engineering, the assessment and documentation of research results.
- He/she is ready to process and systematize information gained through the operation of mechanical systems and processes, make analyses, draw conclusions.
- He/she is able to add genuine ideas to the knowledge base of the field of mechanical engineering.

- He/she is capable of the application of integrated skills from the following fields: machines, mechanical engineering devices, systems and processes, engineering materials and technologies, electronics, informatics.
- He/she is capable of the acquisition of the global design of complex systems on the basis of system-based and process-oriented way of thinking.
- He/she is capable of the complex design and management of the application of engineering, economic, environmental and human resources.
- He/she is capable of the application and further development of processes, models, information technologies used in the design, organisation and operation of mechanical systems and processes.
- He/she is prepared for the quality assurance of mechanical systems, technologies and processes, solving tasks of measurement technique and process control.
- He/she is capable of creative problem-handling, flexibly solving complex tasks, has the commitment to life-long learning, variety and value-orientedness.

c) attitude

- He/she is open and sensitive to get acquainted with, accept and genuinely convey the professional and technological development and innovation undergoing in the engineering field.
- He/she undertakes the professional and ethical value system relating to the engineering field.
- He/she endeavours to contribute to the development of new methods and devices in connection with the engineering field. He/she has a strong sense of vocation.
- He/she endeavours to continuously improve his/her and his/her co-workers' knowledge through self- and further education.
- He/she endeavours to comply with and make others comply with the ethical principles of work and organisational culture.
- He/she endeavours to comply with and make others comply with the requirements of quality.
- He/she endeavours to organise and complete tasks by meeting the expectations of environmental-consciousness, health-consciousness and sustainability.
- He/she endeavours to acquire profound and in-depth education.
- He/she endeavours to meet the requirements of sustainability and energy-efficiency.
- He/she endeavours to design and complete tasks individually or in teamwork at a professionally high level.
- He/she endeavours to work according to system-based and process-oriented way of thinking characterized by a complex approach.
- During his/her work he/she is investigating the possibility of achieving aims in research, development and innovation and endeavours to realise them.
- Having acquired engineering skills, he/she endeavours to become familiar with the observable phenomena as thoroughly as he/she can, describe and explain their principles.
- He/she is committed to high-level work of quality; he/she sets an example to his/her co-workers through displaying this attitude.
- He/she is committed to enriching the field of mechanical engineering by new ideas and research results.
- He/she participates in research and development projects related to the field of mechanical engineering. To achieve the aims, he/she applies his/her theoretical and

practical knowledge, skills in cooperation with the members of the research and development group.

- He/she is committed to health and safety at work, and health improvement.

d) autonomy and responsibility

- He/she shares his/her knowledge and experience with representatives of his/her professional field in formal, non-formal and informal ways of information exchange.
- He/she evaluates his/her inferiors' work, facilitates professional development through his/her critical remarks.
- He/she is able to solve engineering tasks on his/her own.
- He/she takes the initiative in solving engineering tasks.
- He/she takes responsibility for sub-processes under his/her control.
- He/she is able to individually make decisions in his/her field.
- He/she educates his/her co-workers and inferiors to take responsibility and show ethical behaviour in their professional field.
- He/she individually takes the initiative in solving problems related to his/her professional field.
- He/she assumes responsibility for sustainability, health and safety at work and environmental-consciousness.
- He/she is careful before individually making decisions in consultation with representatives from diverse fields (primarily that of law, economics, energy management, environmental protection). He/she takes responsibility for his/her decisions.
- When making decisions he/she considers principles and applicability of environmental protection; quality assurance; consumer protection; product responsibility; equal rights to accessibility; basic principles of health and safety at work; technological, economic and legal regulations; ethics in engineering.

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.

For the Mechanical Engineering MSc program, the following professional fields define the training:

- Natural Sciences (Mathematics, Mechanics, Materials Science, Thermodynamics and Fluid Mechanics) 20-35 credit points;
- Economics and Humanities (Project Management, Leadership and Organizational Skills, Quality Assurance, Environmental Protection, Waste Management, Energy Management, Communication, Marketing, Legal and Financial Skills), other professional skills defined in the curriculum of the institution: 10-20 credit points;
- Mechanical Engineering (Analysis of Mechanical Systems and Processes, Theory of Design and Methodology, Process Control and Modelling, Materials- and Manufacturing Technology, Measurement Theory and Technique) 15-35 credit points.
  Credit points assigned to field-specific subjects along with thesis: 40-60.

Minimum of credit points assigned to optional subjects: 6

Credit points assigned to thesis: 30

Credits total: 120

During the program students have to complete a total amount of 120 credit points. It means approximately 30 credits pro semester. The curriculum contains the list of subjects (with credit points) and the recommended order of completing subjects which takes 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 (120) 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 that the suggested order be followed because some subjects can only be taken after the completion of the 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 Mechanical Engineering MSc programme, Production Engineering specialization:

1st fall semester	1st spring semester
Applied Statistics	Applied Mathematics
Applied Dynamics	Applied Thermodynamics and Fluid Mechanics
Investment and Financial Decisions	Applied Quality and Environmental Management
Machine and Product Design	Electrical measurement and signal processing
Materials Science	Engineering Systems and Modelling
Organizational Techniques and Project Management	Integrated Design Systems
Optional subject I	Optional subject II
	Internship
2nd fall semester	**2nd spring semester**
Design of Manufacturing Devices	Project Work
Design of Material Handling and Storage Systems	Simulation of Manufacturing Systems and Processes
Production Automation	Production Process Optimization
Diagnostics and Condition Monitoring	Maintenance and Repairing Technologies
Thesis I	Thesis II

About the prerequisites of each subject please read the chapter “Course Descriptions of Mechanical Engineering Master’s Program”!

Work and Fire Safety Course

According to the Rules and Regulations of University of Debrecen a student has to complete the online course for work and fire safety. Registration for the course and completion are necessary for graduation. For MSc students the course is only necessary only if BSc diploma has been awarded outside of the University of Debrecen.

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 webpage of the Faculty.

Internship

Internship is a mandatory and integral part of the course of studies and strongly related to thesis. The duration of internship is at least 4 weeks (without interruption) and undertaken at a production company. Credit points: 0

Physical Education

According to the Rules and Regulations of University of Debrecen a student has to complete Physical Education courses at least in one semester during his/her master's training. Our University offers a wide range of facilities to complete it. 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 a student has to complete elective courses during his/her Bachelor or Master training. These elective courses are opened by the Departments at the Faculty of Engineering at the beginning of the actual semester. A student can also select elective courses from other faculties of University of Debrecen to complete but these courses are accepted with less credits than they have originally. During your training you can complete elective subjects in any semester. There is no maximum limit of credits gained on elective courses but please note that courses completed on Erasmus scholarship often can be transferred as optional subjects into your curriculum. In the Mechanical Engineering MSc programme, you have to gain at least 6 credits with completing elective subjects.

Pre-degree Certification

A pre-degree certificate is issued by the Faculty after completion of the master's (MSc) program. The pre-degree certificate can be issued if the student has successfully completed the study and exam requirements as set out in the curriculum, the requirements relating to Physical Education as set out in Section 10 in Rules and Regulations, internship (mandatory) – with the exception of preparing thesis – and gained the necessary credit points (120). The pre-degree certificate verifies (without any mention of assessment or grades) that the student has fulfilled all the necessary study and exam requirements defined in the curriculum and the criteria requirements. Students who obtained the pre-degree certificate can submit the thesis and take the final exam.

Thesis

Precondition for taking the final exam for MSc students is to prepare the thesis. Requirements of the training program contain the content requirements for thesis, general aspects of the evaluation and the number of credits assigned to thesis (30).

Thesis is the creative elaboration of a professional task (scientific, engineering, design, development, research or research development) in 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 and external supervisor. By solving the task, the student relies on his/her studies using national and international literature under the guidance of an internal and external supervisor. By preparing and defending thesis students who complete the Mechanical Engineering master's program prove that they are capable of the practical applications of the acquired skills, summarizing the work done and its results in a professional way, creatively solving the tasks related to the topic and doing individual professional work. The faculty academic calendar (issued by the Vice-Rector for Education) sets the thesis submission deadline.

The latest that thesis topics are announced by the departments is the end of Week 4 of the study period of the last but one semester.

The department hands out thesis guides to assist students with preparing thesis. Thesis topic can be suggested by the student. The head of department decides on the acceptance of the topic. The conditions on the acceptance of thesis as National Conference of Scientific Students' Association (hereinafter NCSSA) topic are specified by the Faculty. The NCSSA work is supposed to meet the requirements in form and content for thesis.

Furthermore, it is necessary that the committee of the Pre-NCSSA makes suggestions on the NCSSA work to become a thesis.

Formal requirements of thesis are announced in writing by the Department of Mechanical Engineering.

Thesis is prepared under the guidance of an internal supervisor previously approved by the Department of Mechanical Engineering and with the assistance of an external supervisor also previously approved by the department.

Precondition for thesis submission is the thesis review report completed and signed by the external supervisor. The internal supervisor decides whether the thesis can be accepted or not. Acceptance is verified by the signature of the internal supervisor.

Thesis is evaluated by the referee (internal or external) in a five-point system. On the basis of the thesis review report the internal supervisor and the coordinator of the specialization make suggestions for the evaluation of thesis. The final exam board is notified by the department of the decision made on the three grades awarded for thesis.

Improving thesis with a fail mark:

If thesis is evaluated with a fail mark by the referee, the head of department may decide to allocate a new referee to review thesis.

If thesis is evaluated with a fail mark by the head of department, the student is not allowed to take the final exam and is supposed to prepare a new thesis.

Conditions on resubmitting the thesis are defined by the program coordinator.

Final exam

Students having obtained the pre-degree certificate will finish their studies in the Mechanical Engineering master's (MSc) program by taking the final exam. Conditions on taking the final exam and issuing the pre-degree certificate are laid down in Rules and Regulations of the University of Debrecen (also see special provisions for the Faculty of Engineering). Final exam means the testing and evaluating of the knowledge (skill) necessary to obtain higher education qualification. In the final exam candidates prove that they can apply the acquired knowledge.

If the candidate fails to take the final exam until the termination of his/her student status, he/she is allowed to take the final exam after the termination of his/her student status according to the regulations (in relation to final exams) which applied at the time of the candidate's first taking the final exam.

Final exam committee

Committee chair is called upon and mandated by the dean with the consent of the Faculty Council. He/she is selected from the acknowledged internal and external experts of the professional field. Traditionally, it is the chair and in case of his/her absence or indisposition the vice-chair who will be called upon, as well. The committee consists of – besides the chair – at least two members and the examiner.

Final exam process

Final exam can be taken both in the autumn and the spring final exam period.

The final exam consists of two parts:

1. defending thesis (presentation on thesis, then answers to questions and remarks),
2. oral exam in two subjects of the final exam depending on the specialization

Subjects of the final exam

Obligatory subject of the final exam:

Production Process Optimization

Optional subject groups of the final exam:

(1) Simulation of Manufacturing Systems and Processes *or*

(2) Topics of the subjects Maintenance and Repairing Technologies *and* Diagnostics and Condition Monitoring

The committee assesses performance in the final exam and awards mark for thesis. The committee decides on diploma grade and thesis grade in closed sitting after thesis

defence. In controversial cases the chair takes the decision. After the end of the final exam the results are announced by the committee chair.

Improving failed final exam

Final exam has to be retaken if any of its part is a fail. The ensuing final exam period is the soonest that the re-sit is allowed. In case the student successfully completes any part of the final exam (defending thesis or oral exam in subjects of the final exam), he/she is supposed to improve only the failed part. Retake final exam is allowed twice in each part.

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

Subject group “Basic Natural Sciences”

Applied Mathematics

Code: MK5ALKMA04GX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 1st spring semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

Survey of differential and integral calculus. Interpolation. Regression. Non-parametric regression models. Taylor polynomials. Trigonometric system, trigonometric polynomials, Fourier series. Optimization problems. Optimization with differentiation. Gradient-based optimization methods. Derivative-free optimization methods. Integral transforms. Exponential system, Fourier transform, discrete Fourier transform. Spectrum. Applications in signal analysis and vibration diagnostics. Laplace transform. 1st drawing week, mid-term test Differential equations, initial value problem, boundary value problem. Direction field. Euler method, Runge-Kutta method. Autonomous systems, phase plane. Some non-linear type differential equations. Linear differential equations. Method of variation of parameters and undetermined coefficients. Solution with Laplace transform. System of linear differential equations. System of linear differential equations with constant coefficients. Matrix functions. Linear and non-linear autonomous systems. Stability. Main types of partial differential equations. Examples. Variational principle. Analytical and numerical solution methods.

Literature:

Compulsory:

- Greenberg, M. D., Advanced Engineering Mathematics, New Jersey, Prentice Hall, 1998.
- Kreyszig, Advanced engineering mathematics, John Wiley & Sons Inc., 2011

- Polyanin, A.D., Manzhirov, A.V., Handbook of Mathematics for Engineers and Scientists, Chapman & Hall, 2007.
- Logan, J. D., Applied Partial differential equations, New York, Springer, 2004.
- Chapra, S. C., Numerical Methods for Engineers, Mc Graw Hill, 2006.
- Dyke, P., An Introduction to Laplace Transforms and Fourier Series, Springer, 2014

Schedule

1st week Registration week	
2nd week: **Lecture:** Survey of differential and integral calculus. **Practice:** Applications of differential and integral calculus.	**3rd week:** **Lecture:** Interpolation. Regression. Non-parametric regression models. **Practice:** Interpolation. Regression.
4th week: **Lecture:** Taylor polynomials. Trigonometric system, trigonometric polynomials, Fourier series. **Practice:** Taylor polynomials. Fourier series.	**5th week:** **Lecture:** Optimization problems. Optimization with differentiation. Gradient-based optimization methods. **Practice:** Optimization with differentiation.
6th week: **Lecture:** Derivative-free optimization methods **Practice:** Derivative-free optimization methods.	**7th week:** **Lecture:** Integral transforms. Exponential system, Fourier transform, discrete Fourier transform. Spectrum. Applications in signal analysis and vibration diagnostics. Laplace transform. **Practice:** Fourier transform. Laplace transform.
8th week: 1st drawing week	
9th week: **Lecture:** Differential equations, initial value problem, boundary value problem. Direction field. Euler method, Runge-Kutta method. **Practice:** Euler method, Runge-Kutta method.	**10th week:** **Lecture:** Autonomous systems, phase plane. Some non-linear type differential equations. **Practice:** Some non-linear type differential equations.
11th week: **Lecture:** Linear differential equations. Method of variation of parameters and	**12th week:** **Lecture:** System of linear differential equations. System of linear differential

undetermined coefficients. Solution with Laplace transform. **Practice:** Method of variation of parameters and undetermined coefficients. Solution with Laplace transform.	equations with constant coefficients. Matrix functions. **Practice:** System of linear differential equations with constant coefficients.
13th week: **Lecture:** Linear and non-linear autonomous systems. Stability. **Practice:** Stability of autonomous systems.	**14th week:** **Lecture:** Main types of partial differential equations. Examples. Variational principle. Analytical and numerical solution methods. **Practice:** Main types of partial differential equations.
15th week: 2nd drawing week	

Requirements

A, for a signature:

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. 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 is on the 8th week and the end-term test is on the 15th week. Students must sit for the tests.

B, for a grade:

The course ends in a mid-semester grade based on the average grade of the two tests.

The minimum requirement of the mid-term and the end-term test is 60% separately. The grade for each test 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).

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

Applied Statistics

Code: MK5ALKSA04GX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 1st fall semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

Sample spaces and events. Axioms of probability. Conditional probability. Multiplication and total probability rules. Independence. Discrete and continuous random variables, probability distribution, density function. Numerical characteristics of random variables. Limit theorems. Joint probability distributions. Correlation, independence. Descriptive statistics. Point and interval estimation. Confidence interval. Hypothesis testing (probability, mean, standard deviation), normality test, ANOVA. Regression analysis. System reliability. Time series. Markov chain. Statistical process control. Statistical tools in 6 process improvement.

Literature:

Compulsory:

- 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
- DeCoursey, W. J., Statistics and Probability for Engineering Applications with Microsoft® Excel, Newnes, 2003
- Allen, T. T., Introduction to Engineering Statistics and Six Sigma, Springer, 2006
- Pham, Hoang (Ed.), Springer Handbook of Engineering Statistics, Springer, 2006, ISBN 978-1-85233-806-0
- NIST/SEMATECH e-Handbook of Statistical Methods, http://www.itl.nist.gov/div898/handbook/Author, Titel, Publisher, Year, ISBN

Schedule

1st week Registration week	
2nd week: **Lecture:** Sample spaces and events. Axioms of probability. Conditional probability. Multiplication and total probability rules. Independence.	**3rd week:** **Lecture:** Discrete and continuous random variables, probability distribution, density function. **Practice:** Random variables.

Practice: Calculation of probability	
4th week: **Lecture:** Numerical characteristics of random variables. Limit theorems. **Practice:** Random variables.	**5th week:** **Lecture:** Joint probability distributions. **Practice:** Joint probability distributions.
6th week: **Lecture:** Correlation, independence. **Practice:** Correlation, independence.	**7th week:** **Lecture:** Descriptive statistics. **Practice:** Descriptive statistics.
8th week: 1st drawing week	
9th week: **Lecture:** Point and interval estimation. Confidence interval. **Practice:** Point and interval estimation. Confidence interval.	**10th week:** **Lecture:** Hypothesis testing (probability, mean, standard deviation), normality test, ANOVA. **Practice:** Hypothesis testing (probability, mean, standard deviation), normality test, ANOVA.
11th week: **Lecture:** Regression analysis. **Practice:** Regression analysis.	**12th week:** **Lecture:** System reliability. **Practice:** System reliability.
13th week: **Lecture:** Time series. Markov chain. **Practice:** Time series. Markov chain.	**14th week:** **Lecture:** Statistical process control. Statistical tools in 6σ process improvement. **Practice:** Statistical process control. Statistical tools in 6 process improvement.
15th week: 2nd drawing week	

Requirements

A, for a signature:

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. 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 is on the 8th week and the end-term test is on the 15th week. Students must sit for the tests.

B, for a grade:

The course ends in a mid-semester grade based on the average grade of the two tests.

The minimum requirement of the mid-term and the end-term test is 60% separately. The grade for each test is given according to the following t (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 of the whole semester material.

Applied Dynamics

Code: MK5ADING05GX17-EN

ECTS Credit Points: 5

Evaluation: exam

Year, Semester: 1st fall semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

Linear and nonlinear dynamical system analysis in time-domain. Differential equations. Duhamel principle and transfer function. Convolution. Typical signals for system analysis. Harmonic functions as input signals for dynamical systems. Ergodic excitations. Dirac and Heaviside functions. Transfer characteristics. Stochastic signals and environmental vibrations on dynamic systems. Autocorrelation function and cross-correlation function. Hamilton-Jacobi equations. Virtual work principle. D'Alembert principle. Classification of the constraints. First order Lagrange equation.

Second order Lagrange equation. Holonomic and nonholonomic constraints.

Generalization of Lagrange principle for 1-DOF and higher DOF dynamic systems.

Analysis of linear systems in complex frequency domain. Integral transformations for analysis of mass-spring-damper systems. Laplace transform for mathematical solution of DEs and for analysis of mass-spring-damper systems. Asymptotic principles. Stability of linear systems. Nyquist criteria Routh-Hurwitz criteria.

Analysis of linear systems in frequency domain. Fourier integral. Fourier transform. Analysis of signals and systems by Fourier transform. Bending vibrations of power transmission systems. Simulation in Matlab, Labview and Simulink. Continuum vibrations.

Torsional vibrations of shafts. Laval-rotor. Rayleigh quotient iteration, Stodola (convergence), Rayleigh's principle, Dunkerley's estimate. Longitudinal and torsional vibrations of prismatic bars.

Vibration of continuum bars The Sturm-Liouville task and relationship with the standing wave solution. Longitudinal vibrations of prismatic beams.

Spatial mechanisms. Robot manipulators. Kinematics and dynamics of wrist movements, kinematic chains, Lagrange equations, TTT / RTT / RRR work spaces. Robotics in machine industry.

Spatial mechanisms direct and inverse kinematic and dynamic characterization tasks, Lagrange equations. Denavit-Hartenberg principle. Grashof principle and Roberts principle for spatial mechanisms. Simscape simulation for spatial mechanisms.

Vibration analysis of cutting machines in manufacturing technology, spindles, rotors as special dynamic systems. Simulations of dynamic systems in Matlab Simulink. Vibration isolation systems, calculation, vibration reduction, critical frequency, resonance, environmental noise and vibration reduction methods.

Literature:

Compulsory:

- Allan G. Piersol, Thomas L.Paez: Harris's Shock and Vibration Handbook, Sixth Edition, McGrraw-Hill,2010. ISBN 978-0-07-163343-7
- S. Graham Kelly: Mechanical Vibrations Theory and Applications, University of Akron, 2012. ISBN -13: 978-1-4390-6214-2
- Harold Josephs- Ronald J. Huston: Dynamics of mechanical systems. 5th Edition, CRC Press Inc., 2006. ISBN 0-8439-0593-4
- Parasuram Harihara, Dara W. Childs: Solving Problems in Dynamics and Vibrations Using MATLAB, Dept. of Mechanical Engineering, Texas, A & M University, 2014
- Eugene Avallone: Standard Handbook for Mechanical Engineers, Eleventh Edition, McGrraw-Hill,2010. ISBN-13: 978-0-07-142867-5

Schedule

1st week: Registration week

2nd week:	**3rd week:**
Lecture: Mathematical basics. Matrices. Tensors. Diff. equations. Eigenvalues. Numerical methods. **Practice:** Matlab applications.	**Lecture:** Linear and nonlinear dynamical system analysis in time-domain. Differential equations. Duhamel principle and transfer function. Convolution.

	Typical signals for system analysis. Harmonic functions as input signals for dynamical systems. Ergodic excitations. **Practice:** Differential equations and calculations.
4th week: **Lecture:** Dirac and Heaviside functions. Transfer characteristics. Stochastic signals and environmental vibrations on dynamical systems. Autocorrelation function and cross-correlation function Practice: Labview and Matlab signal generation for system analysis.	**5th week:** **Lecture:** Hamilton-Jacobi equations. Virtual work principle. D'Alembert principle. Classification of the constraints. First order Lagrange equation. Second order Lagrange equation. Holonomic and nonholonomic constraints. **Practice:** Lagrange equations for dynamical systems. Solution of Diff. equations.
6th week: **Lecture:** Generalization of Lagrange principle for 1-DOF and higher DOF dynamic systems. Practice: Examples and calculations of 1-DOF and higher DOF mass-damper-spring systems.	**7th week:** **Lecture:** Analysis of linear systems in complex frequency domain. Integral transformations for analysis of mass-spring-damper systems. Laplace transform for mathematical solution of DEs and for analysis of mass-spring-damper systems. **Practice:** Laplace transform applications for dynamic systems.
8th week: 1st drawing week	
9th week: **Lecture:** Analysis of linear systems in frequency domain. Fourier integral. Fourier transform. Analysis of signals and systems by Fourier transform. Stability of linear systems. Nyquist criteria Routh-Hurwitz criteria. **Practice:** Analysis of harmonic signals with Fourier transform.	**10th week:** **Lecture:** Bending vibrations of power transmission systems. Laval-rotor. Rayleigh quotient iteration, Stodola convergence, Rayleigh's principle, Dunkerley's estimate. Longitudinal and torsional vibrations of prismatic bars. Vibration of continuum bars The Sturm-Liouville task. **Practice:** Simulation in Matlab, Labview and Simulink.
11th week: **Lecture:** Spatial mechanisms. Robot manipulators. Kinematics and dynamics of	**12th week:**

wrist movements, kinematic chains, Lagrange equations, TTT / RTT / RRR work spaces. Robotics in machine industry. Spatial mechanisms direct and inverse kinematic and dynamic characterization tasks, Lagrange equations. **Practice:** Simscape simulation for spatial mechanisms.	**Lecture:** Spatial mechanisms Denavit-Hartenberg principle. Grashof principle and Roberts principle for spatial mechanisms. **Practice:** Simulation in Simulink and Labview.
13th week: **Lecture:** Vibration analysis of cutting machines in manufacturing technology, spindles, rotors as special dynamic systems. **Practice:** Simulations of dynamic systems in Matlab Simulink.	**14th week:** **Lecture:** Vibration isolation systems, calculation, vibration reduction, critical frequency, resonance, environmental noise and vibration reduction methods. **Practice:** Passive and active vibration isolation system calculations. Vibration measurement and methods for mitigation.
15th week: 2nd drawing week	

Requirements

A, for a signature:

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. 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 is on the 8th week and the end-term test is on the 15th week. Students must sit for the tests.

B, for grade:

The course ends in exam grade. The grade for the test 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).

Applied Thermodynamics and Fluid Mechanics

Code: MK5AHOAL04GX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 1st spring semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

Similarity rules, wind tunnels; Navier-Stokes equation, turbulency models; Meshing of the fluid flow; Isotherm flow modelling; Variable temperature flow modelling; Rotating flow modelling; Non-stationary flow modelling; Multi-source flow modelling; Multi-phase flow modelling; Multi-phase flow thermal modelling; Multi-phase flow thermal modelling; Multi-phase flow thermal modelling

Literature:

Compulsory:

- Yunus A. Çengel, John M. Cimbal Boston : McGraw-Hill Higher Education, cop. 2010 Fluid mechanics: fundamentals and applications ISBN: 9780073529264

Recommended:

- https://support.ansys.com/portal/site/AnsysCustomerPortal guides on the web page

Schedule

1st week: Registration week	
2nd week: **Lecture:** Similarity rules, wind tunnels **Practice:** The practical application of the theoretical curriculum said during the lecture.	**3rd week:** **Lecture:** Navier-Stokes equation, turbulency models **Practice:** The practical application of the theoretical curriculum said during the lecture.

4th week: **Lecture:** Meshing of the fluid flow **Practice:** The practical application of the theoretical curriculum said during the lecture.	**5th week:** **Lecture:** Isotherm flow modelling **Practice:** The practical application of the theoretical curriculum said during the lecture.
6th week: **Lecture:** Variable temperature flow modelling **Practice:** The practical application of the theoretical curriculum said during the lecture.	**7th week:** **Lecture:** Rotating flow modelling **Practice:** The practical application of the theoretical curriculum said during the lecture.
8th week: 1st drawing week	
9th week: **Lecture:** Non-stationary flow modelling **Practice:** The practical application of the theoretical curriculum said during the lecture.	**10th week:** **Lecture:** Multi-source flow modelling **Practice:** The practical application of the theoretical curriculum said during the lecture.
11th week: **Lecture:** Multi-phase flow modelling **Practice:** The practical application of the theoretical curriculum said during the lecture.	**12th week:** **Lecture:** Multi-phase flow thermal modelling **Practice:** The practical application of the theoretical curriculum said during the lecture.
13th week: **Lecture:** Individual problem solving **Practice:** The practical application of the theoretical curriculum said during the lecture.	**14th week:** Lecture: Exam
15th week: 2nd drawing week	

Requirements

A, for signature:

Attendance on the lectures is compulsory.

Student must attend on the lecture 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 is counted as an absence. In case of further

absences, a medical certificate needs to be presented. 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.

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

Materials Science

Code: MK5ANTUG05GX17-EN

ECTS Credit Points: 5

Evaluation: exam

Year, Semester: 1st fall semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

The aim of the course is to extend the material science knowledge taught in the undergraduate course, through the presentation of special materials and its tangible analysis. Additionally, students can get closer to medical materials, which are currently being developed at a remarkable scale.

Literature:

Compulsory:

- Chawla, Krishan K. Composite Materials Science and Engineering 3rd ed. Springer 2012
- Nicolais, Luigi; Meo, Michele; Milella, Eva: Composite Materials: A Vision for the Future, 2011 Springer Verlag
- C.P. Poole, F.J. Owens: Introduction to nanotechnology, Wiley Interscience, 2003

Schedule

1st week: Registration week	
2nd week: **Lecture:** Overview of the groups of substances and presentation of the latest material science results **Practice:** Preparation of a metallographic sample for semester task	**3rd week:** **Lecture:** Composites I. - overview and presentation of composite materials **Practice:** Preparation of a metallographic sample for semester task
4th week: **Lecture:** Composites II. - composite manufacturing technology **Practice:** Charpy impact test for semester task	**5th week:** **Lecture:** Composite III. - Aerospace industrial and space applications **Practice:** Charpy impact test for semester task
6th week: **Lecture:** Composite IV. - Special composites, nano and bio composites **Practice:** Charpy impact test for semester task	**7th week:** **Lecture:** Polymer I. - Overview of Industrial Polymers, Production Technology **Practice:** Charpy impact test for semester task
8th week: 1st drawing week	
9th week: **Lecture:** Polymer II. - Certification procedures for industrial polymers, case studies **Practice:** Charpy impact test for semester task	**10th week:** **Lecture:** Ceramics I. - Overview **Practice:** Charpy impact test for semester task
11th week: **Lecture:** Ceramics II. - Production technology **Practice:** Measurement of toughness and theoretical strength calculation of the ceramic coating of the neural implant.	**12th week:** **Lecture:** Ceramics III. - Qualification procedures **Practice:** Measurement of toughness and theoretical strength calculation of the ceramic coating of the neural implant.
13th week: **Lecture:** Biocompatible materials I.	**14th week:** **Lecture:** Biocompatible materials II.

Practice: Microscopic analysis of human implants	**Practice:** Microscopic analysis of human implants
15th week: 2nd drawing week	

Requirements

A, for a signature:

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. 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 is on the 8th week and the end-term test is on the 15th week. Students must sit for the tests.

B, for grade:

The course ends in a mid-semester grade based on the average grade of the two tests.

The minimum requirement of the mid-term and the end-term test is 60% separately. The grade for each test 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).If the score of any test is below 60, the student once can take a retake test of the whole semester material.

Subject group "Economics and Humanities"

Investment and Financial Decisions

Code: MK5BERPM04GX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 1st fall semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

This course is intended to introduce students to the main concepts and theories about financial, in-vestment analysis and business performance measurement so that students are able to make investment decisions. By the end of the course, the student should be able to use the basic tools and models of investment analysis, and apply them in solving problems.

The course focuses on the theory and application of the following:

The time value of money. Calculating future value and present value. Real and nominal rates of interest. Discounted cash flow analysis. Net present value rule. Future and present value of an annuity/annual payment. Growing annuities. The internal rate of return (IRR) calculation. Shortcomings of IRR. Payback and discounted payback period, profitability index. Making investment decision with the net present value rule. Equivalent annual cost. Capacity-building investments.

Valuing bonds (duration, bond volatility). The value of common stocks. Financial planning (Costs, short-term financing, break-even analysis, cost accounting). General economic and social environment, sustainable development.

Literature:

Compulsory:

- Brealey, R. A. - Myers, S. C. – Allen, F (2014): Principles of Corporate Finances. 11th Edition, McGraw-Hill/Irwin, 2014. ISBN-13: 9780077151560.
- T. Kiss Judit (2016): Introduction to Corporate Financial Decisions for Engineers and Engineering Managers. Dupress, University of Debrecen. Accepted – ISBN: 978-963-318-583 4.

Recommended:

- Scott Besley - Eugene F. Brigham (2011): Principles of Finance. Cengage Learning, 2011 (South Western). ISBN: 1111527369, 9781111527365
- Correia, C. – Flynn, D. K. - Besley – Ulian, E. – Wormald, M. (2012): Financial Management. 6th edition. Juta and Company Ltd. ISBN: 0702171573, 9780702171574.
- E.R. Yescombe (2014): Principles of Project Finance second edition Yescombe ConsultingLtd. London 2014.
- Stefano Gatti (2013): Project Finance in Theory and Practice Designing, structuring and financing private and public projects ELSEVIER INC.Author, Titel, Publisher, Year, ISBN

Schedule

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

Lecture: Introduction; Goals and governance of the firm; Shareholders, Stakeholders of a Company. Global, social and economic processes.

Practice: Preparatory overview of financial calculation I. Calculation/Team Problems – Cash flow analysis.

Lecture: The investment trade-off, investment and financing decision. Comparative analysis. Future value and present value calculation (continuous compounding, frequency of payment, future value of annuity (ordinary and annuity due).

Practice: Preparatory overview of financial calculation II. Calculation/Team problems: Valuing Cash Flows in Several Periods. Future value and present value. Continuous compounding. Ordinary annuity and annuity due.

4th week:

Lecture: The present value of an investment possibility, Net Present Value Rule. Profitability index. Determination of futures cash flows (expenditures and revenues).

Practice: Calculation/Team problems – Net present value and profitability index. The NPV rule.

5th week:

Lecture: Annuities, changing interest rates. Types of annuities. The payback rule; The discounted payback rule. Shortcomings of payback period. Loans.

Practice: Calculation/Team problems/computer related problems – calculation of loan payment, payback period.

6th week:

Lecture: Internal rate of return (IRR). IRR rule, shortcomings of internal rate of return. Comparative analysis of technical investments, case studies. Sensitivity analysis (inflation rate, technological change).

Practice: Calculation/Team problems/computer related problems – Internal rate of return, modified IRR, problem of limited resources

7th week:

Lecture: Choosing between short- and long-lived equipment. Investment with identical life-times and investments with different life-times. Equivalent annual cost and equivalent annual benefit. Inflation and the opportunity cost. Equivalent annual cash-flow and technological change.

Practice: Calculation/Team problems – equivalent annual cost- choosing the discount rate, choosing among projects.

8th week: 1st drawing week

9th week:

Lecture: Investments with limited resources. Mutually exclusive projects. Investment timing. Project analysis.

10th week:

Lecture: Making investment decisions. Corporate strategies and performance measurement. The role of human capital, and innovation.

Practice: Investments with limited resources. Mutually exclusive projects. Investment timing. Project analysis.	**Practice:** Calculation/Team problems/computer related problems for project analysis.
11th week:	**12th week:**
Lecture: Evaluation of a complex investment possibility. Investment and maintenance. General economic and social environment, corporate social responsibility. Private, social and global costs. **Practice:** Calculation/Team problems – examination of complex investment opportunity.	**Lecture:** Valuing Bonds. Types of Bonds. Perpetuities, growing perpetuities. Duration. Bond's yield to maturity. The relationship between coupon rate and interest rate. **Practice:** Calculation/Team problems - Price and interest rate, time to maturity, yield to maturity, and yield to call.
13th week:	**14th week:**
Lecture: The value of Common Stocks. The determinants of stock prices. Return on equity - ROE. Net present value of growth opportunities. **Practice:** Calculation/Team problems - Theoretical price of stocks, financial indicators.	**Lecture:** Options (Calls, puts, and Shares). Strike price. Position and profit diagrams. Put-call parity. Determinants of the option values. Option strategies. **Practice:** Computer related problems Option strategies and option algebra.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Participation at 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 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 (score/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.

Organizational Techniques and Project Management

Code: MK5SZERM04GX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 1st fall 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 familiarize students with different leadership roles and tasks. Contribute to the student's theoretical and practical knowledge of organizing and leadership skills. Knowing the organization methodology and applying it in practical work.

Literature:

Compulsory:

- Schein, Edgar H.: Organizational culture and leadership. San Francisco: Jossey-Bass, 2004. ISBN 0-7879-6845-5
  http://www.untag-smd.ac.id/files/Perpustakaan_Digital_2/ORGANIZATIONAL%20CULTURE%20Organizational%20Culture%20and%20Leadership,%203rd%20Edition.pdf
- Robbins, Stephen P.: Management. Boston, Mass. [u.a.]: Pearson, 2016. ISBN 9781292090207
- Pinto, Jeffrey K.: Project management: achieving competitive advantage. Upper Saddle River, N.J.: Prentice Hall, 2010. ISBN 9780135097557

Schedule

1st week Registration week	
2nd week: Lecture: Management methods Practice: Assessing leadership style through personality tests and situational tasks	3rd week: Lecture: Coordination of task, competence, power and responsibility Practice: In connection with the project, elaborate a complex task based on the job, power and competence
4th week: Lecture: Motivation theories Practice: Case studies and motivational tests to reveal students' self-motivation and motivational tools	5th week: Lecture: Psychology in leadership Practice: Use the psychology methodology to use situations and case studies
6th week: Lecture: Career Plan Practice: Developing specific career plans	7th week: Lecture: Strategy Practice: Develop a specific strategic plan
8th week: 1st drawing week	
9th week: Lecture: Project life cycle and organizational influences Practice: Creating a Lifecycle of a Project	10th week: Lecture: Project management processes Practice: Preparation of project processes
11th week: Lecture: Project Scheduling Practice: Developing a project schedule	12th week: Lecture: Project Cost Practice: Developing a project Cost
13th week: Lecture: Project Risk Practice: Developing Project Risk	14th week: Lecture: Project closure Practice: Project closure
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:

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).

Applied Quality and Environmental Management

Code: MK5AMINM04GX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 1st spring 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 introduce students to the company's quality management and environmental management techniques, the application of which in the European Union, as well as in Hungary, is an essential element of market competitiveness.

Literature:

Compulsory:

- Sven Erik Jørgensen, Joao Carlos Marques, Søren Nors Nielsen, Integrated Environmental Management: A Transdisciplinary Approach, CRC Press, 2015, ISBN 9781498705103
- Kanishka Bedi: Quality Management, Oxford, 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:** Industrial ecology and sustainability **Practice:** Investigating case studies	**10th week:** **Lecture:** Environmental factors and environmental impacts **Practice:** Impact Sheet, Leopold Matrix, ABC Analysis, Eco-mapping
11th week: **Lecture:** Life cycle assessment, analysis of life-cycle phases **Practice:** Life cycle analysis	**12th week:** **Lecture:** Environmental audit and benchmarking **Practice:** Creating an audit plan
13th week: **Lecture:** ISO 14001 standard **Practice:** Tasks about the standard	**14th week:** **Lecture:** Process of assessing environmental performance **Practice:** The relationship between environmental indicators and performance appraisal
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:

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).

Subject group "Professional Subjects"

Electrical Measurement and Signal Processing

Code: MK5EMJFR04GX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 1st spring semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

Industry 4.0 are typical trends, the current and expected trends of development. System engineering: Basic concepts, classification of systems. Bond graphs in electrical engineering. Sensors in manufacturing automation and other industrial applications. Physical engineering practice is the most important measurement of physical quantities: temperature measurement, position detection, proximity switches, flow sensors, speed sensors, acceleration sensors. Sensors (sensors) and measuring transducers. The measuring device structure and characteristics. Measurement errors. Measurement methods. Electromechanical and Electronic Instruments. Analogue, Digital Instruments. Microelectronic sensors. Processing of analogue and digital signals of data. The evaluation of the results, error analysis using data acquisition card (DAQ).

Literature:

Compulsory:

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

Recommended:

- Sabrie Soloman, Sensors Handbook, Mac-Grow Hill Company, 2010, ISBN : 978-0-07-160571-7, Available on-line at: http://ailab.ijs.si/~blazf/kro/SL/Soloman%20-%20Sensors%20Handbook%202nd%20Edition%20-%202010.pdf

Schedule

1st week: Registration week	
2nd week: Lecture: Typical trends of Industry 4.0, current and anticipated trends in development Practice: Process simulation practice	3rd week: Lecture: System engineering: Basic concepts, classification of systems Practice: Modelling of electrical machines
4th week: Lecture: Application of Bond Graph in electrical engineering Practice: Bond graphs	5th week: Lecture: Definition of sensors, grouping of physical effects Practice: Sensors measuring practice
6th week: Lecture: sensor effects, sensor materials and manufacturing processes. Practice: Sensors measuring practice	7th week: Lecture: Overview of proximity switches, position sensors and other industrial sensors

	Practice: Sensors measuring practice
8th week: 1st drawing week	
9th week: **Lecture:** Overview of flow sensors and temperature sensors **Practice:** Sensors measuring practice	**10th week:** **Lecture:** Overview of speed and acceleration sensor sensors **Practice:** Sensors measuring practice
11th week: **Lecture:** Structure and operation of measuring transducers. **Practice:** Measuring analogue and digital measuring transducers	**12th week:** **Lecture:** Structure and operation of analogue and digital instruments **Practical:** Collecting data with acquisition card (DAQ)
13th week: **Lecture:** Measurement system construction, collection of measurement data **Practical:** Signals processing provided by DAQ	**14th week:** **Lecture:** Processing of measured data, analysis of errors **Practical:** Error analysis provided by a data logger card
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 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. 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 table: Score

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

Machine and Product Design

Code: MK5MGTTG04GX18-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 1st fall semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

The goal of the subject is to show the process of machine design, the properties and possibilities of methodical design. Students get acquainted with the main design strategies, and their properties, with process and main steps of the discursive strategy. Birth of the product idea, design of the product, building up of the requirements, techniques of looking for solution principles and combination of principles. Students will be able to choose the right solutions using the technical valuating methods. They acquire the basic rules and guidelines of design, which helps to create constructions suitable for manufacturing and assembly. In practices the goal is to show how the theory functioning in the practice. Students solve design tasks following the steps of design methodology.

Literature:

Compulsory:

- G.Pahl and W. Beitz: Engineering Design: A Systematic Approach Translated by Arnold Pomerans and Ken Wallace, The Design Council London, 1988, ISBN 0 85072 239x

Recommended:

- Koller R..: Design Method for Machine, Device and Apparatus Construction, Springer-Verlag, Berlin/Heidelberg, 1979
- Amaresh Chakrabarti: Engineering Design Synthesis; Understanding, Approaches and Tools, Springer, 2002, ISBN: 978-1-84996-876-8 (Print) 978-1-4471-3717-7 (Online)

Schedule

1st week: Registration week	
2nd week: **Lecture:** Stages of Technical lifetime of products. Functions of products. **Practice:** issuing the 1. task. Compilation of requirements.	**3rd week:** **Lecture:** General process flow of the design process. **Practice:** Analysis of functions of products. The list of requirements.
4th week: **Lecture:** Design strategies. The demand for methodical design. **Practice:** Analysis of functions of products. The list of requirements.	**5th week:** **Lecture:** Product design, specification of the task, Compilation of system of requirements. **Practice:** Issuing the home assignment.
6th week: **Lecture:** Conception design. Abstraction of the task. **Practice:** The process flow of the design process.	**7th week:** **Lecture:** The structure of the functions. **Practice:** Building up the structure of the functions.
8th week: 1st drawing week	
9th week: **Lecture:** Looking for solution principles, combination of principles. Selection of the suitable variations. **Practice:** Building up variations of solutions.	**10th week:** **Lecture:** Technical valuating. Valuating methods in the design process. **Practice:** Technical valuating. Choosing the right solution.
11th week: **Lecture:** mid-term test **Practice:** elaborating the home assignment	**12th week:** **Lecture:** Basic rules and principles of construction. **Practice:** elaborating the home assignment
13th week: **Lecture:** Guidelines of construction for proper design regarding manufacturing and assembly. **Practice:** presentation of the home assignment.	**14th week:** **Lecture:** Technical documentation-systems. Principles of preparing the technical documentation. **Practice:** presentation of the home assignment.
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. 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 design tasks as scheduled minimum on a sufficient level.

During the semester there is an end-term test.

B, for grade:

The course ends in exam.

Engineering Systems and Modelling

Code: MK5GRMOG05GX18-EN

ECTS Credit Points: 5

Evaluation: exam

Year, Semester: 1st spring semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

Fundamentals of systems engineering, technical systems, characteristics of systems, classification of signals and systems. Fundamentals and principles of modelling. Connection between the real systems and models. Process and characteristics of mechanical modelling. Load models, material models and structural models. System models applied in control engineering, control of systems. Investigation of the modelling uncertainties, uncertainty models and its applications. Stochastic models of mechanical engineering systems. Modelling of the random effects in engineering systems. Theoretical background of Fuzzy systems and its application in the modelling of engineering systems. Fuzzy controllers. Dynamic modelling of mechanical engineering systems via finite element method. Generating the matrices of the governing equation of motion. Investigation of free and forced structural vibrations of engineering systems via finite element method. Finite element modelling of mechanical problems. Derivation of stiffness matrix, load vector and the equilibrium equation. Finite element analysis of

nonlinear problems. Handling of material and geometrical nonlinearities. Solution techniques of nonlinear problems. Finite element calculations of nonlinear elastic structures.

Literature:

Compulsory:

- Mankovits T.: Numerical Analysis of Engineering Structures (Linear Elasticity and the Finite Element Method), University of Debrecen, 2014.

Recommended:

- Bonet J., Wood E.D.: Nonlinear continuum mechanics for finite element analysis. 2nd edition. Cambridge University Press, 2008.

Schedule

1st week: Registration week	
2nd week: Lecture: Fundamentals of systems engineering, technical systems, characteristics of systems, classification of signals and systems. Practice: Practical problems related to technical systems.	3rd week: Lecture: Fundamentals and principles of modelling. Connection between the real systems and models. Practice: Modelling case-studies.
4th week: Lecture: Process and characteristics of mechanical modelling. Load models, material models and structural models. Practice: Mechanical modelling case-studies.	5th week: Lecture: System models applied in control engineering, control of systems. Practice: Generating and application of control engineering system models.
6th week: Lecture: Investigation of the modelling uncertainties, uncertainty models and its applications. Practice: Application of uncertainty models.	7th week: Lecture: Stochastic models of mechanical engineering systems. Modelling of the random effects in engineering systems. Practice: Application and characteristics of stochastic models.
8th week: 1st drawing week	
9th week:	10th week:

Lecture: Theoretical background of Fuzzy systems and its application in the modelling of engineering systems. Fuzzy controllers. **Practice:** Practical problems related to generating and application of Fuzzy systems.	**Lecture:** Dynamic modelling of mechanical engineering systems via finite element method. Generating the matrices of the governing equation of motion. **Practice:** Practical problems related to the finite element dynamic modelling. Generating the finite element models.
11th week: **Lecture:** Investigation of free and forced structural vibrations of engineering systems via finite element method. **Practice:** Practical problems related to the finite element dynamic modelling. Solution and evaluation of the finite element models.	**12th week:** **Lecture:** Finite element modelling of mechanical problems. Derivation of stiffness matrix, load vector and the equilibrium equation. **Practice:** Practical examples for the finite element modelling of engineering structures. Pre-processing, solution and post processing.
13th week: **Lecture:** Finite element analysis of nonlinear problems. Handling of material and geometrical nonlinearities. Solution techniques of nonlinear problems. **Practice:** Contact problems.	**14th week:** **Lecture:** Finite element calculations of nonlinear elastic structures. **Practice:** Finite element analysis of hyperelastic materials. **2nd test.**
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 grade:

The course ends in an examination.

The minimum requirement of the 2 tests and the examination is respectively 50%. Based on the score of the tests separately, the grade for the tests and the examination 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 any test is below 50, 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 mid-term tests is at least good (4).

Integrated Design Systems

Code: MK5INTRG05GX17-EN

ECTS Credit Points: 5

Evaluation: mid-semester grade

Year, Semester: 1st spring semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Topics:

In industry, there are several integrated CAD/CAM/CAE solutions. The aim of the course is to introduce the integrated design systems with students and lead on product lifecycle from inception, through engineering design and manufacture. Industry-specific CAD modules (sheet metal part-, welding- and framework design environments). Industrial design, rapid prototype manufacturing. Introduction to surfacing and mechanism design process. Computer aided engineering (CAE). Finite element analysis of engineering parts in integrated design systems (discretization of finite element model, analysis and post-processing). Engineering optimization (target functions, design parameters and design variables). Computer aided manufacturing (CAM) in the integrated design systems. Connection between CAM and NC machines.

Literature:

Compulsory:

- Mankovits, T. (2014): Numerical Analysis of Engineering Structures (Linear Elasticity and the Finite Element Method), University of Debrecen, Debrecen, Hungary, ISBN: 978-963-473-797-1, p. 181.
- P. Hervay, R. Horváth, L. Kátai, I. Madarász, B. Mikó, L. Molnár, I. Nagy, I. Oldal, O. Papp, A. Piros, L. Rabb, I. Szabó, G. N. Tóth, K. Váradi: CAD Book, Typotex Publishing House, 2012, ISBN 978-963-685-7
- Cs. Erdősné Sélley, Gy. Gyurecz, J. Janik, G. Körtélyesi: Engineering Optimization, Typotex Publishing House, 2012, ISBN 978-963-279-686-4
- J. Zheng Li: CAD, 3D Modelling, Engineering Analysis and Prototype Experimentation, Springer International Publishing Switzerland, 2015, ISBN 978-3-319-05920-4, ISBN 978-3-319-05921-1 (eBook)
- M. Fitzpatrick: Machining and CNC Technology, McGraw-Hill, 2014, ISBN 978-0-07-337378-2

Recommended:

- I. Stroud, H. Nagy: Solid Modelling and CAD Systems, Springer-Verlag London, 2011, ISBN 978-0-85729-259-9
- Singiresu S. Rao: Engineering Optimization, John Wiley & Sons, 2009, ISBN 978-0-470-18352-6

Schedule

1st week: Registration week	
2nd week:	**3rd week:**
Lecture: Introduction to integrated design systems. Computer aided product development.	**Lecture:** Product life cycle management. Introduction to top-down, bottom-up and iterative design methods.
Practice: Sketches, constraints and basic features in parametric CAD system.	**Practice:** Assembly design and drafts in parametric CAD system. **Complex design task.**
4th week:	**5th week:**
Lecture: Industry-specific CAD modules. sheet metal part-, weldment- and framework design environments.	**Lecture:** Software solutions for forming, injection moulding and casting.
Practice: Sheet metal part design: basic features	**Practice:** Sheet metal part design in parametric CAD system.
6th week:	**7th week:**
Lecture: Industrial design, rapid prototype manufacturing	**Lecture:** Analysis of mechanisms. Case studies.
Practice: Surfacing using parametric CAD system.	

	Practice: Mechanism connections, motion simulation. Kinematic and kinetic analyses and its evaluation.
8th week: 1st drawing week	
9th week: **Lecture:** Features of finite element modules available in integrated design systems. **Practice:** Finite element analysis of engineering parts (discretization of finite element model, analysis and post-processing).	**10th week:** **Lecture:** Special analysis types. Finite element analysis of nonlinear and dynamic problems. **Practice:** Effects of geometry and material modifications on the simulation results.
11th week: **Lecture:** Engineering optimization (target functions, design parameters and design variables). **Practice:** Structural optimization in an integrated design system.	**12th week:** **Lecture:** Computer aided manufacturing (CAM) in the integrated design systems. Specific features of CAM modules available in integrated design systems. **Practice:** Introduction to CAM software user interface. Tool management.
13th week: **Lecture:** Case study for a product lifecycle management within an integrated design system. **Practice:** Machining operations: face milling, roughing, chamfering cycle, creating CNC code. Simulation.	**14th week:** Lecture: End-term test **Practice:** Connection between CAM and NC machines in laboratory practice. Import CNC code generated by CAM software.
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 is a test in the 14th week. Students have to sit for the test. During the semester there is a complex design task.

B, for grade:

The course ends in a mid-semester grade, based on the average of the test and complex design task.

The minimum requirements of the test and the complex design task is respectively 50%. Based on the score of the test and the task separately, the grade for the tests and the task 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 test and task is below 50, 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 end-term test and the complex design task is at least good (4).

Project Work

Code: MK5PROMG04GX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd spring semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

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

Within the framework of the course students have the opportunity to participate in the research work, innovation tasks, project work, and current industrial work running in the department. During classes students get (from the aforementioned fields) sub-tasks which they are supposed to solve in groups of 2-3. Basically, students work on their own but in consultation with the instructors of the Department of Mechanical Engineering. During this, problems will be solved and interpreted with the help of viewing through national and international literature related to the subject field. Afterwards, different problem-solving suggestions will be formulated to complete the task. Having elaborated the best problem-solving suggestion, the results will be presented in the framework of a presentation. In their future work students will apply the acquired theoretical, practical and software skills.

Design of Manufacturing Devices

Code: MK5GYETG04GX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 2nd fall 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 subject is the students know the types and utilization of the manufacturing devices and tools during the technological process. The first part of the semester the students learn device constriction and designing knowledge. They select standard work piece device for a given technological task on the practice. From the standard device elements, they design workpiece device for special workpieces and serial production. The second part of the semester build on Manufacturing Processes II. the students acquire the basic calculation methods and design principles what necessary for the planning of metal-forming technologies. In practice, the students create a finite element simulation based on the earlier planned metal-forming technologies. During the lectures and practices, the following software are presented: Solidworks, EdgeCAM, Simufact forming.

Literature:

Compulsory:

- Berta M.: CNC szerszámgépek szerszámrendszerei, Nyíregyházi Főiskola, Nyíregyháza, 2015, p. 156, ISBN 978 615 5545 03 0
- Molnár J., Szabó S.: Készüléktervezés, Miskolci Egyetemi Kiadó, 1995
- Childs, Peter R. N.: Mechanical Design Engineering Handbook, Butterworth-Heinemann, 2018, ISBN 9780081013069
- Gen, Mitsuo, Kim, Kuinam J., Huang, Xiaoxia, Hiroshi, Yabe: Industrial Engineering, Management Science and Applications 2015, Springer Verlag, 2015, ISBN 9783662471999
- Prakash M. Dixit, Uday S. Dixit: Modelling of Metal Forming and Machining Processes, Springer-Verlag, 2008, ISBN 978-1-84996-749-5
- Henry S. Valberg: Applied Metal Forming: Including FEM Analysis, Cambridge University Press, 2010, ISBN 978-0-521-51823-9

Recommended:

- Gyáni K., Kazár L., Molnár J.: Készülékszerkesztés, kézirat, Nehézipari Műszaki Egyetem, Gépészmérnöki Kar, Tankönyvkiadó, Budapest, 1977.
- Fritz Klocke: Manufacturing Processes I, Cutting, RWTH Edition, RWTH Aachen University, p. 524, ISBN 978-3-642-11978-1
- Mikel P. Groover: Fundamentals of Modern Manufacturing, Materials, Processes and Systems, Third Edition, United States of Amerika, p. 520, ISBN 978-0-471-74485-6
- Vladimir B. Ginzburg, Robert Ballas: Flat Rolling Fundamentals, Marcel Dekkel, Inc., New York and Basel, 2000, ISBN 978-0-824-78894-0

Schedule

1st week: Registration week	
2nd week: **Lecture:** The device elements of centralization. The types of clamping elements. **Practice:** Analysis of technological system. Survey of the necessary devices.	**3rd week:** **Lecture:** Designing of drilling devices. The manufacturing errors of the drilling process. **Practice:** Computer aided modelling of device elements I. (Solidworks software)
4th week: **Lecture:** Electormechanic, hydraulic, pneumatic and vacuum devices. Magnet force devices. **Practice:** Computer aided modelling of device elements II. (Solidworks software)	**5th week:** **Lecture:** Force transmission elements and constructions. Centralization pressure. **Practice:** Computer assembly designing of devices elements. (Solidworks software)
6th week: **Lecture:** The types and establishment of device bodies. Setting of devices on the technological process. **Practice:** Finite element method analysis of the pressure. (Solidworks software)	**7th week:** **Lecture:** Type and group devices. Devices in flexible manufacturing systems. **Practice:** Computer technological designing of prismatic workpieces. (EdgeCAM software)
8th week: 1st drawing week	

9th week: **Lecture:** Planning aspects of mechanical-, steam- and air hammers. The kinematics of hammers. Acting forces on the ram. The impact energy and the theoretical impact number. The founding of hammers. **Practice:** Selection of device, tool and working machine for a given technological task. Calculation of the technological parameters. Analysis of CNC machine having more cutting tools. Technological planning. (EdgeCAM software)	**10th week:** **Lecture:** The aspects of planning and choosing of hydraulic and mechanical presses. Kinematic relation, characteristic curve and loadability of mechanical presses. **Practice:** Designing of motion cycles of tools. Analysis of production strategies. Selection of the optimal technology. Selection of cutting tool for a given technological task from tool catalogue. (EdgeCAM software)
11th week: **Lecture:** The aspects of planning and loadability testing of rolling mills. The load of structural elements. Sizing and strength checking for plastic deformation and fatigue. **Practice:** Planning and finite element simulation of die forging technology (SolidWorks and Simufact Forming).	**12th week:** **Lecture:** Determination of load of roll stand frame, roll adjust device and different structural elements. **Practice:** Planning and finite element simulation of die forging technology (SolidWorks and Simufact Forming).
13th week: **Lecture:** Mechanical equipment for drawing. Rod and tube drawing machines. Planning of multi-stage wire drawing machines. **Practice:** Planning and finite element simulation of cold rolling technology (SolidWorks and Simufact Forming).	**14th week:** **Lecture:** Test for the signature **Practice:** Planning and finite element simulation of cold rolling technology (SolidWorks and Simufact Forming).
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 create an own planning (device) and finite element simulation tasks.

3.) At the end of the semester they have to write a test.

B, for grade:

Students have to take a written and oral exam for the lecture. They will receive the questions topics. They will get the final grade on the exam (1 - 5).

Subject group "Differentiated Professional Subjects"

Simulation of Manufacturing Systems and Processes

Code: MK5GYFTG04G117-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd spring semester

Its prerequisite(s): Engineering Systems and Modelling

Further courses are built on it: Yes/No

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

Topics:

The series of lectures and practices are based on the topics of production management and business strategy development. The students learn about production strategies and product life time in Tecnomatix environment. The lectures describe the properties of different production processes and the competitiveness of a production system, aggregate planning and the typology of forecasts, and the component of production and operation management in programming (C and C#). The students learn about basic programming skills and programming languages. The target of this subject is to describe company values and culture and to develop process thinking in engineer students with modern computer simulation. By the end of the semester the students will acquire and will be able to use these kinds of methods.

Literature:

Compulsory:

- William J. Stevenson: Operations management 10th ed. Bostob: McGraw-Hill/Irwin 2009. ISBN-13: 978-0073377841 ISBN-10: 0073377848
- Olhager, Jan – Person, Fredrik: Advances in Production Management System Springer-Verlager GmbH, 2007. ISBN 978-0-387-74157-4
- James P. Womack – Daniel T. Jones: Lean Thinking, Banish Waste and Create Wealth in Your Corporation. Revised an Updated, Touchstone, an Imrint of Simon & Schuster, Inc., 2003. ISBN 0-7432-4927-5

- Steffen Bangsow: Tecnomatix Plant Simulation Modelling and programming by Means of Examples ISBN 978-3-319-19502-5

Recommended:

- Clark, Kim – Takahiro, Fujimoto: Product Development Performance, Boston, Harvard Business School Press, 1991. ISBN-10: 0875842453 ISBN-13: 978-0875842455
- Nishiguchi, Toshihiro: Strategis Industrial Sourcing: The Japanese Advantage, Oxford: Oxford University Press, 1994. ISBN: 9780195071092

Schedule

1st week: Registration week	
2nd week: **Lecture:** Cycle Time, Bottle Neck **Practice:** Basic programming knowledge	**3rd week:** **Lecture:** Basics of Quality, G8D, scrap **Practice:** Basic functions of Tecnomatix environment
4th week: **Lecture:** Production planning in Tecnomatix **Practice:** Information flow programming in Tecnomatix	**5th week:** **Lecture:** Variables in production **Practice:** Modelling of transportation ways
6th week: **Lecture:** Robots and material handling equipment in Tecnomatix **Practice:** Attributes, variables, Pick and Place elements, Robot simulation, "The lock out Zone"	**7th week:** **Lecture:** Storage systems **Practice:** Buffer in Tecnomatix, Stock level calculations, Kanban, Supermarket
8th week: 1st drawing week	
9th week: **Lecture:** Organization in Tecnomatix, operation shift **Practice:** Simulation of machine operators, Chaku-Chaku cells	**10th week:** **Lecture:** Ergonomics, safety elements **Practice:** Simulation of machine operators with different efficiency
11th week: **Lecture:** Single Minute Exchange of Dies (SMED), Value Stream Map (VSM), Value Stream Design (VSD) **Practice:** SMED programming, "speed changes" in production	**12th week:** **Lecture:** Key Performance Indicator in production **Practice:** OEE calculation

13th week: **Lecture:** Icon editor, animations **Practice:** 3D plant simulation	**14th week:** **Lecture:** Fluid simulation **Practice:** Energy system analysis, statistics

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 practices 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 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 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 behaviour 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 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 a mid-semester grade. Based on the average of the grades of the drawings and the average of the test results, the mid-semester grade is calculated as an average of them: - the grade of the drawing task - 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, students once can take a retake test of the whole semester material.

Production Process Optimization

Code: MK5TFOPG04G117-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 2nd spring semester

Its prerequisite(s): Applied Statistics

Further courses are built on it: Yes/No

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

Topics:

The goal of the subject is to develop a process-oriented view in the students. During the lectures and practices the students get acquired with the evaluation, meaning and principles of Lean management. They acquire the definition of the added value, the waste in the production and administrative processes, the methods of mapping and analysis of material- and information-flow. The students get routine in problem solving and in Kaizen team-work. Detailed analysis of production systems, and their design methodology. Definition of goals, and determination of key indicators. During practices students get routine in valuation of processes, determination of process- and time-data, methods of time-recording. Basics of quality management, and process control. Operational cost calculations, process costs. Material flow. Basics of ergonomics and the principles of ergonomically correct workplace-design.

Literature:

Compulsory:

- William J. Stevenson: Operations management 10th ed. Boston: McGraw-Hill/Irwin

Recommended:

- James P.W.: Lean thinking, Free press, 2003
- Olhager, Jan - Persson, Fredrik: Advances in Production Management System. Springer-Verlag GmbH, 2007

Schedule

1st week: Registration week	
2nd week:	**3rd week:**
Lecture: Basics and principles of the Lean management.	**Lecture:** Definition of waste. Waste in the production processes.
Practice: Introduction to the methods of process analysis.	**Practice:** Identification of waste in production process. Simulation in teamwork.
4th week:	**5th week:**
Lecture: Work system, organization of the work, taxonomy of planning.	**Lecture:** Valuation of processes. Valuation of processes, Key indicators.
Practice: Identification of waste in production process. Simulation in teamwork.	**Practice:** Issuing the home assignment.
6th week:	**7th week:**

Lecture: Determination of process-data. **Practice:** Building up the work system of a production process.	**Lecture:** Determination of time features of a process. **Practice:** Analysis of a production process.
8th week: 1st drawing week	
9th week: **Lecture:** Determination of planned times. **Practice:** Analysis of a production process.	**10th week:** **Lecture:** Quality management. Statistical process control. **Practice:** Time recording techniques of processes in the practice.
11th week: **Lecture:** Ergonomics. Introduction to the principles of ergonomically correct workplace-design. **Practice:** Time recording techniques of processes in the practice.	**12th week:** **Lecture:** Operational cost calculations, calculation with process costs. **Practice:** Presentation of the home assignment.
13th week: **Lecture:** Material flow design. **Practice:** Presentation of the home assignment.	**14th week:** **Lecture:** End-term test. **Practice:** Supplement of missing or not sufficient assignments. Pre-exam.
15th week: 2nd drawing week	

Requirements

A, for a signature:

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. If student's behaviour 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 the home assignment as scheduled minimum on a sufficient level.

During the semester there is one test in the 14th week.

B, for grade:

The course ends in exam.

Design of Material Handling and Storage Systems

Code: MK5AMOTG04G117-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd fall semester

Its prerequisite(s): Machine and Product Design

Further courses are built on it: Yes/No

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

Topics:

Designing process and steps of material handling and logistic systems. Methods for the comparison of design variants. Modelling methods of material handling systems. Representing the material handling systems as bulk service systems. Applying queueing models for the investigation of material handling systems. Designing methods of continuous operating material handling systems for bulk materials and itemised products. Analysis of the storage systems of itemised product warehouses. Required data for the planning of itemised product warehouses, the planning procedure and the main planning steps. Designing the storage space of itemised product warehouses, configuration aspects of traffic connections and product reorganization spaces. Types and design of order picking systems. Technological systems and material handling machinery of high bay warehouses. Simulation methods of material handling and storage systems.

Literature:

Compulsory:

- Gudehus, T., Kotzab, H.: Comprehensive Logistics, Springer Berlin Heidelberg, 2012. ISBN-9783642243677

Recommended:

- Mulcahy, David E.: Materials Handling Handbook; McGraw-Hill Professional, 1999. ISBN-007044014X

Schedule

1st week: Registration week

2nd week:	**3rd week:**
Lecture:	**Lecture:**
Designing process and steps of material handling and logistic systems.	Methods for the comparison of design variants.
Practice:	**Practice:**
Examples of the design of material handling systems.	Comparison of several design variants.

4th week: **Lecture:** Modelling methods of material handling systems. **Practice:** Investigation of the models of material handling systems.	**5th week:** **Lecture:** Representing the material handling systems as bulk service systems. **Practice:** Analysis of bulk service systems.
6th week: **Lecture:** Applying queueing models for the investigation of material handling systems. **Practice:** Analysis of queueing models.	**7th week:** **Lecture:** Designing methods of continuous operating material handling systems for bulk materials and itemised products. **Practice:** Designing examples of material handling systems.
8th week: 1st drawing week	
9th week: **Lecture:** Storage systems in itemised product warehouses. **Practice:** Analysis of the storage systems of itemised product warehouses.	**10th week:** **Lecture:** Required data for the planning of itemised product warehouses, the planning procedure and the main planning steps. **Practice:** Planning examples of itemised product warehouses I.
11th week: **Lecture:** Designing the storage space of itemised product warehouses, configuration aspects of traffic connections and product reorganization spaces. **Practice:** Planning examples of itemised product warehouses II.	**12th week:** **Lecture:** Types and design of order picking systems. **Practice:** Analysis of order picking systems.
13th week: **Lecture:**	**14th week:** **Lecture:**

Technological systems and material handling machinery of high bay warehouses. **Practice:** Analysis of high bay warehousing systems.	Simulation methods of material handling and storage systems. **Practice:** Simulation analysis of material handling and storage 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 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 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 (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 60, the student once can take a retake test covering the whole semester material.

Production Automation

Code: MK5GYAUG04G117-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd fall semester

Its prerequisite(s): Electrical Measurement and Signal Processing

Further courses are built on it: Yes/No

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

Topics:

The aim of the subject is the technological process planning and CNC production of workpieces in automation production environment. Knowing of the coordinate systems and CNC program blocks are necessary for the creation of a CNC program. During this course the students learn the CNC production designing of special and typical milling operations. They learn the edge geometry of the milling cutting tool and the selection method of devices for milling tasks.

Based on the result of CAD modelling and CAM simulation the real production could be done by automatic CNC working machines.

In the second half of the course students will learn about the installation and automation issues of pneumatic systems. Through practical exercises they learn about pneumatics, electro pneumatics and PLC and meet industry-specific solutions. They gain experience in building pnematic circuits during the exercises. Students learn different methods of debugging in the system.

Literature:

Compulsory:

- Berta M.: CNC szerszámgépek szerszámrendszerei, Nyíregyházi Főiskola, Nyíregyháza, 2015, p. 156, ISBN 978 615 5545 03 0
- Szabó T.: Gépészeti automatizálás, Edutus Főiskola, Tatabánya, 2011., p. 98.
- Takács J.: Gyártásautomatizálás, Typotex kiadó, Budapest, 2012., p. 192.
- Prasad, Birendra: CAD/CAM Robotics and Factories of the Future, Volume II: Automation of Design, Analysis and Manufacturing, Springer Verlag, 2012, ISBN 9783642523250
- Wang, Lingfeng, Tan, Kay CHen: Modern Industrial Automation Software Design, Blackwell Publishers (Wiley), 2006, ISBN 9780471683735

Recommended:

- Fritz Klocke: Manufacturing Processes I, Cutting, RWTH Edition, RWTH Aachen University, p. 524, ISBN 978-3-642-11978-1
- Mikel P. Groover: Fundamentals of Modern Manufacturing, Materials, Processes and Systems, Third Edition, United States of Amerika, p. 520, ISBN 978-0-471-74485-6

Schedule

1st week: Registration week	
2nd week:	3rd week:
Lecture: The construction of CNC working machines, the main functions	Lecture: CNC milling machines, coordinate systems, CNC program generation

Practice: Analysis of manufacturing technologies for CNC machines I.: tools, tool selections, motion cycles	**Practice:** Analysis of manufacturing technologies for CNC machines II.: milling tasks, methods
4th week:	**5th week:**
Lecture: Analysis of the edge geometry of milling tools	**Lecture:** Selection of workpiece devices for milling tasks
Practice: Analysis of manufacturing technologies for CNC machines III.: workpiece clamping, programing, experimental production	**Practice:** Technological process planning by SolidCAM software I.
6th week:	**7th week:**
Lecture: Designing of milling technology for CNC machine. Typical milling tasks. **Practice:** Technological process planning by SolidCAM software II.	**Lecture:** Determination of the technological parameters of milling technology. Special milling tasks. **Practice:** Technological process planning by SolidCAM software III.
8th week: 1st drawing week	
9th week:	**10th week:**
Lecture: The structure and general characteristics of pneumatic systems **Practice:** Design and installation of pneumatic circuits	**Lecture:** The structure and general characteristics of electro-pneumatic systems **Practice:** Learn about electro-pneumatic tools
11th week:	**12th week:**
Lecture: Pneumatic control systems, PLC programming **Practice:** Building a PLC-controlled pneumatic system	**Lecture:** Automation of pneumatic systems **Practice:** Task release
13th week:	**14th week:**
Lecture: Troubleshooting, Diagnostics **Practice:** Exercise Solution	**Lecture:** Written examination **Practice:** Presentation of tasks
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 create two own tasks (technological task and automation task).
3. There will be two tests in the semester. They have to write them for minimum sufficient marks. Based on these results they will get the final practice mark.

Maintenance and Repairing Technologies

Code: MK5KJATG04G117-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 2nd spring semester

Its prerequisite(s): Engineering Systems and Modelling

Further courses are built on it: Yes/No

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

Topics:

Type of maintenance strategies: corrective, preventive, predictive. Prognostics and health management (PHM). Remaining useful life estimation based on mathematical methods. (RUL). Autoregressive (AR) model, neural networks (NNs) and neural fuzzy (NF) systems. Support Vector Machines (SVM) for machine learning based RUL estimation. The concept and basics of reliability-centred maintenance (RCM), total productive maintenance (TPM), Root cause analysis (RCA) and Root cause failure analysis (RCFA), Computerized maintenance management system (CMMS), basics of TQM. Terotechnology. Aims of machine repairing, Fault Tree. Event Tree, FMEA. Machine fault diagnosis: vibration diagnosis, thermography, endoscopy. Fourier (FFT) and wavelet transform (WT). CWT and DWT. Envelope spectrum with Hilbert transform. HFRT. Fault frequency detection of machines. Filtering by Butterworth and Chebysev filters. Cepstrum analysis before repairing. Traditional and advanced machining technologies in machine repairing. Modern thin layer techniques, plasma beam technique, laser beam technique, nano-techniques. High energy technology to increase surface integrity. Advanced EDM technologies and machines and ultrasonic machining (USM).

Literature:

Compulsory:

- R. K. Mobley, An Introduction to Predictive Maintenance, Butterworth-Heineman, 2002.

- R. K. Mobley, Maintenance Fundamentals, Butterworth-Heineman, 2004.
- R. K. Mobley, L. R. Higgins, D. J. Wikoff: Maintenance Engineering Handbook, McGraw-Hill, 2008.
- J. Moubray: Reliability-Centred Maintenance: Industrial Press Inc., 2001.
- Heinz P. Bloch, Fred K. Geitner: Machinery Component Maintenance And Repair, Elsevier, 2004.ISBN: 978-0-7506-7726-4
- Allan G. Piersol, Thomas L.Paez: Harris's Shock and Vibration Handbook, Sixth Edition, McGrraw-Hill, 2010. ISBN 978-0-07-163343-7

Recommended:

- Fred K. Geitner, Heinz P. Bloch: Maximizing Machinery Uptime, Gulf Professional Publishing, 2006.
- Ricky Smith, R. Keith Mobley: Industrial Machinery Repair: Best Maintenance Practices Pocket Guide, Elsevier, 2003

Schedule

1st week: Registration week	
2nd week: **Lecture:** Maintenance methods in mechanical engineering. Corrective, Preventive, Predictive Maintenance. Some case study. The concept and basics of reliability-centred maintenance (RCM). The concept and basics of total productive maintenance (TPM). Examples from industrial environment. Advanced "bathtub curve theory" Prognostics and health management (PHM). Remaining useful life (RUL). Prognostics ad probability estimation based on mathematical functions. Effects of fatigue and mechanical stress development for RUL. **Practice:** RCM in the machine industry. TPM in the machine industry in mechanical engineering practice. RUL estimation calculation and simulation by mathematical software.	3rd week: **Lecture:** Selecting proper prognostics algorithmstochastic models such as the autoregressive (AR) model, neural networks (NNs) and neural fuzzy (NF) systems. Support Vector Machines (SVM) for machine learning based RUL estimation for maintenance time calculations. **Practice:** RUL estimation by statistical processes with mathematical software.
4th week: **Lecture:** Root cause analysis (RCA) and Root cause failure analysis (RCFA). Examples from industrial environment.	5th week: **Lecture:** Monitoring based machine repairing methods. Online and offline monitoring. Parameter selection for

Computerized maintenance management system (CMMS). Examples from industrial environment.

Practice: RCA analysis of examples. Using of CMMS and interpretation.

6th week:

Lecture: Maintenance and TQM, quality control in maintenance. Examples from industrial environment.

Maintainability. Design for Maintainability

Practice: TQM analysis of examples.

maintenance and diagnosis before machine repairing. Connection with CMMS systems for total monitoring (TM).

Practice: Industrial monitoring methods.

7th week:

Lecture: Terotechnology. Objectives of terotechnology, Principles of terotechnology, Costs of implementing terotechnology. Introducing terotechnology to an organisation.

Practice: Terotechnology in the industry. Case studies.

8th week: 1st drawing week

9th week:

Lecture: Tribology, wear, wear types, wear mechanism. Causes of machine faults. Aim of machine repairing and repairing technologies. Wear analysis of bearing elements, outer and inner rings. Mechanical stress development.

Yu and Harris's fatigue life model for ball bearings, Paris and Erdogan's crack growth model.

Practice: Wear analysis by optical microscope and surface testers.

10th week:

Lecture: Probabilistic risk assessment. Fault Tree. Event Tree. Failure Mode and Effect Analysis (FMEA) in manufacturing and repairing with examples. Ishikawa diagram before machine repairing with application examples

Practice: How to create FMEA for analysis in machine industry. System modelling in mechanical engineering.

11th week:

Lecture: Machine fault diagnosis before repairing. Vibration measurement methods. ISO 10816 standard. SPM method.

Fourier (FFT) and wavelet transform (WT). CWT and DWT. Thermography. Infrared theory. Endoscopy. Eddy-current testing. Acoustic emission (AE).

Practice: Measurements and data analysis. Some practical device presentation (NI DAQ and SPM Leonova). Labview and Matlab applications.

12th week:

Lecture: Advanced analysis methods before repairing. Time-domain analysis by kurtosis and skewness. Cepstrum analysis by logarithmical inverse Mother wavelets for filter banks: Symlet and Daubiches. Morlet filter bandwidth and centre frequency optimization. Optimization by genetic algorithm and differential evolution algorithm. Envelope spectrum with Hilbert transform. HFRT. Fault frequency detection. Filtering: Butterworth and Chebysev filters.

	Practice: Cepstrum, wavelet and HRFT by Labview and Matlab.
13th week: **Lecture:** Traditional machining processes and machining tools in machine repairing. Turning, boring, drilling, milling, grinding of re-manufactured machine elements. Reaming. Threading. Superfinishing. Welding. Gluing. Basic methods and purpose of heat treatment after repairing by cutting technologies. Advanced machine processing I. EDM technologies and machines. Ultrasonic machining. (USM). **Practice:** Case studies with applications of repairing technologies.	**14th week:** **Lecture:** Advanced machine repairing techniques. Chemical machining. WJM technologies. Abrasive jet machining. Laser beam machining. Plasma machining. Electrochemical grinding. Laser welding. Fast prototyping. Modern thin layer techniques, plasma beam technique, laser beam technique, nano-techniques. High energy technology to increase surface integrity. **Practice:** Case studies with applications of advanced repairing technologies.
15th week: 2nd drawing week	

Requirements

A, for a signature:

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. 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 is on the 8th week and the end-term test is on the 15th week. Students must sit for the tests.

B, for grade:

The course ends in exam grade. The grade for the test 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).

Diagnostics and Condition Monitoring

Code: MK5DIAFG04G117-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 2nd fall semester

Its prerequisite(s): Electrical Measurement and Signal Processing

Further courses are built on it: Yes/No

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

Topics:

The aim of the subject is expanding the knowledge in technical diagnostics and condition monitoring acquired through bachelor program: use of up-to-date methods, application of reliability-based and risk-based approach in maintenance, effective identification of failures of machines and machine elements.

Time-domain analysis and statistical parameters, kurtosis, skewness. Trend analysis. Wavelet transform. FIR and IIR filter design. Energy and entropy for wavelet selection. Transient analysis. Machine learning in diagnostics.

Literature:

Compulsory:

- Czichos, H. (ed.), Handbook of Technical Diagnostics (Fundamentals and Application to Structures and Systems), Springer, 2013.
- Harris, C. M., Piersol, A. G. (ed.), Harris' Shock and Vibration Handbook, McGraw-Hill, 2002
- Taylor, J.: The Vibration Analysis Handbook VCI, 2000
- Taylor, J.: The Gear Analysis Handbook, VCI, 2000
- Taylor, J., Kirkland, D.W.: The Bearing Analysis Handbook, VCI, 2000
- Moubray, J., Reliability-Centred Maintenance: Industrial Press Inc., 2001.
- Smith, D. J., Reliability, Maintainability and Risk: Practical Methods for Engineers, Elsevier, 2011

Schedule

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

Maintenance strategies. Reliability-based and risk-based approach in Maintenance, RCM analysis, FMEA. Role of Technical Diagnostics in Maintenance (TPM and Lean systems), condition-based maintenance. **Practice:** Practice for FMEA for diagnostics. Quality management methods in the applied diagnostics.	**Lecture:** The main fields of technical diagnostics: vibration diagnostics, acoustics, ultrasound analysis, thermography, endoscopy, oil analysis. **Practice:** Practical measurements of devices.
4th week: **Lecture:** Generalization of signals. Noise signals in diagnostics. Sampling theorem. **Practice:** Introduction to the signals in Labview.	**5th week:** **Lecture:** Theoretical background of vibration: sources and types of vibration, statistical evaluation of vibration signals, Fourier spectrum of periodic and non-periodic signals, Fourier transform. **Practice:** Balancing.
6th week: **Lecture:** Short time Fourier transform. Discrete Fourier transform, FFT. Skewness. Kurtosis. Statistical analysis of non-perodical signals. **Practice:** Transforms in practice.	**7th week:** **Lecture:** Sampling, information content in discrete signal (aliasing, leakage). Shannon sampling principle. Parseval theorem. Power spectrum. **Practice:** Measurements and analysis of signals.
8th week: 1st drawing week	
9th week: **Lecture:** Windowing, averaging, filtering. FIR and IIR filters. Design of filters. Csebisev and Butterworth filters. Elliptic filters. Parks-McClellan algorithm. **Practice:** Filter design.	**10th week:** **Lecture:** Application of wavelet transform in condition monitoring. **Practice:** Bearing condition evaluation with shock pulse method.
11th week: **Lecture:** Mother wavelets. Symlet and Daubechies, Morlet wavelets, Complex Morlet wavelets. **Practice:** Mother wavelets for transient analysis.	**12th week:** **Lecture:** Z transform and inverse Z transform, Cepstrum analysis. Machine learning, ANN, ANFIS, SVM for fault classification. **Practice:** Application of digital transforms in practice. Machine learning applications in software.
13th week:	**14th week:**

Lecture: Machine failures and related symptoms in machine elements: bearing fault analysis and gear fault analysis. **Practice:** Measurements of gears and bearings with devices.	**Lecture:** Machine failures and related symptoms in dynamic systems and machines: unbalance, shaft and coupling alignment problems, looseness, bearing and gear faults, electric motor failures. **Practice:** Measurements with devices of integrated machines.
15th week: 2nd drawing week	

Requirements

A, for a signature:

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. 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 is on the 10th week and the end-term test is on the 15th week. Students must sit for the tests.

B, for a grade:

The course ends in exam grade. The grade for the test 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). If the score of any test is below 60, the student once can take a retake test of the whole semester material.

DIPLOMA

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 Mechanical Engineering master's program. 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; specialization; mode of attendance; place, day, month and year issued. Furthermore, it has to contain the rector's (or vice-rector's) 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=(A+B)/2, where

A: Average of the grades of the subjects of the final exam

B: Grade awarded for defending thesis

Classification of the award:

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

Award with Distinction

An award with Distinction is permitted where a student obtained grade 5 in all subjects of the final exam. The average of thesis grade, his/her exam grades and mid-semester grades during his/her studies is at least 4,00. Moreover, he/she is not permitted to have a grade worse than grade 3 during his/her studies.

MODEL CURRICULUM OF MECHANICAL ENGINEERING MSC - PRODUCTION ENGINEERING SPECIALIZATION (FALL START)

Nr.		Subject	Neptun code	1st semester				2nd semester				3rd semester				4th semester				Prerequisite
				L	P	E	C	L	P	E	C	L	P	E	C	L	P	E	C	
1.	Basics of Natural Sciences	Applied Mathematics	MK5ALKMA04GX17-EN					2	2	m	4									
2.		Applied Statistics	MK5ALKSA04GX17-EN	2	2	m	4													
3.		Applied Dynamics	MK5ADING05GX17-EN	2	3	e	5													
4.		Applied Thermodynamics and Fluid Mechanics	MK5AHOAL04GX17-EN					2	2	m	4									
5.		Materials Science	MK5ANTUG05GX17-EN	2	3	e	5													
6.	Econo-mics and Huma-nities	Investment and Financial Decisions	MK5BERPM04GX17-EN	2	2	e	4													
7.		Organizational Techniques and Project Management	MK5SZERM04GX17-EN	2	2	m	4													
8.		Applied Quality and Environmental Management	MK5AMINM04GX17-EN					2	2	m	4									
9.	Professional Compulsory Subjects	Electronics Measurement and Signal Processing	MK5EMJFR04GX17-EN					2	2	e	4									
10.		Machine and Product Design	MK5MGTTG04GX18-EN	2	2	e	4													
11.		Engineering Systems and Modelling	MK5GRMOG05GX18-EN					2	3	e	5									
12.		Integrated Design Systems	MK5INTRG05GX17-EN					2	3	m	5									
13.		Project Work	MK5PROMG04GX17-EN													0	4	m	4	
14.		Design of Manufacturing Devices	MK5GYETG04GX17-EN									2	2	e	4					
15.	Field-specific Vocational Subjects	Simulation of Manufacturing Systems and Processes	MK5GYFTG04G117-EN													2	2	m	4	MK5GRMOG05GX18-EN
16.		Production Process Optimization	MK5TFOPG04G117-EN													2	2	e	4	MK5ALKSA04GX17-EN
17.		Design of Material Handling and Storage Systems	MK5AMOTG04G117-EN									2	2	m	4					MK5MGTTG04GX18-EN
18.		Production Automation	MK5GYAUG04G117-EN									2	2	m	4					MK5EMJFR04GX17-EN
19.		Maintenance and Repairing Technologies	MK5KJATG04G117-EN													2	2	e	4	MK5GRMOG05GX18-EN
20.		Diagnostics and Condition Monitoring	MK5DIAFG04G117-EN									2	2	e	4					MK5EMJFR04GX17-EN
21.		Thesis I.	MK5DIP1G15G117-EN									0	10	m	15					
22.		Thesis II.	MK5DIP2G15G117-EN													0	10	m	15	
23.	Optional Subjects	Optional subject I.					3													
24.		Optional subject II.									3									
25.		Internship	MK5SZGYG00G117-EN	4 weeks																

Classes per week:	12	14			12	14			8	18			6	20					
Classes total:	26				26				26				26						
Credits per semester:				29				29				31				31			
Credits total:	**120**																		
Exam:			4				2				2				2				
Mid-semester grade:			2				3				3				3				

Subjects of the final exam:

compulsory subject:

Design of Material Handling and Storage Systems, Production Process Optimization

optional group of subjects:

Simulation of Manufacturing Systems and Processes + Production Automation

or Maintenance and Repairing Technologies + Diagnostics and Condition Monitoring

Abbreviations:
L= Lecture, P= Practice, E= Evaluation, C= Credits, e = exam, m = mid-semester grade, FE= final exam, s= signature