Óbuda University

Bánki Donát Faculty of Mechanical and Safety Engineering

TRAINING PROGRAM

Mechatronical Engineering MSc

Budapest

2022.

MECHATRONICAL ENGINEERING DEGREE PROGRAM KNOWLEDGE DESCRIPTION

1. Educational objective

The aim is to train mechatronic engineers capable to integrate mechanical engineering with electronics, electrotechnics and computer control synergically at world standards; to develop and model the concept of, and subsequently to produce the design and production design of mechatronic equipment, processes and systems and smart machines, as well as to operate and maintain them. They are capable to develop and introduce new technologies, procedures and materials as required for mechatronic systems; to perform higher-level duties of management, control and organization; to perform assignments involving technical development, research, design and innovation; to join and manage engineering projects of domestic and international level. They are prepared to continue their studies at a PhD course.

2. Field of training: technical

3. Training duration and languague:

full-time, English 4 semesters, total number of contact hours: 896, 882

4. Number of credits to be acquired: 120 credits

5. Level of qualification and professional qualification as indicated in the degree certificate:

• level of qualification: master of science (magister, master; rövidítve: MSc-)

• professional qualification: Master in Mechatronical Engineer

6. Main training areas

	Credit score
Basic knowledge from natural science *(20-35 credits)*	20
Human and economic knowledge *(10-20 credits)*	10
Basic professional knowledge *(15-35 credits)*	29
Optional subjects *(min. 6 credits)*	7
Differential engineering knowledge *(40-60 credits)*	54
Total:	210

7. Professional traineeship

The duration of the internship is four (4) weeks. The completion of the internship outside the institute is a requirement.

In special cases, with the permission of the dean of the faculty, the internship can be completed in one of the institutes of the university. Professional traineeship is included in the criteria prescribed.

8. Physical education

Each student is required to complete two semesters of Physical education. The subject is announced in the first two semesters in the model Knowledge description, with a load of 1 lesson per week.

9. Forms of training

Full-time

11. Knowledge verification

a) Signature

b) Midterm grade

c) Exam

d) Final exam

11. Criteria for admission to a final examination:

a) Final completition certificate (absolutorium) granted

b) Diploma work accepted by the reviewer

Admission to a final examination is subject to a final completion certificate being granted. A final completion certificate is issued by a higher education institution to a student who has complied with the study and examination requirements prescribed in the Knowledge description and completed the professional traineeship required – except for meeting the foreign language requirement and completion of the degree project / thesis –,and has acquired the credits prescribed.

12. Parts of the final examination:

The final examination consists of defending the diploma work and a complex oral examinations in the 3 final exam subject groups prescribed in the Knowledge description. The list of questions of the oral examination will be made available to the candidates 30 days before the date of the final examination. The preparation time for the final exam is at least 15 minutes per question.

The candidate can start the examination if the diploma work has been accepted by the final examination committee with at least a sufficient (2) rating. The conditions for correcting a failed diploma work are determined by the competent institute.

13. Result of the final examination:

The weighted average of the grades received for the diploma work (D) and the oral part of the final exam (F1, F2, …, Fm) - taking into account the number of subjects in the final exam - is as follows:

$$\mathbf{F = (D + F1+F2+\ldots+Fm)/(1+m).}$$

14. Criteria for issuing a diploma:

Successful final examination

15. Optional specializations:

• vehicle mechatronics

• intelligent mechatronic systems

16. Time of entry into force: 2023. september 1.

Budapest, 2022. november 23.

Prof. Dr. Rajnai Zoltán

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Course descriptions

Basic Knowledge from Natural Science

Course name : **Applied Mathematics**	***NEPTUN code:***	***Lessons: lc+pr+lb*** 2+2+0	***Credits: 4*** ***requirement.: e***
Supervised by: Dr. Hanka László	***Position:*** Associate prof.	***Prerequisite:*** -	
Knowledge description:			
Theory of matrices, theory of eigenvalues and eigenvectors. Orthogonal and symmetric matrices. SVD. Differential equations. Systems of differential equations. Analytic and numerical methods, Euler's and Runge-Kutta methods. Examination of LTI systems, DT and CT signals, convolution. Fourier-series representation of CT and DT signals, Laplace transform, Fourier transform, Z-transform. Frequency response, Bode diagram. Lagrange, Hermite, spline interpolation. Curve fitting, Least squares method. Application of Matlab and Simulink.			
Literature:			
Thomas Calculus I-III.; Pearson Addison-Wesley, 2005 Stewart Calculus; Brooks, 2008 Sheldon Ross: A first course in probability, Pearson, 2010 Paul Dawkins: Differential Equations, Prentice-Hall, 2007 Oppenheim: Signals and systems: MIT 2017. Dawkins: Differential equations; Prentice Hall, 2007 Strang: Linear algebra and its applications, MIT, 2007.			

Course name: **Selected chapters of mechanics**	**_NEPTUN- code:_**	**_Lessons number:_** _lec+pract+lab_ 2+1+0	**_Credit_**_:_ 4 **_Requirements_**_:_ e
Supervised by: Dr. Árpád CZIFRA	**_Position:_** associate professor	**_Prerequsites:_** -	

Course description:

The objective of the course: The subject overview and extend the topics of static, strenght of material and kinematics and dynamics of particles and rigid bodies. Furthermore topics covered include the study of the fundamental single-degree-of-freedom vibrating systems using Newton's law of motion and Lagrange's equations. Free and forced vibrations with various types of damping and response to transite-state and transient excitations are presented.

Topics: Reactions and internal effects of statically indetermined systems. Kinematics of rigid bodies and mechanisms. Relativ kinematics. Dynamics of rigid bodies and mechanisms. Free, damped and forced single-degree-of-freedom vibrating systems. Fundamentals of vibration isolation and principles of machine foundations.

Literature::

1. Beer, F.P., Johnston, E. R.: Vector Mechanics for Engineers. Dynamics. McGraw-Hill, 2004.

2 McLean, W.G., Nelson, E.W.: Engineering Mechanics. Statics and Dynamics. Schaum's Outline Series, McGraw-Hill, 1988

3. György Szeidl, László Péter Kiss: Mechanical Vibrations, Springer Nature Switzerland AG, 2020

<table>
<tr><td>Course name:

Selected Chapters from Electricity</td><td>NEPTUN code:</td><td>Lessons/week:
lec+pract+lab

2+1+0</td><td>Credits: 4

Requirement: e</td></tr>
<tr><td>Supervised by:

Prof. Dr. habil. Szabolcsi Róbert</td><td>Position:

full professor</td><td colspan="2">Prerequisite: —</td></tr>
<tr><td colspan="4" align="center">Knowledge description:</td></tr>
<tr><td colspan="4">Electrical circuits. Electrical devices. Electrical systems. Basic laws of electricity. Ohm's Law. Kirchhoff's Current Law (KCL). Kirchhoff's Voltage Law (KVL). Finding resulting resistances. Finding resulting conductances. Current division. Voltage division. Analysis of electrical circuits using node voltage method. Analysis of electrical circuits using mesh current method. Phase compensation in electrical circuits. Basics of electrical machines. Measurement of electrical machines. AC and DC servo measurements.</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">1. Fodor Gy.: Hálózatok és Rendszerek, Műegyetemi Kiadó, Budapest, 2006.</td></tr>
<tr><td colspan="4">2. Zombory L.: Elektromágneses terek, Műszaki Kiadó, Budapest, 2006.</td></tr>
<tr><td colspan="4">3. Fodor Gy.: Villamosságtan példatár, Nemzeti Tankönyvkiadó, Budapest, 2001.</td></tr>
<tr><td colspan="4">4. Paul, C.R. – Nasar, S.A. – Unnewehr, L.E.: Introduction to Electrical Engineering, McGraw-Hill, Inc., Int. Eds., 1992.</td></tr>
<tr><td colspan="4">5. Morris, N.M.: Electrical Circuit Analysis and Design, The MacMillan Press Ltd., 1993.</td></tr>
<tr><td colspan="4">6. Edwards, J.D.: Electrical Machines, The MacMillan Press Ltd., 1986.</td></tr>
<tr><td colspan="4">7. Bolton, W.: Electrical and Electronic Measurement and Testing, Longman Scientific & Technical, 1992.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Megjegyzés:</td></tr>
</table>

Course name: **Selected parts from Thermo- and Fluid Dynamics**	***NEPTUN-code:***	***Lesson number:*** *lec+prac+lab* 2+0+0	***Credits*: 3** ***Requirement*** *:* e
Supervised by: Dr. habil. Szlivka Ferenc	***Position:*** full professor	***Prerequisite:***	
Knowledge description:			
Derivation of hydrostatics DE in differential vector form. of the potentials of force fields. Layering, etc. Equilibrium of isothermal and variable-temperature (polytropic) atmospheres. Some applications of the Bernoulli equation. Instantaneous Bernoulli equation. Derivation and application of the integral uniform form of the impulse theorem. Euler turbine equation. Allievi-theory and its application. Force acting on bodies in flow. Wing theory. Determination of the performance of different wind generators based on flow principles. Analysis and calculation of supersonic flows. The Navier - Stokes equation. Similarity of currents. Basics of similarity theory. Simple solutions of the Navier-Stokes equation. Pressure loss in a cylindrical straight pipe. Frictional Bernoulli equation. Flow, thermodynamic and material transfer DE similarity in boundary layer theory.			
Irodalom:			
1. Dr. Szlivka Ferenc: Thermo- and Fluid Dynamics ÓE-BGK 3074, Budapest, 2019. 2. MOODLE educational material			

Course name: **Polymer technologies**	*NEPTUN- code:*	*Lesson number:* *lec+prac+lab* 2+0+0	*Credits*: 3 *Requirement* : e
Supervised by: Dr. Ráthy Istvánné	*Position:* Associate professor	*Prerequisite:* -	

Knowledge description:

The aim of the subject is to familiarize students with the basics of macromolecular chemistry, the grouping of polymers, the most important chain building processes, the structure of macromolecules, the technological grouping of polymers for technical purposes (thermoplastic and thermosetting), their technical properties and usability, as well as the properties and processability of special plastics . Production technologies of plastic shaped products. Injection molding process, injection molding machines, injection molding tools. Extrusion process, machines and tools. Pipe production, plate production, cable production. Hollow component manufacturing techniques, extrusion blow molding, injection molding, rotational molding. Vacuum forming technology, Polymer welding and bonding techniques. Production technology of cross-linked (spatieled network) polymer products, rubber production, production of polymer foams. Basic concepts of polymer composites, reinforcing fibers, production technologies, lamination, BMC, SMC, RTM, RIM, pultrusion. Prototype production technologies, 3D printing Recycling possibilities of polymers.

Literature:

1. Joel R. Fried - Polymer Science and Technology-Prentice Hall (2014)

2. B. Vollmert: Polymer Chemistry, Springer-Verlag, New-York, 1973. e-ISBN-13: 978-3-642-65293-6

3.G. Odian: Principles of Polymerization, 4th edition, Published by John Wiley & Sons, Inc., Hoboken, New Jersey, 2004, ISBN 13: 9780471274001

Human and Economic Knowledge

<table>
<tr><td>Course name:
Business Economics</td><td>NEPTUN- code:</td><td>Lesson number:
lec+prac+lab
2+1+0</td><td>Credits: 5
Requirement : m</td></tr>
<tr><td>Supervised by:
Dr. Takácsné Prof. Dr. György Katalin</td><td>Position:
Full professor</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td colspan="4" align="center">Knowledge description:</td></tr>
<tr><td colspan="4">To acquaint the students with the system of macroeconomic conditions for the establishment and operation of enterprises. To interpret the basic concepts of business organization management in the framework of a regulated market economy. To present the main types of corporate strategies, the process and the need for planning. Analyze business processes: marketing, production / service, innovation and asset management, human resource management, logistics, finance and crisis management. The subject mainly deals with the management issues of production processes, the foundations of technological innovation and its role in corporate competitiveness.

Practical knowledge:

Due to the nature of the subject, Students should analyze business processes using a project approach (based on economic and management theory), during which they prepare a situation assessment (case study) of an existing company as a teamwork (Company Introduction_1) and present a business plan of an existing or planned company as an individual task (Business plan_1). With this, they acquire the analysis methods necessary for strategic planning (STEEP, competitive environment analysis; resource diagnostics). During presentation they have to defend their plan, before schoolmates.</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">Mandatory:
Devhurst, J.A. (2014): An introduction to business and business planning. 1rst Edition. bookboon.com. p. 123

Course material (Moodle). Handbook on Business Economics, in the Moodle system</td></tr>
<tr><td colspan="4">Suggested:
Savov R, Takács-György K: Selected chapters from strategic management. Nyitra: Slovak Agricultural University, 2016. 85 p.

Turèková,N. – Svetlanská, T. – Takács I. (2016): Business Economics – International V4 Studies. Nitra. International Visegrad Fund´s, Visegrad University. Studies Grant No. 61200004. 109. p</td></tr>
</table>

Course name: **Engineering Management**	**_NEPTUN- code:_**	**_Lesson number:_** _lec+prac+lab_ 1+2+0	**_Credits_: **5 **_Requirement_** _:_ m
Supervised by: Dr. Lázár-Fülep, Tímea	**_Position:_** Senior lecturer	**_Prerequisite:_** -	

Knowledge description:

To gain deeper insight and skills for the application of management-related organizational tools and methods, for creative problem-solving, responsible multidisciplinary decision-making, emphasizing the characteristics of the most relevant management areas, the importance of resilience and self-reflection, which is fundamental in lifelong, active self-development.
The center of management is man, the management of individuals and groups. Motivation. The concept, relationship and appearance of manager and leader in theory and practice. Relationships between managerial roles, behavior and management styles. Business process, coopetition, Intellectual Property and Patent Registration. IQ and EQ. Change management, conflict management. Overview of managerial skills and abilities, possibilities and examples of the practical implementation of the management philosophy.

Literature:

1. Berde, Csaba: Management Skill. Digitális Tankönyvtár, Debrecen, 2013
2. Lukovics, Miklos: Project leading – Teaching material. Digitális Tankönytár, 2016

Basic Professional Knowledge

Course name: **Embedded systems**	**_NEPTUN- code:_**	**_Lesson number:_** _lec+prac+lab_ 2+0+3	**_Credits_**: 5 **_Requirement_** _:_ m
Supervised by: Dr. Frigyik Béla András	**_Position:_** lecturer	**_Prerequisite: -_**	

Knowledge description:
Structure and purpose of IT systems. The main characteristics and areas of application of embedded systems. Architecture of embedded systems and the most frequently used peripherals. Characteristics of communication channels used in industry. RS 232, RS 485, I2C, SPI, CAN protocols and their programming issues. Characteristics of RISC, CISC processors. Characteristics of PIC microcontrollers and their programming. Microcontroller-based circuit designs and their practical knowledge. Real-time sampling, measurement, data processing P, PI and PID control. Special tools for embedded software development (JTAG, ICD).

Literature:
1. Tim Wilmshurst: Designing Embedded Systems with PIC Microcontrollers, ISBN: 1856177505, 2009
2. Armstrong Subero: Programming PIC Microcontrollers with XC8, ISBN: 1484232720, 2017
3. Martin Bates: PIC Microcontrollers: an Introduction to Microelectronics, ISBN: 978-0-08-096911-4, 2012

<table>
<tr><td>Course name:
Modeling and Simulation</td><td>NEPTUN- code:</td><td>Lesson number:
lec+prac+lab
2+0+1</td><td>Credits: 4
Requirement : m</td></tr>
<tr><td>Supervised by:
Prof. Dr. Pokorádi László</td><td>Position:
Full professor</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td colspan="4" align="center">Knowledge description:</td></tr>
<tr><td colspan="4">Students will learn the basics of the theory of modeling and simulation used in mechatronics. They will acquire skills to help them apply this knowledge in practice and run systems that facilitate the creation of these kind of models.</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">1. Bungartz et al. Modeling and Simulation. eBook. ISBN 978-3-642-39524-6.</td></tr>
</table>

Course name:	NEPTUN- code:	Lesson number:	Credits: 4
System and Control Theory		*lec+prac+lab* 2+0+1	***Requirement*** *:* m
Supervised by: Prof. Dr. Szabolcsi Róbert	***Position:*** full professor	***Prerequisite:*** Applied Mathematics	

Knowledge description:

Aim: To provide the Students with the most widely applied methods of system modeling and control.

Knowledge description: The canonical LTI model form and its generalizations: LPV, qLPV, globally linearizable sastem; General solution of the equation of motion of the LTI systems; Generalized eigenvectors, the canonical form introduced by Jordan; The Cayley-Hamilton Theorem; Stability, controllability and observability of LTI systems; Luenberger observer for LTI systems; Pole placement; Introduction of the frequency domain; Laplace transformation; The function class D; The H∞ controller (SVD); The “Computed Torque Control” (CTC); The Robust Variable Structure / Sliding Mode Controller; Lyapunov’s 2nd Method; The Adaptive Inverse Dynamics controller for robots (AIDC); The “Model Predictive” and Receding Horizon Controllers (MPC, RHC); Stability of the solution: stability check based on perturbation calculus; Adaptive Control based on Fixed Point Iteration; The Model Reference Adaptive ontroller (MRAC);

Literature:

Mandatory: Free of charge available lecture notes and programming aids.
Recommended:

1. Kemin Zhou, John C. Doyle, Keith Glover: Robust and Optimal Control, Pearson; 1 edition, 1995.

2. J. K. Tar, L. Nádai, I. J. Rudas: System and Control Theory with Especial Emphasis on Nonlinear Systems, TYPOTEX, Budapest, 2012, ISBN 978-963-279-676-5

<table>
<tr><td>Course name:
Mechatronic constructions</td><td>NEPTUN- code:</td><td>Lessons number: lec+pract+lab
2+0+0</td><td>Credit: 4
Requirements: e</td></tr>
<tr><td>Supervised by:
Dr. Árpád CZIFRA</td><td>Position:
associate professor</td><td colspan="2">Prerequsites: -</td></tr>
<tr><td colspan="4" align="center">Course description:</td></tr>
<tr><td colspan="4">The objective of the course: The subject gives an overview of advanced topics of mechanical engineering design in mechatronics. Theoretical principles of mechanics, tribology and machine design are presented and furthermore students get acquainted with mechanical elements and constructions of mechatronics systems.

Topics: Sizing theories in static and dynamic systems. Dynamics of machines. Principles of tribology. Introduction to design methodology. Analysis (construction, kinematics and design) of applied mechanical elements in devices of mechatronics: High-precision sliding and rolling bearings, hydrostatic bearings. Linear techniques: ball screws, linear bushings. Special clutches. Brake systems. Driving system: planetary gear, harmonic drives and cyclo drive systems.</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">1. Á. Czifra: Mechatronic construction, E-learning lecture notes (ÓE), 2021</td></tr>
<tr><td colspan="4">2. R. Pratap and A. Ruina: Introduction to Statics and Dynamics, Oxford University Press, 2001</td></tr>
<tr><td colspan="4">3. Godfrey Onwubolu: Mechatronics: Principles and Applications, Butterworth-Heinemann, 2005</td></tr>
<tr><td colspan="4"></td></tr>
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<table>
<tr><td>Course name:

Statistical Machine Learning</td><td>NEPTUN- code:</td><td>Lesson number:
lec+prac+lab

2+0+1</td><td>Credits: 4

Requirement : e</td></tr>
<tr><td>Supervised by:

Dr. Frigyik Béla András</td><td>Position:

Associate professor</td><td colspan="2">Prerequisite:

-</td></tr>
<tr><td colspan="4" align="center">Knowledge description:</td></tr>
<tr><td colspan="4">The purpose of the subject is to give a survey of the theory of statistical machine learning. The course starts with a short introduction into machine learning. Next we cover the theory of statistical machine learning. The second part of the course deals with an assortment of practical questions. The Knowledge description of the course: Probability theory and statistics, theory of risk, supervised learning methods, method of nearest neighbors, support machine learning, optimization algorithms, theory of kernels</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">1. Rodrigo Fernandes de Mello, Moacir Antonelli Ponti, Machine Learning. A Practical Approach on the Statistical Learning Theory, Springer (2018)

2. Sugiyama, Masashi, Introduction to Statistical Machine Learning, Morgan Kaufmann (2016)</td></tr>
</table>

<table>
<tr><td>Course name:

CAD Systems</td><td>NEPTUN code:</td><td>Lesson number:
lec+prac+lab

0+0+2</td><td>Credit: 4

Requirement:
m</td></tr>
<tr><td>Supervised by:

Prof. Dr. Horváth László</td><td>Position:

Full professor</td><td colspan="2">Prerquisite:-</td></tr>
<tr><td colspan="4" align="center">Knowledge description:</td></tr>
<tr><td colspan="4">The subject delivers knowledge about theoretical, methodological, and systematic foundations of the currently most advanced modeling platform, applied at engineering activities required by industrial and commercial products operated by systems and containing cyber-physical-biological structures. Classes are arranged at the Virtual Research Laboratory (VKL). VKL has its own world-class cloud platform configured for scientific and industrial purposes on the Dassault Systémes 3DEXPERIENCE platform and suitable for the all topics in the subject. The main issues are engineering modeling in collaborative space, structure of platform components available on the basis of roles, form feature and functional feature based, and functional organic shape models with boundary representation, complex engineering connection of solid body models, model of systems which is defined by structures of functional and logical components, includes behavior representations in components, and available for its virtual execution, situation-based system-level decisions, modeling topics related to additive manufacturing technologies, robotic modeling that completes the above issues, knowledge and context representations that ensure autonomous operation of models, and simplified human model to simulate human-product interactions for ergonomic purposes. In VKL, AIAMDI PhD topics related to the topics of the subject are available.</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">1.L. Horváth and I. J. Rudas, Modeling and Problem Solving Methods for Engineers. ISBN 0-12-602250-X, Elsevier, Academic Press, 2004</td></tr>
<tr><td colspan="4">2. E. Cohen, R. F. and R. G. Elber, Geometric Modeling with Splines: An Introduction, ISBN 156-8811-37-3, AK Peters, Ltd., 2001</td></tr>
<tr><td colspan="4">3. Saaksvuori and A. Immonen, Product Lifecycle Management, ISBN 354-0403-73-6, Springer, 2003</td></tr>
<tr><td colspan="4">4. L. Horváth, L.: Számítógépes tervezőrendszerek, aktuális oktatási anyagok és eset-tanulmányok, ÓE-NIK, 2022.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4"></td></tr>
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Course name: **Fuzzy Systems**	**NEPTUN code:**	**Lesson number:** *lec+prac+lab* 2+1+0	**Credit:** 4 **Requirement:** e
Supervised by: Dr. Pokorádi László	**Position:** full professor	**Prerequisite:** Applied Mathematics	

Syllabus:

Introduction: soft computing methods

Comparison of classic crisp set theory and fuzzy set theory

Fuzzy sets and their features

Operations on fuzzy sets. T-norm, t-conorm

Aggregation. Fuzzy relations, relation composition

Extension principle

Elements of the inference system

Mamdani & Sugeno (TS, TSK) type inferences

Fuzzy inference systems in Matlab environment

Fuzzy based prediction models in engineering applications

References:

R. Jager: Fuzzy Logic in Control, 1995

Chakraverty, S., Sahoo, D. M., & Mahato, N. R. (2019). Concepts of Soft Computing. Singapore: Springer.

Comments: -

Vehicle Mechatronics Specialization

Course name: **Vehicle Mechatronics I**	***NEPTUN-code:***	**Lessons number*:*** *the+pra+lab* 2+0+1	***Credits*:** 4 ***exam type*:** e
Supervised by: Dr. Szakács Tamás	***Position:*** Assistant professor	**Prerequisites**: Technical Physics	
Syllabus*:*			
The structure of the vehicles based on vehicle mechatronics aspects. Grouping of the main structural parts of motor vehicles, various resources, drive systems, suspensions of superstructures. Vehicle electronics and IT. Engine and drive chain controls. Sensors, controllers and actuators used in control. Typical elements of torque transmission from the engine to the wheels (transmission clutch, differential, etc.) Active and passive suspensions, shock absorbers, active and passive safety elements.			
Literature::			
Mandatory 1. Szakács Tamás Gépjárművek erőátviteli berendezései. Óbudai Egyetemi jegyzet. 2: Varga, Szauter: Járműmechatronika 3: Zinner: Gépjárműszerkezetek.			
Recommended: http://siva.banki.hu/~szakacs/			
Remarks:			

Course name: **Vehicle Mechatronics II**	**_NEPTUN-code:_**	**Lessons number:** *the+pra+lab* 2+0+2	***Credits***: 4 ***exam type***: e
Supervised by: Dr. Szakács Tamás	***Position:*** Assistant professor	**Prerequisite**: Technical Physics	
Syllabus:			
Types of resources, characteristics, rolling resistance, longitudinal and lateral dynamics of vehicles, brake systems, ABS, operation of longitudinal and transverse stability programs. Typical voltage levels of vehicles, trend of used electricity, one or two (three) wire systems. Energy management. Lighting systems and other vehicle electrical elements. Air conditioning, HVAC			
Literature::			
Mandatory 1. Szakács Tamás Gépjárművek erőátviteli berendezései. Óbudai Egyetemi jegyzet. 2: Varga, Szauter: Járműmechatronika 3: Zinner: Gépjárműszerkezetek.			
Recommended: http://siva.banki.hu/~szakacs/			
Remarks:			

<table>
<tr><td>Subject name:
Vehicle electronics</td><td>NEPTUN code:</td><td>Lesson number:
lec+prac+lab
2+0+1</td><td>Credit: 4
Requirement.: m</td></tr>
<tr><td>Responsible for the subject :
Dr. Szakács Tamás</td><td>Position:
Associate Professor</td><td colspan="2">Prerequisites:
Selected chapters from Electricity
BMXVVE1MNF</td></tr>
<tr><td colspan="4">Description of knowledge:</td></tr>
<tr><td colspan="4">On-board electricity supply for vehicles. Electricity management. Vehicle powertrain (conventional, electric, hybrid). Electronic control of petrol and diesel engines, fuel supply. Driver assistance systems. Mechatronics of braking systems. Design and operation of traction stabilisation systems. Electronics of chassis systems. Semi-active and active shock absorption. Electric steering. Adaptive cruise control (ACC) Other comfort and safety equipment electronics (e.g. airbag, belt tensioning, lighting). Vehicle diagnostics.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Literature:</td></tr>
<tr><td colspan="4">1. Bosch: Automotive Handbook Wiley</td></tr>
<tr><td colspan="4">2. T. Denton:Automobile electrical and electronic system, 2018</td></tr>
<tr><td colspan="4">3. K. Reif: Automotive Mechatronics Springer 2015</td></tr>
<tr><td colspan="4">4. SIMULINK® TUTORIAL</td></tr>
<tr><td colspan="4"></td></tr>
</table>

Course name: **Alternative vehicle driving**	**_NEPTUN code:_**	**_Lesson number:_** _lec+prac+lab_ 2+1+0	**_Credit:_** 4 **_Requirement.:_** e
Supervised by: Dr. Lukács Judit	**_Position:_** assistant lecturer	**_Prerequisites:_**	

Syllabus:

Types of electric vehicles. Construction of electric vehicles, main and auxiliary functions. Kinetics and dynamics of electric drives.

Traction requirements. Standard and realistic driving diagrams.

Electrical construction, power supply and development trends of electric and hybrid cars. Advanced power electronic components and their applications.

Drive control tasks: torque, speed, position, sensorless, energy saving control, direct control in AC drives. Intelligent embedded controls.

Energy feedback solutions. Selection of electric motors for different plants. Main auxiliary protection and traffic safety equipment for vehicles. Fundamentals of electric drive diagnostics.

References:

Chiasson J: Modelling and High-Performance Control of Electric Machines, Wiley, 2005.

Comments: -

<table>
<tr><td>Corse name:

Reliability of Mechatronic Systems</td><td>NEPTUN code:</td><td>Lesson number:
lec+prac+lab

2+1+0</td><td>Credits: 4

Requirement:
m</td></tr>
<tr><td>Supervior:

Dr. Pokorádi László</td><td>Position:

full professor</td><td colspan="2">Prerequisite:

Mechatronic Systems</td></tr>
<tr><td colspan="4" align="center">Knowledge description:</td></tr>
<tr><td colspan="4">Theoretical background of technical reliability; Parameter anomalies, failures; Elements' reliability; Reliability of canonical systems; Reliability of complex interconnected systems; Maintenance strategies and philosophies Redundant systems and redundancy Ageing and maintenability; Fault Tree Analysis (FTA) and Event Tree Analysis (ETA); Bow Tie Analysis (BTA) and Ishikawa Analysis; Failure Mode and Effects Analysis (FMEA); Reliability Sensitivity Analysis of systems;</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">Igor A. Ushakov, Handbook of Reliability Engineering, John Wiley & Sons, 1994.

Eric Bauer, Xuemei Zhang, and Douglas A. Kimber, Practical System Reliability Institute of Electrical and Electronics Engineers, Inc., 2009.</td></tr>
</table>

Intelligent Mechatronic Systems Specialization

Course name: **Intelligent Systems**	***Neptun code:***	***Lesson number:*** *lec+prac+lab* 2+0+1	***Credit:*** 4 ***Requirement:*** e
Supervised by: Dr. Nagy István	***Position:*** associate professor	***Prerequisite:*** Fuzzy systems registration	

Knowledge description:

Probability calculations mainly using **Bayesian** Theorem.

Fundamentals of **Real Time**, **Any-Time** algorithms.

An overview of the principles of neural networks (**NN**). Learning methods (supervised non-supervised) trainings. Implementation and types of NNs.

Back propagation (**BP**) in practice.

Fundamentals of genetic algorithms (**GA**), definitions, introduction to optimisation procedures using GA methods. GA mathematics (selection, mutation, recombination) **Schema** theorem and practical examples.

Literature:

1. Kinsley H., : NN from Scratch in Python; 2020
2. Gurney K., An introduction to NN, 2004
3. Sivanandam, Deepa: Introduction to GA, 2008
4. Brownlee: Probability for machine learning, 2021

<table>
<tr><td>Course name:

Complex Data Structures and Programming</td><td>NEPTUN- code:</td><td>Lesson number:
lec+prac+lab

1+0+3</td><td>Credits: 4

Requirement : m</td></tr>
<tr><td>Supervised by:

Dr. habil Laufer Edit</td><td>Position:

Associate professor</td><td colspan="2">Prerequisite:

-</td></tr>
<tr><td colspan="4" align="center">Knowledge description:</td></tr>
<tr><td colspan="4">The purpose of the lecture is to deepen algorithmic thinking. Review of basic algorithms and data structures. Presentation of dynamic data structures and their algorithms. Learning about graph algorithms in the field of robotics can be well utilized in trajectory planning and optimal route planning. In the laboratory classes, the students deepen their knowledge through practical tasks, thereby becoming able to solve complex tasks at the end of the semester.
Knowledge description: Basic data structures and their operations. List data structure. Binary search tree. Graph algorithms. traversals (inorder, preorder, postorder), topological sorting. Pathfinding in graphs. Minimum spanning trees.</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">1. Kyhan Erciyes, Guide to Graph Algorithms, Springer International Publishing, 2018
2. Even Shimon, Graph Algorithms, Cambridge, 2011</td></tr>
</table>

Course name: **Multi-agent Mobile Robot Systems**	***NEPTUN code:***	***Lesson number:*** *lec+prac+lab* 2+0+1	***Credit:*** 4 ***Requirement:*** e
Supervised by: Dr. Nagy István	***Position:*** Associate professor	***Prerequisite:*** Complex data structures and programming	

Knowledge description:

An overview of the self-organization of the operational basics of multi-agent cooperating mobile robots.

Self-learning systems, reinforcement learning (**RL**) methods, **Q-learning**, **graph-based** path planning methods, A*, A**, **Dijsktra** algorithm, **GA** and **NN** used path planning methods are presented.

Introduction to **3D** path planning methods in **dynamic environment**.

Implementation of multi-agent tasks, path planning, theoretical path planning methods adopted.

Examination of case studies, through simulations written in **MatLab** (possibly **ROS**) environment.

Literature:

1. Leadott órai anyag, és egyéb segédletek, lásd Moodle
2. J.Liu, J. Wu: Multi-agent robotic systems, CRC Press, 2001
3. see: http://siva.bgk.uni-obuda.hu/jegyzetek/Mechatronikai_alapismeretek/English_Mechatr/MobRobots/Literature/

<table>
<tr><td>Course name:

Additive manufacturing</td><td>NEPTUN- code:</td><td>Lesson number:
lec+prac+lab

2+0+0</td><td>Credits: 4

Requirement : m</td></tr>
<tr><td>Supervised by:

Dr. Horváth Richárd</td><td>Position:

Associate professor</td><td colspan="2">Prerequisite: -</td></tr>
<tr><td colspan="4" align="center">Knowledge description:</td></tr>
<tr><td colspan="4">The aim of the course is to provide students with an understanding of the methodology to design something for additive technologies under industrial conditions. After the basics of special, non-traditional design methodology, they will gain insight into the most challenging additive processes and then solve real problems in industrial environments by carrying out projects within the framework of the course.</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">1. Noorani, R. (2017). 3D printing: technology, applications, and selection. CRC Press.</td></tr>
<tr><td colspan="4">2. Redwood, B., Schöffer, F., & Garret, B. (2017). The 3D printing handbook: technologies, design and applications. 3D Hubs.</td></tr>
</table>

<table>
<tr><td>Course name:

Industrial Robots Kinematics and Dynamics</td><td>NEPTUN- code:</td><td>Lesson number:
lec+prac+lab
2+0+1</td><td>Credits: 4
Requirement : e</td></tr>
<tr><td>Supervised by:
Prof. Dr. Tar József</td><td>Position:
Full professor</td><td colspan="2">Prerequisite:
Applied Mathematics</td></tr>
<tr><td colspan="4" align="center">Knowledge description:</td></tr>
<tr><td colspan="4">Aim: To provide the Students with the fundamental mathematical and modeling methods by the use of which for a redundant, open kinematic chain of general structure the forward and the differential inverse kinematic task can be formulated in well structured, lucid form. For solving the inverse kinematic task the method of optimization under constraints is applied. Providing the students with the Euler-Lagrange equations of motion for the dynamic model of the arm with negected frictions effects. Presentation of the siplest model-based control solutions for such robots. The aim of the laboratory exercises is proving the Students with the most efficient simulation and documentation methods.
Knowledge description: Robot arms of open kinematic chain: kinematic parameters related to the „home position”. Workshop („World”) coordinates and joint coordinates in trajectory planning: homogeneous coordinates and matrices, the forward kinematic task. Formulation and solutin of the differential inverse kinematic task using optimization under constraints: Newton – Raphson Aalgorithm, Gradient descent Algorithm, Laglrange’s Reduced Gradient Algorithm, the Moore-Penrose generalized invrese. Kinematic singularities. Creation of the dynamic model by the use of the hmogeneous matrices; Euler-Lagrange equations of motion, the physical interpretation of the generaéized forces. The Computed Torque Control method. The Robust Variable Structure/Sliding Mode control for the compensation of modeling errors and external disturbances. Simulation of the solution if inverse kinematic and dynamic control tasks by the use of Julia language and documentation of the results using LATEX.</td></tr>
<tr><td colspan="4" align="center">Literature:</td></tr>
<tr><td colspan="4">1. Somló J., Lantos B.,P.T. Cat, Advanced Robot Control. Akadémiai Kiadó, Budapest 1997

3. Programming aids to FANUC robots; Mitsubishi – programming aid.</td></tr>
</table>