Course Description		
Course title:	Data Structures and Algorithm	
Neptun code:	GEMAK117-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Dr. Attila Házy, associate professor	
Contact of lecturer:	matha@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	2	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, e	
Course objectives (50-100 words):	Algorithm is an important concept in mathematics and informatics. Our first aim is to get a general description of algorithms and the concepts used to complexity of algorithms. We will review the main concepts and problems in theory of algorithm. We introduce the notions of time and space complexity and apply it to characterise algorithms. This is followed by concrete algorithms.	
Course structure:	**Week**	**Topic**
	1.	Abstract data types, data structures.
	2.	Elementary data structures, arrays, stacks, rows, lists and their typical applications.
	3.	Introduction to graph theory.
	4.	Tree structure and its main properties and operations.
	5.	Rooted trees, heap.
	6.	Algorithms of number theory and encryptions.
	7.	Searching techniques (searching algorithms).
	8.	Searching techniques (hash tables, optimal search on trees).
	9.	Selection methods (maximum, parallel min-max, k-th element, median).
	10.	Sorting algorithms (bubble sort, minimum-selection sort, insertion sort,
	11.	Sorting algorithms (quicksort, merge-sort, shell-sort, counting sort, radix sort, bucket sorting,...).
	12.	Optimal tasks on trees.
	13.	Techniques to accelerate algorithms (divide-and-conquer method, dynamic programming).
Required readings:	1. Attila Házy: Data structures and algorithm, elektronical, Memooc 2. Cormen, Leiserson, Rivest, Stein: Introduction to Algorithms, Third Edition (ISBN 978-0-262-03384-8) The MIT Press ambridge, Massachusetts London	
Recommended readings:	1. Lecture Notes for Data Structures and Algorithms (Revised each year by John Bullinaria) School of Computer Science University of Birmingham Birmingham, UK, 2019 (https://www.cs.bham.ac.uk/~jxb/DSA/dsa.pdf) 2. Lecture Notes for Data Structures and Algorithms (by B Padmaja) https://www.iare.ac.in/sites/default/files/lecture_notes/IARE_DS_LECTURE_NOTES_2.pdf	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Design of Material Handling Systems and Warehouses	
Neptun code:	GEALT177-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Prof. Dr. Tamás Bányai, professor	
Contact of lecturer:	alttamas@iit.uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	2	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, e	
Course objectives (50-100 words):	The course introduces students to the design methods of material handling and warehousing systems, enabling them to solve practical design problems.	
Course structure:	**Week**	**Topic**
	1.	Systems engineering of material handling machines and equipment.
	2.	Modern material handling methods.
	3.	Typical material flow systems.
	4.	Material flow systems for supply and delivery.
	5.	In-process material flow systems.
	6.	Service systems for production systems.
	7.	Flexible material handling systems.
	8.	Typical bulk material flow systems.
	9.	Basic principles and indicators for the design of material flow systems.
	10.	Mathematical description of material flow characteristics (material flow intensity, material flow functions, etc.).
	11.	Definition of storage characteristics.
	12.	Design of typical warehousing systems and processes (entry, identification, storage, picking, reordering, delivery, etc.).
	13.	Theoretical aspects of designing material flow systems.
Required readings:	1. Sule, D.L. Manufacturing facilities: location, planning and design. PWS-Kent Publishing, 1988. ISBN 0-534-91971-5 2. Simchi-Levi D., Chen X., Bramel J.: The logic of logistics - theory, algorithms, and applications for logistics and supply chain management. Springer, 2005. ISBN 0-387-22199-9	
Recommended readings:	1. Apple, J.M. Plant layout and material handling. John Wiley &Sons, 177. ISBN 0-471-07171-4 2. Langford, J.W.: Logistics, principles and applications. McGraw-Hill, 2007. ISBN 978-0-07-147224-1	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Environmental Management	
Neptun code:	GEVGT301-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/1	
Name and position of lecturer:	Dr. Zoltán Szamosi, associate professor	
Contact of lecturer:	szamosi@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	1	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, m	
Course objectives (50-100 words):	The aim of the course is to introduce the energy production and consumption systems in a complex way for the students. Another goal is to present the points in the energy supply and consumer trends/attitude where we see the possibility of intervention, to use our environmental resources in a sustainable way.	
Course structure:	**Week**	**Topic**
	1.	Description of the structure and composition of energy consumption, energy mix, and related problems.
	2.	Energy sources and their distribution.
	3.	Possibilities for electricity generation.
	4.	The stocks of our energy resources and the reasons and time for their expected depletion.
	5.	Changes in atmospheric CO2 content, their causes and possible methods of reduction.
	6.	Alternatives to fossil fuels.
	7.	Nuclear energy.
	8.	Hydropower.
	9.	Pumped storage power stations.
	10.	Pumped storage power plants in Hungary.
	11.	Biomass utilization. Possibilities for increasing the energy density of biomass.
	12.	Mechanical procedures. Thermal processes.
	13.	Biomass based oil substitutes. Biomass - based plastics.
Required readings:	1. Richard S. Stein, Joseph Power: Energy problem, World Scientific, USA 2011. 2. David J Mackay: Fenntartható energia mellébeszélés nélkül, Cambridge, 2008. 3. John Blewitt: Understanding Sustainable Development, Earthscan, 2008.	
Recommended readings:	1. Szamosi Zoltán: Mezőgazdasági melléktermékek energiasűrűség-növelésének vizsgálata, Miskolc, 2016. 2. P.C.A Bergman: The TOP process, ECN, 2005. 3. Ram B. Gupta: Gasoline, diesel and ethanol biofuels from grasses and plants, Cambridge University Press, 2010.	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Industrial Automation	
Neptun code:	GEVAU303-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Dr. Attila Trohák, associate professor	
Contact of lecturer:	trohak.attila@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	1	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, e	
Course objectives (50-100 words):	Introducing the fundamentals of automated production and the role of Programmable Logic Controllers (PLC). Introducing the sensors which are able to provide information about pre manufacturing system and the actuators which are able to influence the production process. The types of Human Machine Interfaces (HMI) which can inform the operator about the machine. The wired and wireless communication methods providing data exchange with MES/ERP systems. Introducing the development method of unique production surveillance systems.	
Course structure:	**Week**	**Topic**
	1.	PLC systems in general.
	2.	Digital and analog sensors.
	3.	Digital and analog actuators.
	4.	PLC programming languages.
	5.	Basics of control.
	6.	Control loops and their operation.
	7.	HMI devices and methods.
	8.	HMI services: basics, creating screens, archiving data.
	9.	HMI services: event logging, alarm handling.
	10.	HMI services: multilanguage projects, user rights.
	11.	Wired communication.
	12.	Wireless communication.
	13.	Case studies: the development of unique production surveillance systems
Required readings:	1. Dr. Ajtonyi István: PLC és SCADA-HMI rendszerek I., ISBN 978-963-06-3165-5, AUT-INFO Kft., 2007. 2. Dr. Ajtonyi István: PLC és SCADA-HMI rendszerek III., ISBN 978-963-06-5774-7, AUT-INFO Kft., 2008. 3. Dr. Ajtonyi István: PLC és SCADA-HMI rendszerek IV., ISBN 978-963-08-1516-1, AUT-INFO Kft., 2011. 4. K.H. John, M. Tiegelkamp: IEC61131-3: Programming Industrial Automation Systems. Springer-Verlag Berlin Heidelberg, New York, 1995.	
Recommended readings:	1. IDC Technologies: Industrial Programming using 61131-3 for PLCs	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Industry 4.0 and Logistics	
Neptun code:	GEALT173-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Prof. Dr. Béla Illés, professor	
Contact of lecturer:	bela.illes@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	1	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, m	
Course objectives (50-100 words):	The Fourth Industrial Revolution will fundamentally change the operation of production and service systems, so within the course we aim to introduce students to the benefits of the Fourth Industrial Revolution as an Industry 4.0 system. Students will gain an overview of Industry 4.0 technologies, with a particular focus on cloud-based systems, cyber-physical systems, and smart factories. We focus on the impact of Industry 4.0 solutions in logistics. Through case studies, students will become familiar with logistics solutions operating in an Industry 4.0 economic environment. Our goal is to provide students with the theoretical knowledge required for Industry 4.0 applications.	
Course structure:	**Week**	**Topic**
	1.	Industrial revolutions
	2.	The Fourth Industrial Revolution: Industry 4.0
	3.	Industry 4.0 technologies: cloud-based systems.
	4.	Industry 4.0 technologies: cyber-physical systems.
	5.	Industry 4.0 technologies: smart factories.
	6.	Industry 4.0 business models.
	7.	Industry 4.0 and energy efficiency.
	8.	Impact of industry 4.0 on logistics.
	9.	Logistics 4.0 solutions.
	10.	Industry 4.0 and quality assurance.
	11.	Social Impact of Industry 4.0.
	12.	Practical application of Industry 4.0.
	13.	Practical application of Industry 4.0.
Required readings:	1. Bányai T., Bányainé Tóth Á., Illés B., Tamás P.: Ipar 4.0 és logisztika, Miskolci Egyetem, Miskolc-Egyetemváros, ISBN 9789633581827, 2019. 2. G. Reinhart: Handbuch Industrie 4.0, Geschäftsmodelle, Prozesse, Technik, Hanser Verlag, 2017. 3. Illés B., E. Glistau, N. I. C. Machado: Logisztika és Minőségmenedzsment, ISBN 978-963-87738-0-7, Miskolc, 2007.	
Recommended readings:	1. Tamás P., Illés B., Dobos P., Seres L.: Lean logisztika I., Miskolci Egyetem, Logisztikai Intézet, Miskolc-Egyetemváros, ISBN 9789633581742, 2018. 2. B. Vogel-Heuser, T. Bauernhansl, M. ten Hompel: Handbuch Industrie 4.0 Bd.3 Logistik. Springer Verlag, ISBN 978-3-662-53250-8, 2017. 3. H-C. Pfohl, B. Yahsi, T. Kurnaz: The Impact of Industry 4.0 on the Supply Chain. In: W. Kersten, T. Blecker, C. M. Ringle (eds) Sustainability in logistics and supply chain management: New designs and strategies, 1st ed. epubli GmbH, Berlin, 2015., pp. 31–58.	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Industry 4.0 Information Systems	
Neptun code:	GEIAL550-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Prof. Dr. László Kovács, professor	
Contact of lecturer:	kovacs@iit.uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	4	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, e	
Course objectives (50-100 words):	Overview of the role of information systems in I4.0 architecture; Different types of applications (OLTP,OLAP). Foundation of data warehouses. MD models and operations, application areas. Web-based applications: architecture and application areas. Application of intelligent sensors, data analysis. Cloud and Big Data architectures, Application of blockchain technologies. Smart applications.	
Course structure:	**Week**	**Topic**
	1.	History of I4.0.
	2.	Role of IT in I4.0.
	3.	OLTP and OLAP systems.
	4.	Decision support systems
	5.	Databases and data warehouses, application areas
	6.	MD data model.
	7.	Data operations.
	8.	MDX
	9.	Blockchain technologies
	10.	Web-architecture, application areas
	11.	Cloud-architecture, application areas
	12.	Intelligent sensors
	13.	Smart applications
Required readings:	1. Alasdair Gilrichst: Industry 4.0: The industrial internet of things, Apress, 2016. 2. Alp Ulstundag, Emre Cevikcan. Industry 4.0: Managing the Digital Transformation, Springer, 2018. 3. Jerzy Duda, Aleksandra Gąsior: Industry 4.0 A Glocal Perspective, Published September 17, 2021 by Routledge	
Recommended readings:	1. P. Tan, M: Steinbach, V. Kuwar Introduction to Data Mining, 1st Edition 2. Klaus Schwab: The Fourth Industrial Revolution, Crown Publishing, 2016. 3. Luis Norberto , Jorge Posada: New Industry 4.0 Advances in Industrial IoT and Visual Computing for Manufacturing Processes, MDPI Publisher, 2020	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Intelligent Material Handling Machines and Systems	
Neptun code:	GEALT176-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Dr. Péter Telek, associate professor	
Contact of lecturer:	alttelek@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	1	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, m	
Course objectives (50-100 words):	Objective of the course is to present the intelligent material handling solutions for the students. The course gives an overview about the types, structures and operation of the automated handling machines applied in logistic processes.	
Course structure:	**Week**	**Topic**
	1.	Principles of material handling.
	2.	Operation of material handling machines.
	3.	Elements of material handling machines.
	4.	Principals of automated material handling.
	5.	Automated material handling machines.
	6.	Theory of material handling systems.
	7.	Material handling system solutions.
	8.	Automated material handling systems.
	9.	Intelligent logistic solutions.
	10.	Planning of material handling.
	11.	Planning of handling systems.
	12.	Planning of automated handling processes.
	13.	Reliability and maintenance of automated handling machines and systems.
Required readings:	1. R. A. Kulwiec: Materials handling handbook. J. Wiley and Sons, 1985. 2. M. P. Stephens, F. E. Meyers: Manufacturing Facilities Design and Material Handling, Pearson, 2010. 3. J. M. Apple: Material handling system design, J. Wiley and Sons, 1977.	
Recommended readings:	1. Müller, T.: Automated guided vehicles. IFS (Publications) Ltd., Berlin, Heidelberg, New York 1983. 2. Heinrich Martin: Förder- und Lagertechnik. Vieweg. Braunschweig 1978. 3. Michael G. Kay: Material Handling Equipment, North Carolina State University, 2012.	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Introduction into Datamining	
Neptun code:	GEIAL529-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Prof. Dr. László Kovács, professor	
Contact of lecturer:	kovacs@iit.uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	2	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, e	
Course objectives (50-100 words):	Foundation of data management and data analysis. Basic skills in relational databases, Basic statistical tools for data analysis; Statistical tests and regression; introduction into data mining; Overview of the basic clustering and classification methods, introduction in neural networks, Learing how to use Excel, rapidMiner and Python for basic data analysis tasks.	
Course structure:	**Week**	**Topic**
	1.	Relational databases, architecture and operations, basic SQL commands
	2.	Basic programming skills in Python
	3.	Overview of basic statistical methods, normal distribution, statistical tests, regression
	4.	Statistical tools and visualisation in Excel, Python and rapidMiner
	5.	Overview of the DataMining methods, application areas
	6.	Association rule mining, markert basket analysis
	7.	Clustering methods
	8.	HAC algorithm, k-means method
	9.	Clustering Python and rapidMiner
	10.	Classification methods, Bayesian algorithm, decision tree method
	11.	Classifrication in Python and rapidMiner
	12.	Overview of neural networks
	13.	NN-tools in Python and rapidMiner
Required readings:	1. J. Han – M. Kamber: Data Mining. Concepts and Techniques, 3rd Edition (The Morgan Kaufmann Series in Data Management Systems), 2017 2. Pang -Ning Tan: Introduction to Data Mining., Publisher: Pearson Education; 2019 3. Provost: . Data Science for Business: What You Need to Know about Data Mining andData Analytic Thinking, 2014	
Recommended readings:	1. Jared Dean, Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, 2014 2. Witte, Frank, Hall, Pal : Data Mining: Practical Machine Learning Tools and Techniques, 2011 3. Berson, Smith: Data Warehousing, Data Mining and OLAP. McGraw Hill, 1997.	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Mechatronics in Logistics	
Neptun code:	GEALT196-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Dr. Ákos Cservenák, senior lecturer	
Contact of lecturer:	cservenak.akos@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	2	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, e	
Course objectives (50-100 words):	Nowadays, in logistics, material handling cannot be carried out without the use of various mechatronic equipment and tools. The aim of the course is to present the concept and subject areas of mechatronics to students of logistics engineering. Mechatronics covers three main disciplines, and the subject presents them as well. Another element of the subject is the fit of mechatronics into logistics.	
Course structure:	**Week**	**Topic**
	1.	Presentation of the concept of mechatronics
	2.	History of mechatronics
	3.	Detailing the disciplines of mechatronics
	4.	Overview of actuators
	5.	Overview of hydraulic systems
	6.	Overview of pneumatic systems
	7.	Overview of electric motors
	8.	Sensor overview
	9.	Automation of material handling equipment and devices with mechatronic devices
	10.	Overview of industrial robots
	11.	Programming of industrial robot
	12.	Industrial robot simulation
	13.	Mechatronic devices in road vehicles
Required readings:	1. Robert H. Bishop: The Mechatronics Handbook, 2002 CRC Press, Boca Raton-London-New York- Washington, D.C.	
Recommended readings:	1. Habib, M.K. Handbook of research on advanced mechatronic systems and intelligent robotics (2019) Handbook of Research on Advanced Mechatronic Systems and Intelligent Robotics, pp. 1-466. 2. Hans-Peter Schöner, Automotive mechatronics, Control Engineering Practice, Volume 12, Issue 11, 2004, Pages 1343-1351, ISSN 0967-0661	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Modeling and Simulation of Transport Systems	
Neptun code:	GEALT197-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Dr. Róbert Skapinyecz, associate professor	
Contact of lecturer:	altskapi@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	4	
Number of credits:	4	
Requirements (exam/practical mark/signature/report, essay):	s, m	
Course objectives (50-100 words):	During the course, students will be introduced to the structure of the road transport system, the basics of road traffic and public transport modeling, the use of modern traffic simulation and traffic planning software, and the application possibilities of the latter.	
Course structure:	**Week**	**Topic**
	1.	The concept and purpose of transport. Modal split, transport cooperation and coordination.
	2.	Transport system and subsectors. The system of road transport: road network, means and indicators of road passenger transport, traffic technology.
	3.	Advanced tools for measuring road traffic.
	4.	Quality indicators and characteristic parameters of public transport. Sustainability in transport.
	5.	Parameters describing road traffic flows. Typical traffic generation, traffic distribution, traffic sharing and traffic load models.
	6.	Advanced traffic management strategies. The purpose of traffic simulations and their application possibilities.
	7.	Introduce students to the main functions of the traffic simulation environment to be used during the semester. Creating a simple intersection, setting priority rules, creating a roundabout, defining public transport in the simulation environment.
	8.	Creating intersections with traffic lights, setting up pedestrian traffic, using 3D objects in the simulation environment.
	9.	Creating and examining complex traffic nodes with traffic signal control using the simulation environment.
	10.	Introduce students to the main functions of the traffic planning software to be used during the semester.
	11.	Defining traffic zones, creating traffic networks, defining traffic flows, and applying different traffic models in the traffic planning software.
	12.	Creating a public transport network, defining and applying timetables in the transport planning software.
	13.	Modeling and examining complex transport networks. Main characteristics of fixed track transport and its application in urban transportation.
Required readings:	1. Tettamanti, Tamás, Tamás Lupsay, and István Varga. "Road Traffic Modeling and Simulation." (2019), Budapest, Hungary: Akadémiai Kiadó, ISBN 978 963 454 385 5 2. Tamás, Péter. „Innovative simulation testing methods in logistics.” (2021), Miskolc-Egyetemváros, Hungary: Miskolci Egyetem, Logisztikai Intézet, ISBN 9789633582398	
Recommended readings:	1. Femke. Kessels. (2018). Traffic Flow Modelling: Introduction to Traffic Flow Theory Through a Genealogy of Models. SPRINGER. ISBN 9783319786940 2. Theeg, G., and S. Vlasenko. "Railway Signalling & Interlocking: Edition." Germany, Leverkusen PMC Media House GmbH (2020).	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Modern Information Technologies	
Neptun code:	GEIAL551-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Prof. Dr. László Kovács, professor	
Contact of lecturer:	kovacs@iit.uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	1	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, e	
Course objectives (50-100 words):	The subject introduces one of the critical points of information systems, the concepts of computer security, the components used for security purposes, and their role. It explains the principles and basics of encryption in more detail. It covers public key cryptography and its role. In the second part of the course, basic programming techniques that can be used to automate business processes using MS Excel are presented.	
Course structure:	**Week**	**Topic**
	1.	Data; information; information security.
	2.	Protection demand; sources of danger; classification of risk classes; defense costs.
	3.	Protection of information; protection against physical injury.
	4.	Protection against unauthorized access; intrusions.
	5.	Common identification methods; property-based identification.
	6.	Knowledge-based identification; biometric identifiers; strict identification; multifactor identification.
	7.	Security policy; Firewalls; firewall building blocks: Packet filtering; stateful packet filtering; deep inspection firewall; circuit level gateway; proxy firewall.
	8.	Security structures; VPN, Content filtering firewall; Web Application firewall;
	9.	IPS and IDS systems; personal firewall.
	10.	Virus scanners; antivirus engines; their operating principle; encrypted viruses; heuristic, resp. negative heuristic search.
	11.	Introduction to Excel - VBA Basics.
	12.	Excel Form elements and programming, data validation.
	13.	Excel data display and analysis functions.
Required readings:	1. Jonathan Katz: Digital Signatures (Advances in Information Security): 2010, Springer, ISBN: 978-0387277110 2. John R. Vacca: Computer and Information Security Handbook. 2017, ISBN 978-0-12-803843-7 3. Bruce Schneier: Applied Cryptography. 2015, ISBN 9781119096726 4. Michael Alexander, Dick Kusleika: Excel 2019. Power Programming with VBA, Wiley, ISBN: 978-1-119-51492-3	
Recommended readings:	1. Michael Alexander, Richard Kusleika, John Walkenbach: Excel 2019 Bible, Wiley, ISBN: 978-1-119-51476-3 2. David Slager: Essential Excel 2016 (A Step-by-Step Guide). Apress, 2016, ISBN: 978-1-4842-2160-0 3. John Walkenbach: Microsoft Excel 2016 Bible. Wiley, 2015, ISBN: 978-1-119-06751-1	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Numerical Methods and Optimization	
Neptun code:	GEMAK116-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Dr. Attila Körei, associate professor	
Contact of lecturer:	matka@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	1	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, e	
Course objectives (50-100 words):	Applying iterative methods in solving mathematical problems. Effective methods and algorithms in optimization theory. Using Matlab/Octave to formulate and solve problems on optimization and numerical analysis.	
Course structure:	**Week**	**Topic**
	1.	Preliminaries: basic concepts of linear algebra and analysis
	2.	Representation of numbers, number systems, different types of errors
	3.	Direct and iterative methods for solving systems of linear equations
	4.	Computing eigenvalues and eigenvectors
	5.	Solving nonlinear equations and nonlinear systems: fixed point method, Newton method
	6.	Interpolation and the least square method
	7.	Numerical solution of differential equations
	8.	Basic concepts of optimization, classification of optimization problems
	9.	Solving linear programming problems by the simplex method
	10.	Duality and sensitivity analysis
	11.	Special LP problems
	12.	Some methods of unconstrained optimization
	13.	Constrained optimization: Karush-Kahn-Tucker conditions
Required readings:	1. Pardalos, P. M. and Butenko, S.: Numerical Methods and Optimization: An Introduction, CRC Press, Taylor & Francis Group, 2014. 2. Cheney, W., Kincaid, D: Numerical Mathematics and Computing, Brooks Cole, 2012. 3. Foulds, L. R.: Optimization Techniques, Springer Verlag, 1981.	
Recommended readings:	1. Hunt, B. R., Lipsman, R. L., Rosenberg, J. M.: A Guide to MATLAB – for Beginners and Experienced Users, Cambridge University Press, 2001. 2. Nocedal, J., Wright, S. J.: Numerical Optimization, Springer, 1999.	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Projectmanagement	
Neptun code:	GTVSM7004Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/1	
Name and position of lecturer:	Prof. Dr. Mariann Veresné Somosi, professor	
Contact of lecturer:	szvvsm@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	3	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, m	
Course objectives (50-100 words):	This course aims to provide students with the basic tools and techniques of project management, to demonstrate the importance of project management knowledge for future career decision making, and to reinforce project management skills by means of experiential learning and lecture-based methodologies.	
Course structure:	**Week**	**Topic**
	1.	Basic informations about the subject.
	2.	Foundation Principles of Project Management. Basic definitions of PM. Type of projects. Project scope management.
	3.	Project life cycle. Definig the Project. Project Documents.
	4.	Project planing. Resource planning and costing.
	5.	Stakeholder analysis. Project risk management. Teamwork during the project.
	6.	Work breakdown structure. GANTT diagram.. Fulfilment of resource plan. Milestone events.
	7.	Project metrics. Project fulfilment strategy. Feasibility study.
	8.	Project control. Project organisations. Management of R&D projects.
	9.	Project Portfolio Management.
	10.	Projekt management competency measurement with online software.
	11.	Project supporting softwares. (SAP, MS Project).
	12.	Teamwork presentation.
	13.	Consultation.
Required readings:	1. Course material (ppt slides; handouts) 2. Görög M: A projektvezetés mestersége, Aula kiadó, 2003. (meghatározott fejezetek) 3. Project Management Institute (2013): Projektmenedzsment útmutató (PMBOK Guide). Akadémia Kiadó, Budapest. ISBN 978 963 05 9426 4. E. Verzuh: Project Management, 2003.	
Recommended readings:	1. Szabó –Egri (2004): Pályázati alapismeretek, Bessenyei Kiadó 2. Peter Hobbs (2011): Projektmenedzsment, Scolar Kiadó Bp. 3. J. G. Monks: Operations Management, McGraw-Hill, 1982. Chapters 12, 13. 4. https://www.academia.edu/3438417/The_project_managers_leadership_style _as_a_success_factor_on_projects_a_literature_review	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Quality Management of Logistics Systems	
Neptun code:	GEALT179-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Prof. Dr. Béla Illés, professor	
Contact of lecturer:	bela.illes@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	4	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, m	
Course objectives (50-100 words):	During the course, students will be introduced to the relationship between quality assurance and logistics, as well as the application of the basic methods and techniques used in quality assurance in logistics.	
Course structure:	**Week**	**Topic**
	1.	Logistics product, logistics process and logistics system.
	2.	The concept and development of quality.
	3.	The relationship between quality and logistics. Logistics quality.
	4.	Total quality management in logistics.
	5.	Capturing customer needs, the benefits of Customer Relationship Management.
	6.	QFD method for the realization of customer expectations. Use of QFD in logistics - LFD.
	7.	Application of benchmarking in logistics.
	8.	Prevention techniques, error analysis in logistics.
	9.	Business Process Reengineering (BPR) in logistics. Comparison of Kaizen method and reengineeering.
	10.	Use of the seven analytical tools and other analytical methods in logistics.
	11.	Logistics application of the seven management tools and additional management tools.
	12.	Manageability of logistics processes, six sigma, regulatory circuits, statistical process control.
	13.	Relationship system of quality assurance and logistics, mathematical manageability of quality assurance logistics.
Required readings:	1. Pyzdek, Thomas, and Paul Keller. Handbook for quality management: A complete guide to operational excellence. McGraw-Hill Education, ISBN 978-0071799249, 2013. 2. Illés, B., Glistau, E., Machado, N. I. C.: Logistik und Qualitätsmanagement, Budai Nyomda, ISBN 978-963-87738-1-4, 2007. 3. Márquez, F. P. G., Segovia, I., Bányai, T., & Tamás, P. (Eds.). (2020). Lean Manufacturing and Six Sigma: Behind the Mask. BoD–Books on Demand. ISBN 978-1-78923-908-9	
Recommended readings:	1. Hompel, Michael, and Thorsten Schmidt. (2006): Warehouse management: automation and organisation of warehouse and order picking systems. Springer Science & Business Media 2. Bányai, Tamás, and Ireneusz Kaczmar, eds. Green Supply Chain: Competitiveness and Sustainability. BoD–Books on Demand, ISBN 978-1-83968-301-5, 2021.	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Simulation Examination of Logistics Systems	
Neptun code:	GEALT178-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Prof. Dr. Péter Tamás, professor	
Contact of lecturer:	peter.tamas@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	2	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, m	
Course objectives (50-100 words):	During the course, students will be introduced to the possibilities of simulation modeling, evaluation and efficiency improvement of typical logistics systems. Using the knowledge gained, students will be able to model, evaluate, develop and design logistics processes with a simulation framework.	
Course structure:	**Week**	**Topic**
	1.	Objectives of modeling logistics systems.
	2.	Principles of simulation modeling.
	3.	Possibilities of simulation modeling.
	4.	Application of Lean philosophy in modeling logistics systems.
	5.	Logistics objects of procurement logistics systems.
	6.	Logistics objects of production, logistics systems.
	7.	Logistics objects of distribution logistics systems.
	8.	Logistics objects of recycling logistics systems.
	9.	The material flow characteristics to be taken into account when modeling the logistics subsystems.
	10.	Method of modeling logistics operations in a simulation framework.
	11.	Method of modeling logistics processes in a simulation framework.
	12.	Description of case studies for modeling and development of automotive logistics systems.
	13.	Solving practical tasks.
Required readings:	1. Tamás P.: Innovative simulation testing methods in logistics, Tankönyv, ISBN: 978-963-358-239-8 , 2021. 2. Pedro García Márquez, F.; Segovia, R. I.; Bányai, T., Tamás, P.: Lean Manufacturing and Six Sigma – Behind the Mask, London, Egyesült Királyság/Anglia: InTech Open Access Publisher, 2021.	
Recommended readings:	1. Tamás P., Illés B.: Examining the Integration Possibilities for Lean Tools and Simulation Modeling, Solid State Phenomena 261: pp. 516-522. (2017) 2. Illés B., Glistau E., Machado N. I. C.: Logistik und Qualitätsmanagement, ISBN 978 963 87738 1 4, Miskolc, 2007.	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	Standard Solutions in Logistics Networks	
Neptun code:	GEALT182-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Prof. Dr. Péter Tamás, professor	
Contact of lecturer:	peter.tamas@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	3	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, e	
Course objectives (50-100 words):	During the course, students will be introduced to the standard processes of supply chain identification, data collection, and data sharing. The process activities and their measurement techniques, that mainly occur in logistics, play a major role in the course. The course also aims to familiarize students with the practical uses of sector-independent standards and solutions developed to make business communication and supply chain processes more efficient.	
Course structure:	**Week**	**Topic**
	1.	The role of standards in business processes.
	2.	The basics of the GS1 standards system.
	3.	GS1 Standard Identification Keys.
	4.	GS1 Standard storage media.
	5.	Createing standard ID keys and media.
	6.	Data structures and data elements.
	7.	Non-GS1 standard identification systems, their comparison and application.
	8.	GS1 Data Sharing Standards and their application in business communications.
	9.	Optimizing processes in the healthcare sector with GS1 standards.
	10.	IoT solutions using GS1 standards.
	11.	Application of blockchain technology in the development of a tracking system.
	12.	Basics of tracking.
	13.	Tracking models in the supply chain.
Required readings:	1. Fekete B., Kétszeri D., Kecskés K., Krázli Z., Dr. Lakner Z., Vatai K.: Nyomon követés globális szabványokkal, GS1 Magyarország Kht., ISBN 978 963 06 2647 7, Budapest, 2007. 2. Cselényi J., Illés B. (szerk.): Logisztikai rendszerek I., Miskolci Egyetemi Kiadó, Miskolc-Egyetemváros, 2004. 3. Rushton, A., Croucer, P., Baker, P.: The handbook of logistics and distribution management, 3rd edition, Kogan Page Limited, ISBN 9780749446697, 2006	
Recommended readings:	1. Langford, J.: Logistics principles and applications, Sole Press, ISBN-10: 0-07-147224-X, 2007. 2. Szegedi Z., Prezenszki J.: Logisztika-menedzsment, Kossuth Kiadó, ISBN 97896309-8877-3, Budapest, 2008.	
Evaluation method:	Continuous evaluation of mid-semester work	

Course Description		
Course title:	System Engineering and System Modeling	
Neptun code:	GEGET335-Ma	
Type (core, specialization, optional, dissertation, other):	core	
Lecture/ Seminar (practical); hours per week:	2/2	
Name and position of lecturer:	Prof. Dr. Gabriella Vadászné Bognár, professor	
Contact of lecturer:	matvbg@uni-miskolc.hu	
Prerequisite course(s):	no	
Language of the course:	English	
Suggested semester: autumn /spring, 1-4	2	
Number of credits:	5	
Requirements (exam/practical mark/signature/report, essay):	s, m	
Course objectives (50-100 words):	Modeling of the elements of mechanical systems and their relation system, recognition of the internal laws of the systems, mathematical description. Getting to know the basic elements of modeling, the general conditions of application, taking into account its limitations.	
Course structure:	**Week**	**Topic**
	1.	The subject of mechanical system engineering. Basic concepts of system technology.
	2.	Passive and active systems. Deterministic and stochastic systems. Problem of analysis and synthesis. System identification.
	3.	Structural hierarchy of machine configurations: element, element group, subsystem, machine, machine group.
	4.	Characterization of systems with impact diagram. Examples of the construction of an effect scheme.
	5.	Structure graph, examples of the application of the structure graph. Signal flow diagram.
	6.	Peculiarities of structure graphs. Operations with graphs.
	7.	Analysis and management of roads and networks.
	8.	Modeling of machine structures, levels of functions, function structures.
	9.	System construction with structural variants. Structural connections in machine systems.
	10.	Relational force interfaces: linear and nonlinear relations. Dry friction joints.
	11.	Peculiarities of the structure of energy chains within the system, issues of system protection.
	12.	Frictional force relationship as a system with memory. Dry friction surface built into equations of motion.
	13.	Real example analysis. Special logistics systems.
Required readings:	1. Thompson D.E: Design Analysis: Mathematical Modeling of Nonlinear Systems, Cambridge University Press; 1st edition 1999. 2. Lewis, J.W.: Modeling Engineering Systems: Math Modeling Made Easy, Jack W. Lewis; 1st edition 2013. 3. Sokolowski, J. A–Banks, C. M.: Modeling and Simulation, Fundamentals, JOHN WILEY & SONS, ISBN 978-0-470-48674-0.	
Recommended readings:	1. Bruns, M.: Systemtechnik. Ingenieurwissenschaftliche Methodik zur interdisziplinären Systementwicklung. Springer Berlin, Heidelberg. 1991. 2. Buede D.M., Miller W.D.: The Engineering Design of Systems: Models and Methods, Wiley; 3rd edition 2016. 3. Esfandiari R. S., Lu B.: Modeling and Analysis of Dynamic Systems, CRC Press; 3rd edition 2018.	
Evaluation method:	Continuous evaluation of mid-semester work	