Course title: Computer aided modeling of curves and surfaces	**Number of credits: 5**
Name and position of course coordinator: Dr. Imre Juhász, professor	
Suggested semester: spring	
Weekly lecture + seminar hours: 2 lectures	
Assessment: colloquium	
Course webpage:	

Course objectives:

to get familiar with the basics of Computer Aided Geometric Design (CAGD), which are used both in geometric design and in computer graphics

Course content and structure:

Homogeneous coordinates, coordinate and point transformations, transformation groups. Description of curves, permissible parameter transformation, representation independent geometric characteristics. Interpolating and approximating curves, Bézier and B-spline curves. Deduction, description and shape modification of rational Bézier and B-spline (NURBS) curves, modeling of complex shapes. Description of surfaces, interpolating and approximating surfaces, surfaces swept by a moving curve, Bézier and B-spline surfaces, rational Bézier and B-spline (NURBS) surfaces. Representation of translational and rotational surfaces by means of NURBS surfaces. Curves, surfaces and solids in CAD systems.

Evaluation method:

written exam

Required reading:

Hoschek, J., Lasser, D. Fundamentals of Computer Aided Geometric Design, A. K. Peters, Wellesley, MA, 1993.
Farin, G., Curves and surfaces for computer aided geometric design: A practical guide, Academic Press, fifth edition Morgan-Kaufmann, 2002.

Suggested reading:

Cohen, E; Riesenfeld, RF; Elbert, G., Geometric modeling with splines: an introduction, AK Peters/CRC Press, 2001.
Anand, V. B. Computer graphics and geometric modeling for engineers, John Wiley & Sons, Inc., 1996.

Course title: Computerised Measurement Systems, GEVEE412	**Number of credits: 5**
Name and position of course coordinator: Lajos Tóth, Assoc. Prof	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+2	
Assessment: colloquium	
Course webpage:	

Course objectives:

Familiarize with the building blocks and operation of computerized measurement systems.

Course content and structure:

Electronics test and test equipment, properties and operation of test instruments, automatic test equipment. Hardware parts of test equipment, sampling theorem, A/D and D/A conversion, features and properties of DAQ cards, communication bus systems: RS232 (Interface Between Data Terminal Equipment and Data Communications Equipment), RS485, RS422, USB (Universal Serial Bus), GPIB (General Purpose Interface Bus – IEEE488), platforms: LXI (LAN eXtension for Instrumentation), VXI (VME eXtension for Instrumentation), PXI (PCI eXtension for Instrumentation), JTAG/Boundary-scan IEEE Std 1149.1, Software side of test equipment, Standard Commands for Programmable Instruments (SCPI), LabWindows/CVI, LabView

Evaluation method:

During the semester, the completion of the signature is subject to a sufficient level (at least 50%) of two papers and participation in the demonstration measurement. The duration of the papers is 50 minutes. The value of a thesis is 30 points. So you have to earn 15-15 points each for signing. A total of 60 points can be obtained.
The method of passing the exam is based on verbal prequalified exam questions. There are two questions that need to be elaborated at a satisfactory level for successful exams. Points earned during a semester are 2x30 = 60. 1. 0-29 insufficient, 2. 30-39 sufficient, 3. 40-49 medium, 4. 50-55 good, 5. 56-60 excellent. Whoever reaches a good or excellent level receives rating recognition.

Required reading:

O'Connor, Patrick DT: Test Engineering. JohnWiley&Sons Ltd., 2001
DM. Considine: Process/Industrial Instruments &ControlHandbook. McGraw-Hill, 1993

Suggested reading:

Seippel RG.:Transducers, Sensors, and Detectors. Prentice-Hall Inc., 1983

Course title: Computer Aided Electronic Circuit Design, GEVEE413	**Number of credits: 5**
Name and position of course coordinator: Lajos Tóth, Assoc. Prof	
Suggested semester: autumn	
Weekly lecture + seminar hours: 2+2	
Assessment: colloquium	
Course webpage:	

Course objectives:

Familiarize with the tools and process of Computer Aided Electronic Circuit Design.

Course content and structure:

Electronic components, packages, materials, properties and manufacturing process of printed wired boards, soldering materials, fluxes, soldering technologies, automatic component insertion systems, reflow and wave soldering. Design issues of electronics products, EMC/EMI problems, International Protection Marking (IP Code), manufacturability and serviceability considerations. Components of computerized electronic design systems, software components for design and production. Circuit Design, Schematic Drawings, circuit simulation, printed circuit board (PCB) design, manual and automatic wiring, finalization of the project, creating production files.

Evaluation method:

During the semester, completion of signature is subject to a sufficient level (at least 50%) of a test and preparation a design task. The duration of the written test is 50 minutes. The maximum value of test and the design is 30 points. Student has to earn 15 points on the test for signing. A total of 60 points can be obtained.
The method of passing the exam is based on verbal prequalified exam questions. There are two questions that need to be elaborated at a satisfactory level for successful exams. Points earned during a semester are 2x30 = 60. 1. 0-29 insufficient, 2. 30-39 sufficient, 3. 40-49 medium, 4. 50-55 good, 5. 56-60 excellent. Whoever reaches a good or excellent level receives rating recognition.

Required reading:

C. F. Coombs: Printed Circuits Handbook, McGraw-Hill 1995.
OrCAD offline documentation

Suggested reading:

Ralph W. Woodgate, The Handbook of Machine Soldering: SMT and TH,Wiley; 3th edition (1996)

Course title: GEIAL432 Computational Intelligence	**Number of credits:** 5
Name and position of course coordinator: Szilveszter Kovacs, associate professor	
Suggested semester: autumn	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage: -	

Course objectives:

The main goal of the subject is to give an introduction to the main areas of Computational Intelligence, to Fuzzy Logic, Neural Networks, Genetic Algorithms and their combination.

Course content and structure:

The subject summarizes the basic concepts of fuzzy sets, fuzzy logic and fuzzy reasoning. It also gives some introduction to the concept of Fuzzy Rule Interpolation and the possible practical application areas of fuzzy systems. Gives an introduction to the artificial neural network structures and to the concept of Multilayer Perceptron. It also discusses some methods related to the genetic algorithms and reinforcement learning.

Evaluation method:

The subject is closing with a colloquium. The colloquium has written and oral parts. The written part is a test with short questions. Having more than 50% fulfilled, the exam is continuing with its oral part, which is a short essay on a given subject. The final result is the average of the written and oral parts according to the following evaluation:

89%-100% excellent (5)
76%-88% good (4)
63%-75% average (3)
51%-62% pass (2)
0%-50% inadequate (1)

Required reading:

Lecture slides: www.iit.uni-miskolc.hu/~szkovacs
Michael Negnevitsky: Artificial Intelligence: a guide to intelligent systems, Addision Wesley, 2002, ISBN 0-201-71159-1.

Suggested reading:

J.-S. R. Jang, C.-T. Sun, E. Mizutani: Neuro-Fuzzy and Soft Computing, Prentice Hall, 1997, ISBN 0-13-261066-3
George J. Klir, Bo Yuan: Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995
Richard S. Sutton, Andrew G. Barto, Reinforcement Learning: An Introduction. MIT Press, ISBN 0-262-19398-1, 1998.

Course title: Data Mining: Theory and Practice	**Number of credits: 5**
Name and position of course coordinator: Dr. László Kovács, associate professor	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+1	
Assessment: colloquium	
Course webpage:	

Course objectives:

The course presents the role of data mining and it shows the related key methods and techniques on clustering, classification and association rule detection.

Course content and structure:

Levels of data analysis; overview of probability theory, role of normal distribution; supervised and unsupervised learning; learning methods, avoiding overfitting; classification: Bayesian method; k-NN method, decision trees; random forest; NN-based methods; SVM method; evaluation of classification; Clustering: HAC method; k-means method, SOM method, evaluation of clustering methods. Methods for dimension reduction: SVD, PCA. Application programs in R.

Evaluation method:

There are two tasks to be completed: oral exam and a paper draft. The topic of the paper related to the application of some DM methods.

Required reading:

1: Trevor Hastie, Robert Tibshirani, Jerome Friedman The Elements of Statistical Learning: Data Mining, Inference, and Prediction
2: Joel Grus : Data Science from Scratch: First Principles with Python
3: John W. Foreman : Data Smart: Using Data Science to Transform Information into Insight

Suggested reading:

Robert Kabacoff : R in Action: Data Analysis and Graphics with R

Course title: Discrete Mathematics I. (GEMAN401)	**Number of credits: 5**
Name and position of course coordinator: Jenő Szigeti professor of mathematics	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+2	
Assessment: colloquium	
Course webpage:	

Course objectives:
Introduction to combinatorics and graph theory and to some aspects of algebra
Course content and structure:
Exclusion-inclusion (sieve) formula and its applications: number of fixed point free permutations, number of surjective functions, Euler's phi function. Catalan numbers: different equivalent definitions. Some combinatorial identities. Graph theory: chromatic number, Brooks theorem, perfect graphs, Turan's problem, complete matchings, theorems of Tutte, linear algebraic methods in graph theory, further topics in recent graph theory. Introduction to Ramsey theory. Semigroups, groups and rings. Permutation groups.
Evaluation method:
short presentation of a given subject
Required reading: 1. Stephan Foldes: Fundamental Structures of Discrete Mathematics, Wiley, 2. R. Distel: Graph Theory, Springer, 3. R. P. Stanley: Enumerative Combinatorics, http://www-math.mit.edu/~rstan/ec/ec1.pdf
Suggested reading:
J. Riordan: Combinatorial identities, R.E. Krieger Pub. Co.

Course title: Electrical Servo Drives, GEVEE 416	**Number of credits: 5**
Name and position of course coordinator: Csaba Blága, Assoc. Prof	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+2	
Assessment: colloquium	
Course webpage:	

Course objectives:

Familiarize the special electric machines, servomotors and their electric drive with power electronics.

Course content and structure:

Features of power electronics semiconductor devices. On and off times. Parallel and serial connection of diodes. Thyristor family: SCR, triak, GTO, LTT, SITh, MCT. Commutation of thyristors. Ignition of thyristors. Transistor family: Power BJT, MOSFET, IGBT structure, operation and characteristics. Base controls, Totem-Pole. Structure, technology and application of power modules. AC / AC converters: phase shaping, waveguide, dimming. DC / DC converters: PWM, PFM. H-bridge. Tracking control signal. Current vector control. Control integrated circuits. Electric drives. DC power machines. PM servomotors. AC servomotors. Inverter, inverters, U / f control. Stepping motors and their applications. Basic concepts of magnetic circles. Hydraulic and pneumatic actuator magnets, solenoids, proportional magnets and electronic control.

Evaluation method:

During the semester, the completion of the signature is subject to a sufficient level (at least 50%) of two papers and participation in the demonstration measurement. The duration of the papers is 50 minutes. The value of a thesis is 30 points. So you have to earn 15-15 points each for signing. A total of 60 points can be obtained.
The method of passing the exam is based on verbal prequalified exam questions. There are two questions that need to be elaborated at a satisfactory level for successful exams. Points earned during a semester are 2x30 = 60. 1. 0-29 insufficient, 2. 30-39 sufficient, 3. 40-49 medium, 4. 50-55 good, 5. 56-60 excellent. Whoever reaches a good or excellent level receives rating recognition.

Required reading:

M. P. Kazmierkowski, H. Tunia, Automatic Control of Converter-Fed Drives, Elesevier, Amsterdam, 1994.

Suggested reading:

Rashid, M., H.: Power Electronics, Prentice Hall, 1993.

Course title: Electrical Modelling and Simulation, GEVEE 417	**Number of credits: 5**
Name and position of course coordinator: Csaba Blága, Assoc. Prof	
Suggested semester: autumn	
Weekly lecture + seminar hours: 2+2	
Assessment: colloquium	
Course webpage: ….(if there is one)	

Course objectives:

Familiarize the computer modelling procedures of electrical machines and devices. Develop a comprehensive approach that highlights system modelling with hard and soft computing methods.

Course content and structure:

Circuit models of electrical machines and devices. Mathematical description of the transient phenomena of the circuits using differential equations. Calculating transient processes using the Laplace transform. Use Circuit Simulation Programs to Study Time Processes: PSpice, PSCAD. The kinematics and dynamics of electric rotary machines. Mathematical description of kinematic and dynamic equations using differential equations. Use of computer simulation software package to solve general differential equation systems. The regulatory technology block diagram of electric drives. Use of Simulink software package for the development of a dynamic model of electrical machines and devices. Case studies: retractable coil, starter motor, car generator.

Evaluation method:

During the semester, the completion of the signature is subject to a sufficient level (at least 50%) of two papers and participation in the demonstration measurement. The duration of the papers is 50 minutes. The value of a thesis is 30 points. So you have to earn 15-15 points each for signing. A total of 60 points can be obtained.
The method of passing the exam is based on verbal prequalified exam questions. There are two questions that need to be elaborated at a satisfactory level for successful exams. Points earned during a semester are 2x30 = 60. 1. 0-29 insufficient, 2. 30-39 sufficient, 3. 40-49 medium, 4. 50-55 good, 5. 56-60 excellent. Whoever reaches a good or excellent level receives rating recognition.

Required reading:

Marci N.F., Thaler G. J.: Modelling and Simulation of Dynamic Systems, Thomson Delmar Learning, 2005.

Suggested reading:

Campbell S. L., Chancelier J-P., Nikoukhah R.: Modelling and Simulation in Scilab/Scicos, Springer, 2006

Course title: Electronic Systems and Metrology, GEVEE405	**Number of credits: 5**
Name and position of course coordinator: Lajos Tóth, Assoc. Prof	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+2	
Assessment: colloquium	
Course webpage:	

Course objectives:

Familiarize with the theory and operation of modern electronic measurement systems.

Course content and structure:

Students learn Electronic principles to build measuring instruments. Structure and operation of semiconductor devices, properties and parameters of amplifier circuits, passive and active filter configurations, operational and instrumentation amplifiers, properties and operation of different type of sensors and transducers, measurement theory, types and operation of analog instruments, process and building blocks of analog to digital converters, signal processing theorems and principles. Students gain practical laboratory experiences in measurements with instruments, building and testing simple electronic circuits and doing simple signal processing tasks

Evaluation method:

During the semester, the completion of the signature is subject to a sufficient level (at least 50%) of two papers and participation in the demonstration measurement. The duration of the papers is 50 minutes. The value of a thesis is 30 points. So you have to earn 15-15 points each for signing. A total of 60 points can be obtained.
The method of passing the exam is based on verbal prequalified exam questions. There are two questions that need to be elaborated at a satisfactory level for successful exams. Points earned during a semester are 2x30 = 60. 1. 0-29 insufficient, 2. 30-39 sufficient, 3. 40-49 medium, 4. 50-55 good, 5. 56-60 excellent. Whoever reaches a good or excellent level receives rating recognition.

Required reading:

Tietze, U., Schenk, Electronic Circuits - Handbook for Design and Applications, 2008
J. G. Webster: Electrical Measurement, Signal processing and Displays, 2004

Suggested reading:

E. O. Doeblin: Measurement systems, McGraw-Hill International Editions, 1990.

Course title: GEVAUX1-A Embedded systems and Architectures	**Number of credits: 5**
Name and position of course coordinator: Dr. Vásárhelyi József associate professor	
Suggested semester: spring/autumn	
Weekly lecture + seminar hours: 2 + 2	
Assessment colloquium	
Course webpage:	

Course objectives:

The course give advanced knowledge for the PhD students in embedded system hardware and software theory. Extend the knowledge of the embedded system to design methods and methodologies.

Course content and structure:

Embedded system hardware and software; Embedded system standard and user specified peripherals. Data processing units, signal conditioning with microporocessors, microcontrollers, FPGAs (Field Programmable Gate Arrays), The optimal solution for embedded systems architecture comparison for system integration, Hardware-software co-design methodolgies, System development strategies, Reconfigurable computing in embedded systems, reconfiguration management, Adaptable computing technology.

Evaluation method:

Required reading:

1. Scott Hauck and Andre´ DeHon, Reconfigurable Computing the Theory and Practice of Fpga-based Computation, Elsevier, 2008, pp. 945, ISBN: 978-0-12-370522-8.
2. Labrosse J.J et all: Embedded Software know it all. Newnes, 2008, pp. 770, ISBN: 978-07506-8582-5.
3. Labrosse J.J: MicroC/OS-II The real-time kernel. CMP Books,ISBN: 1-57820-103-9. 2002, pp. 606
4. Larry Pyeatt, Modern Assembly Language Programming with the ARM Processor, ISBN 9780128036983, 2004, pp. 504
5. Andrew Sloss Dominic Symes Chris Wright, ARM System Developer's Guide, ISBN 9781558608740, 2004, pp. 689

Suggested reading:

Louise H. Crockett, Ross A. Elliot, Martin A. Enderwitz, Robert W. Stewart, The Zynq Book, www.zynqbook.com, Department of Electronic and Electrical Engineering, University of Strathclyde, Glasgow, Scotland, UK, 2014, pp. 484

Course title: GEIAL456 Fuzzy Systems	**Number of credits:** 5
Name and position of course coordinator: Szilveszter Kovacs, associate professor	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage: -	

Course objectives:

The main goal of the subject is to give an introduction to the basic concepts of fuzzy sets, fuzzy reasoning and its engineering application.

Course content and structure:

The subject summarizes the basic concepts of fuzzy sets and fuzzy logic. It discusses the main characteristics of fuzzy operations, covering a variety of t-norm and s-norm families. It describes the concept of fuzzy relation and the fuzzy composition. Based on the fuzzy composition, some classical fuzzy reasoning methods are introduced (Zadeh-Mamdani, Takagi-Sugeno). The subject also gives some introduction to the concept of Fuzzy Rule Interpolation and the possible practical application areas of fuzzy systems.

Evaluation method:

The subject is closing with a colloquium. The colloquium has written and oral parts. The written part is a test with short questions. Having more than 50% fulfilled, the exam is continuing with its oral part, which is a short essay on a given subject. The final result is the average of the written and oral parts according to the following evaluation:

89%-100% excellent (5)
76%-88% good (4)
63%-75% average (3)
51%-62% pass (2)
0%-50% inadequate (1)

Required reading:

Lecture slides: www.iit.uni-miskolc.hu/~szkovacs
George J. Klir, Bo Yuan: Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995

Suggested reading:

Michael Negnevitsky: Artificial Intelligence: a guide to intelligent systems, Addision Wesley, 2002, ISBN 0-201-71159-1.
J.-S. R. Jang, C.-T. Sun, E. Mizutani: Neuro-Fuzzy and Soft Computing, Prentice Hall, 1997, ISBN 0-13-261066-3

Course title: Global logistics	**Number of credits: 5**
Name and position of course coordinator: Dr. György Kovács, associate professor	
Suggested semester: spring/autumn	
Weekly lecture + seminar hours: 2 + 0	
Assessment: colloquium	
Course webpage: -	

Course objectives:
Gain knowledge about global logistics tendencies and logistics processes.
Course content and structure:
Global logistics tendencies. Logistical aims. Global manufacturing and service systems (postal service, banks, forwarding, warehousing, industrial parks, logistics centers, etc.) operating in network like structure. Supply Chain conception, goals and advantages of supply chain management. Characteristics of Lean-, Agile- and Leagile Supply Chains. General types of manufacturing activities and service providers. Virtual Enterprise networks. Models and methods for designing and controlling of supply chains. Closed loop economy.
Evaluation method:
Oral exam.
Required reading:
John Mangan, Chandra L. Lalwani: Global Logistics and Supply Chain Management, John Wiley & Sons Ltd., 2016, ISBN 978-111-911782-7 Donald J. Bowersox, David J. Closs, M. Bixby Cooper: Supply Chain Logistics Management, McGraw-Hill International Edition, 2010, ISBN 978-007-127617-7
Suggested reading:
Alan Rushton, Phil Croucher, Peter Baker: The handbook of Logistics and Distribution Management, Replika Press Ltd., 2014, ISBN 978-0-7494-4669-7

Course title: Information Technology of Logistics	**Number of credits:** 5
Name and position of course coordinator: Tamás Bányai PhD, assoc. prof.	
Suggested semester: spring/autumn	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage: n.a.	

Course objectives:

IT and telecommunication in logistics.

Course content and structure:

Identification systems focusing on barcode and RFID. GPS. Intelligent transportation systems. CIM and CAxx technologies. E-business and e-commerce. Enterprise resource planning. How to choose and install an ERP (case study of Oracle). SAP modules. Industry 4.0 technologies. Internet of Things.

Evaluation method:

presentation + oral exam

Required reading:

Proceedings of the 4th International Physical Internet Conference (IPIC 2017), Verlag der Techniche Universität Graz, 2017. ISBN 978-3-85125-531-7

Suggested reading:

Kannan Govindan, T. C. E. Cheng, Nishikant Mishra, Nagesh Shukla (2018) Big data analytics and application for logistics and supply chain management. Transportation Research Part E: Logistics and Transportation Review, 114, 343-349. doi: 10.1016/j.tre.2018.03.011

Angappa Gunasekaran, Nachiappan Subramanian, Thanos Papadopoulos (2017) Information technology for competitive advantage within logistics and supply chains: A review. Transportation Research Part E: Logistics and Transportation Review, 99, 14-33. doi: 10.1016/j.tre.2016.12.008

L. Barreto, A. Amaral, T. Pereira (2017) Industry 4.0 implications in logistics: an overview. Procedia Manufacturing, 13, 1245-1252. doi: 10.1016/j.promfg.2017.09.045

Course title: Logistics of manufacturing systems	**Number of credits: 5**
Name and position of course coordinator: Dr. György Kovács, associate professor	
Suggested semester: spring/autumn	
Weekly lecture + seminar hours: 2 + 0	
Assessment: colloquium	
Course webpage: -	

Course objectives:

Gain knowledge about manufacturing systems and logistics processes to design, operate and control logistics processes.

Course content and structure:

Logistical processes of manufacturing systems. Inbound and outbound logistics. Characteristics of production systems. Make to stock and make to order production processes. General types of production processes (intermittent production, continuous production). Logistical aspects and comparison of project production, job-shop production, batch production, mass production and process production. Component supply of manufacturing processes, stocking strategies. Simulation of manufacturing processes. Performance measurement of production processes, often used key performance indicators. Efficiency improvement methods, case studies.

Evaluation method:

Oral exam.

Required reading:

Peter Nyhuis, Hans-Peter Wiendahl: Fundamentals of Production Logistics - Theory, Tools and Applications, Springer, 2009, ISBN 978-3-540-34211-3
Dethloff, J., Haasis, H., Kopfer, H., Kotzab, H., Schönberger, J. (Ed): Logistics Management - Products, Actors, Technology, Springer, 2015, ISBN 978-3-319-13177-1

Suggested reading:

Alan Rushton, Phil Croucher, Peter Baker: The Handbook of Logistics and Distribution Management, Replika Press Ltd, 2014, ISBN 978-0-7494-4669-7
Donald J. Bowersox, David J. Closs, M. Bixby Cooper: Supply Chain Logistics Management, McGraw-Hill International Edition, 2010, ISBN 978-007-127617-7

Course title: Logistics of Quality Assurance, Product Logistics	**Number of credits:** 5
Name and position of course coordinator: Dr. Péter Telek, associated professor	
Suggested semester: autumn	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage: -	

Course objectives:

Presentation of the relations, effects and cooperation between the quality assurance and logistic systems. Students attended this course gain knowledge on using the quality concept, methods and techniques for logistic systems.

Course content and structure:

Quality requirements of typical logistic systems and their mathematical description. Methods and evaluation procedures for increasing the quality of logistic systems. Effects of the quality assurance system to the logistic system. Methods used for quality control processes of logistic systems. Methods of product identification and tracking in different production processes. Logistic modules of product design and product management.

Evaluation method:

Requirements: fulfil of 2 tests and one project work.
Evaluation so the results:

85-100 points	excellent (5)
70-84 points	good (4)
55-69 points	average (3)
40-54 points	pass (2)
0-39 pointsinadequate (1)	

Required reading:

[1] Rushton, A., Croucher, P., Baker, P. (eds.): The handbook of logistics and distribution management. Kogan Page. London and Philadelphia. 2009.
[2] Langford, J.: Logistics principles and applications. Sole press. London. 2006.

Suggested reading:

[1] Gudehus, Timm, Kotzab, Herbert: Comprehensive Logistics. Springer-Verlag Berlin Heidelberg. 2012.
[2] Fox, M. J.: Quality assurance management. Springer-Science+Business Media B. V. 1993.

	Number of credits: 5

Course title: Modelling of Production Processes**,** GEIAK403	
Name and position of course coordinator: Dr. Samad Dadvandipour	
Suggested semester: both (spring/autumn)	
Weekly lecture + seminar hours: 2+2	
Assessment: Colloquium	
Course webpage: -	

Course objectives:

The course aims at improving the students' theoretical and practical knowledge in modeling and simulation of production processes. In this respect, after reviewing the basic notions related to the topic, mathematical models and methods used in modeling and processing of signals, as well as of processes will be outlined. Analog and digital signal processing techniques used in modeling of time-continuous, of time-discrete and state-discrete production processes, are presented. Fundamental stochastic aspects will also be reviewed.
The analytical methods learned in the theoretical part are to be completed by practical simulation examples. Developing and solving of simulation models in various IT environments (MATLAB-SIMULINK, Plant Simulation, etc.) represent part of the seminar hours and homework.

Course content and structure:

Course content:

1. Basic notions related to the topic: system, signal, model, state, process, production, control. Classification possibilities. Continuous and discrete production systems. Basic methods used in modeling of production systems.
2. Mathematical modeling of signals: Time-domain descriptions. Frequency-domain (spectral) descriptions. Sampling and recovery problems.
3. Modeling of time-continuous, linear dynamic systems: the input-output approach, the state-space approach, the operator approach, the frequency-domain approach. The transfer function: zeros, poles, system parameters, relation with the impulse-response, the step-response, the frequency function.
4. Modeling of time-discrete linear dynamic systems: generating of time-discrete-models from continuous differential equations, time-shift operator representation, z-transform representation, the pulse-transfer function.
5. Modeling of state-discrete dynamic systems: discrete state-space representation. Events and event-driven processes. Batch production processes. The OO approach. Stochastic aspects, basics of the Queueing theory. Production planning and control problems.
6. Other modeling approaches neural networks, Petri-nets, knowledge-based models, introduction to modeling of large-scale systems.

Course structure:

The course follows the principle from simple to complex, from easy to difficult, aiming at convincing students to go deep inside, if necessary.
The theoretical knowledge is completed by practical simulation problems solved in the computer-supported environment during the seminar hours.

Evaluation method:

Written + oral exam:
Written exam:
0-39%: fail
40-54%: pass
55-69%: satisfactory
70-84%: good
85-100%: excellent
Proof of oral examination: At least pass completion of the written examination.

Required reading:

1. Presented materials.
2. ***: Modelling of Dynamic Systems, Textbook. Outcome of TEMPUS S_JEP07759/94 (available at the Library of the Institute of Information Science).
3. Holly Moore: MATLAB for Engineers (www.amazon.com, available also as e-book

Suggested reading:

1. Paulo S.A. Diniz, Eduardo A. B. da Silva, Sergio L. Neto: Digital Signal Processing, Cambridge University Press, 2010
2. Gene Franklin, David Powell, Michael Workman: Digital Control of Dynamic Systems, Addison-Wesley, 1998
3. Guy L. Curry, Richard M. Feldman: Manufacturing Systems Modeling and Analysis (http://www.mescenter.ru/images/abook_file/ManufacturingSystems.pdf
4. Clarence W. de Silva: Modeling of Dynamic Systems with Engineering Applications, CRC Press, 2017

Course title: Nature Inspired Optimization Algorithms, GEIAL 483	**Number of credits: 5**
Name and position of course coordinator: Zsolt Csaba Johanyák, professor	
Suggested semester: autumn	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	

Course webpage:

Course objectives:

The aim of this course is the introduction of the concept of nature inspired optimization algorithms and their practical applications.

Course content and structure:

- Aims of optimization. Evaluation. Constraints.
- Genetic algorithms.
- Particle swarm optimization.
- Ant and bee algorithms.
- Artificial immune system based algorithms.
- Firework algorithm.
- Firefly algorithm.
- Cuckoo algorithm.
- Comparative evaluation of the algorithms.
- Case studies.

Evaluation method:

Students have a written test from the material of the lectures (40%) and they prepare a project where they apply at least two of the studies algorithms (60%). The project assignment may include individual research work as well.

Required reading:

- Jason Brownlee: Clever Algorithms: Nature-Inspired Programming Recipes, 2012, ISBN 978-1-4467-8506-5
- Xin-She Yang: Nature-Inspired Optimization Algorithms, Elsevier, 2014, ISBN 978-0-12-416743-8

Suggested reading:

- Xin-She Yang: Nature-Inspired Metaheuristic Algorithms, Luniver Press, 2010, ISBN 978-1-905986-28-6

Course title: Ontology-based Data Models	**Number of credits: 5**
Name and position of course coordinator: Dr. László Kovács, associate professor	
Suggested semester: autumn	
Weekly lecture + seminar hours: 2+1	
Assessment: colloquium	
Course webpage:	

Course objectives:
The course presents the role of ontology and it shows the related key methods and techniques on ontology modelling, ontology languages and ontology management.
Course content and structure:
Levels of ontology representations; semantic networks, RDF language, triplet-based modelling; SPARQL language; OWL language; OWL modelling; Logic languages, Description logic; DL-based query operations; Reasoning methods, Tableau algorithm, OWL API elements, Ontology editors, Ontology reasoners; Ontology management: database construction; ontology integration; RDF Store Databases; Generating ontology from natural texts; Application of ontology in information systems, IoT Ontology systems.
Evaluation method:
There are two tasks to be completed: oral exam and a paper draft. The topic of the paper related to the application of some ontology methods.
Required reading:
1: Ron Weber : Ontological Foundations of Information Systems 2: Poli, Roberto, Healy, Michael, Kameas : Theory and Applications of Ontology: Computer Applications 3: Robert Arp, Barry Smith and Andrew D. Spear : Building Ontologies with Basic Formal Ontology
Suggested reading:
Martin Hepp, Pieter de Leenheer , Aldo de Moor , York Sure : Ontology Management: Semantic Web, Semantic Web Services, and Business Applications (Semantic Web and Beyond)

Course title: Procurement and Distribution Logistics	**Number of credits:** 5
Name and position of course coordinator: Tamás Bányai PhD, assoc. prof.	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage: n.a.	

Course objectives:
Models of procurement and distribution.
Course content and structure:
Structure of purchasing and distribution solutions. Models and methods of design and operation of procurement and distribution solutions. Information technology and telecommunication in procurement and distribution. Just in time and just in sequence paradigm in purchasing and distribution. Modelling of make or buy decisions. Material flow technology in procurement and distribution related supply chains. Outsourcing in procurement. Evaluation of suppliers. Benchmarking.
Evaluation method:
presentation + oral exam
Required reading:
K. Simchi-Levi, X. Chen, J. Bramel: The logic of logistics. Springer, 1997 W. L. Winston: Operation research – applications and algorithms. Duxbury Press, 1994
Suggested reading:
Thomas E. Johnsen, Joe Miemczyk, Mickey Howard (2017) A systematic literature review of sustainable purchasing and supply research: Theoretical perspectives and opportunities for IMP-based research. Industrial Marketing Management, 61,130-143. doi: 10.1016/j.indmarman.2016.03.003 Deborah Carver, Mickey Parsons (2012) Value-Based Purchasing and Practice Strategies. Perioperative Nursing Clinics, 7(3), 297-303. doi: 10.1016/j.cpen.2012.06.005 Genovaitė Liobikienė, Jurga Bernatonienė (2017) Why determinants of green purchase cannot be treated equally? The case of green cosmetics. Journal of Cleaner Production, 162, 109-120. doi: 10.1016/j.jclepro.2017.05.204

Course title: Production logistics	**Number of credits: 5**
Name and position of course coordinator: Dr. György Kovács, associate professor	
Suggested semester: spring/autumn	
Weekly lecture + seminar hours: 2 + 0	
Assessment: colloquium	
Course webpage: -	

Course objectives:
Gain knowledge about production logistics to design, operate and control production logistics processes.
Course content and structure:
Global logistics tendencies, changes in production philosophies and production processes. Main activities of production logistics. Characteristics and comparison of Push and Pull production concepts. JIT and Kanban production philosophies. 5 principles, main methods and wastes of Lean manufacturing. Models and methods for designing and controlling of production logistics processes. Logistics integrated production planning and scheduling. Computer Integrated Manufacturing (CIM), Computer Integrated Logistics (CIL). Inventory management.
Evaluation method:
Oral exam.
Required reading:
Peter Nyhuis, Hans-Peter Wiendahl: Fundamentals of Production Logistics - Theory, Tools and Applications, Springer, 2009, ISBN 978-3-540-34211-3 Alan Rushton, Phil Croucher, Peter Baker: The handbook of Logistics and Distribution Management, Replika Press Ltd., 2014, ISBN 978-0-7494-4669-7
Suggested reading:
Timm Gudehus, Kotzab Herbert: Comprehensive logistics, Springer, 2009, ISBN 978-3-642-24367-7 David Simchi-Levi, Xin Chen, Julien Bramel: The Logic of Logistics - Theory, Algorithms, and Applications for Logistics Management, Springer, 1997, ISBN 978-1-4684-9309-2

Course title: Production Systems and Processes**,** GEIAK401	**Number of credits: 5**
Name and position of course coordinator: Dr. Samad Dadvandipour	
Suggested semester: both (spring/autumn)	
Weekly lecture + seminar hours: 2+0	
Assessment: Colloquium	
Course webpage: -	

Course objectives:

The course aims at acquainting students with the basic description of production systems. It is necessary to review the basics, as the inventory plays a central role in the production system operation. We are looking for the answers to the question of how the underlying stocks are related to the production system. Students will also gain insight into (to attain more in-depth knowledge) the planning of different production process systems so that they can visualize and analyze aspects of a production process system. They learn what the value-added process, activity analysis, and an organization production process mean.

Course content and structure:

Course content:
During the analysis of an organization's production process, students learn about the concept of the production system through a detailed discussion as the following:
-the market determines the price of the product - the accountants calculate the payment of wholesalers and employees - the Human Resources Department (HR) hire employees to produce the products - the engineers need for production planning, and determination of the materials and components - the wholesalers are for the sale and purchases (materials and components) - the necessary materials and components are stored in the warehouses for a specified period.

In summary, the production system means that resources and procedures convert the raw material into the final product and then the product is handed to the customer (consumer). The production and delivery of a product is a core activity of a factory. Production functions are of value if they can increase their profitability.

Course structure:

The objectives of production; the hierarchy of production planning activities; the components and hierarchy of the system; production activity and information flow; types of production systems; time cycle; managing the flow of the product; the role of the stock; types of stocks; the various costs incurred during the production process; study of production systems based on models; systems and models.
Theoretical knowledge is supported by the practical analysis of the value table of a company (oil company).

Evaluation method:

Written + oral exam:
Written exam:
0-39%: fail
40-54%: pass
55-69%: satisfactory
70-84%: good
85-100%: excellent
Proof of oral examination: At least pass completion of the written examination.

Required reading:

1. Presented materials.
2. The European e-Business Report 2008 6th Synthesis Report of the Sectorial e-Business Watch Executive Summary.
3.http://ec.europa.eu/enterprise/archives/e-business-watch/key_reports/documents/EBR08_ExecSum_EN.pdf.

Suggested reading:

1. Li, Jingshan; Semyon, M. Meerkov 2009. *Production Systems Engineering.* Springer.

2. Bellgran, Monica, Säfsten, Eva Kristina 2010. *Production Development. Design and Operation of Production Systems*. Springer. https://www.springer.com/gp/book/9781848824942.

3. Ulrich, Karl T.; Eppinger, Steven D. (2000). Product Design and Development (Second ed.). Boston: Irwin McGraw-Hill.

4. Graeme Arthur Britton, Seppo Torvinen, June 23, 2018 , Design Synthesis: Integrated Product and Manufacturing System Design, 380 Pages, ISBN 9781138073746 - CAT# K33937

Course title: Recycling Logistics	**Number of credits:** 5
Name and position of course coordinator: Tamás Bányai PhD, assoc. prof.	
Suggested semester: spring/autumn	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage: n.a.	

Course objectives:
Impact of environmental protection, energy efficiency and closed loop economy on logistic systems and processes.
Course content and structure:
Sustainability. Closed loop economy. Design of collection systems for recycling technologies. Energy efficiency in design of supply chain solutions, focusing on first mile and last mile logistics. Recycling technologies, focusing on shredding and disassembly and their logistics.
Evaluation method:
presentation + exam
Required reading:
H. L. Fund: Recycling Handbook. McGraw-Hill, 2001 B. Mang et al.: Business for better environment. Final presentation of EUREKA CLEANTECH project. Bochum. 1997. 15.
Suggested reading:
Kannan Govindan, Marina Bouzon (2018) From a literature review to a multi-perspective framework for reverse logistics barriers and drivers. Journal of Cleaner Production, 187, 318-337. doi: 10.1016/j.jclepro.2018.03.040 Md Tasbirul Islam, Nazmul Huda (2018) Reverse logistics and closed-loop supply chain of Waste Electrical and Electronic Equipment (WEEE)/E-waste: A comprehensive literature review. Resources, Conservation and Recycling, 137, 48-75. doi: 10.1016/j.resconrec.2018.05.026 Tsai-Yun Liao (2018) Reverse logistics network design for product recovery and remanufacturing. Applied Mathematical Modelling, 60, 145-163. doi: 10.1016/j.apm.2018.03.003

Course title: Selected topics in Operating Systems, GEIAL403	**Number of credits:** 5
Name and position of course coordinator: David Vincze, associate professor	
Suggested semester: spring	
Weekly lecture + seminar hours: 2	
Assessment: colloquium	
Course webpage: -	

Course objectives:
In depth study of various operating system related topics
Course content and structure:
Process synchronization – background. Starvation and efficiency. Deadlock problems. Requirements of deadlocks. Avoiding deadlocks. Virtual memory handling. Hardware support for virtual memory handling. Paging based systems.
Evaluation method:
oral exam
Required reading:
A. Silberschatz, P. B. Galvin: Operating Systems Concepts, Addison-Wesley, 1994
Suggested reading:
M. Maekawa, A.E. Oldehoeft, R.R. Oldehoeft: Operating Systems, Advanced Concepts, The Benjamin/Cummings Publishing Comp, 1987

Course title: Service logistics	**Number of credits:** 5
Name and position of course coordinator: Dr. Péter Telek, associated professor	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage: -	

Course objectives:

Presentation of the operation, planning and control of service logistic systems. Students attended this course gain knowledge on planning and operation of service logistic systems and able to analyse their elements.

Course content and structure:

Variations of service logistic tasks, their planning and control methods and models. Typical models of service logistic processes. Questions of commercial logistics. Characteristic tasks of postal, airport, bank, medical- and healthcare-centres and communal waste services. Information systems and automation possibilities of service logistic processes. Optimisation of the parameters of transport, storing and loading systems.

Evaluation method:

Requirements: fulfil of 2 tests and one project work.
Evaluation so the results:

85-100 points	excellent (5)
70-84 points	good (4)
55-69 points	average (3)
40-54 points	pass (2)
0-39 pointsinadequate (1)	

Required reading:

[3] Rushton, A., Croucher, P., Baker, P. (eds.): The handbook of logistics and distribution management. Kogan Page. London and Philadelphia. 2009.
[4] Gudehus, Timm, Kotzab, Herbert: Comprehensive Logistics. Springer-Verlag Berlin Heidelberg. 2012.

Suggested reading:

[3] Wing, G. M.: An introduction to transport theory. John Wiley & sons. New York-London. 1962
[4] Taniguchi, E., Thompson, R. G., Yamada, T., van Duin, R.: City logistics. Emerald. London. 2008

Course title: Software Defined Networking, GEIAL 482	**Number of credits: 5**
Name and position of course coordinator: Zsolt Csaba Johanyák, professor	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage:	

Course objectives:

The aim of this course is the introduction of the concept of software defined networking and how it is changing the way communications networks are managed, maintained, and secured.

Course content and structure:

- History, concepts structure, centralized and distributed data planes.
- The OpenFlow protocol.
- SDN controllers.
- Network Virtualization
- Operating systems
- Language based Virtualization.
- SDN Programming.
- Pyretic Language
- Security.

Evaluation method:

Students have a written test from the material of the lectures (40%) and they write an essay on a topic given by the instructor (60%), which may include individual research work as well.

Required reading:

Thomas D. Nadeau and Ken Gray: SDN: Software Defined Networks, O'Reilly Media, 2013, ISBN 978-1-449-34230-2

Suggested reading:

Paul Goransson and Chuck Black: Software Defined Networks: A Comprehensive Approach, Elsevier, 2014, ISBN 978-0124166752

Course title: Speech Information Systems	**Number of credits: 5**
Name and position of course coordinator: László Czap Phd,	
Suggested semester: autumn	
Weekly lecture + seminar hours: 2 + 2	
Assessment: colloquium	

Course objectives:

The aim of the program is the preparation of specialists that are capable of participating in research and project works in the field of speech information technologies with specialization in speech recognition and synthesis, visual speech processing, multimodal HMI systems, in the design and development of information systems.

Course content and structure:

Voiced, unvoiced sounds, pitch, intensity, formants, speech production, vocal tract, vocal cord, phonemes, manner and place of articulation, co-articulation, linear prediction, mel-cepstrum, spectrograms, speech coding, speech enhancement, speech recognition, acoustic modelling, time/pitch scale modification, speech synthesis, audio-visual speech processing, human auditory system, speech perception, speech quality measures

Evaluation method:

Oral exam

Required reading:

Rabiner, Schafer: An Introduction to Digital Speech Processing, ISBN 978-1601980700
Benesty, Sondhi and Huang, Ed.: Springer Handbook of Speech Processing and Speech Communication, ISBN 978-3-662-53300-0
Parke, Waters: Computer Facial Animation, ISBN 9781568814483

Suggested reading:

A. Nejat Ince (Ed.): Digital Speech Processing: Speech Coding, Synthesis and Recognition, Springer, ISBN 978-1441951281
Granström, House, Karlsson: Multimodality in Language and Speech Systems, ISBN 9789401723671

Course title: GEVAUX2 System on chip modelling and design methods	**Number of credits: 5**
Name and position of course coordinator: Dr. Vásárhelyi József associate professor	
Suggested semester: spring/autumn	
Weekly lecture + seminar hours: 2	
Assessment: colloquium	
Course webpage:	

Course objectives:

The course give advanced knowledge for the PhD students in System on Chip modelling, simulation and design with different methods.

Course content and structure:

ARM and RISC V. architectures, Soft and hard processors for SOC, System modelling and simulation with hardware description languages, High level modelling, Simics processor modelling and simultation. ARM SOC with M0 core system design.

Evaluation method:

Required reading:

1. Ben Cohen, VHDL Answers to Frequently Asked Questions, Springer Science+Business Media, LLC, ISBN 978-1-4613-7581-4, 1994, pp. 400
2. Pong Chu, RTL Hardware Design Using VHDL, Coding for Efficiency, Portability, and Scalability, John Wiley and Sons, ISBN 978-0-471-72092-8, 2006, pp. 696
3.
4.
5.

Suggested reading:

Louise H. Crockett, Ross A. Elliot, Martin A. Enderwitz, Robert W. Stewart, The Zynq Book, www.zynqbook.com, Department of Electronic and Electrical Engineering, University of Strathclyde, Glasgow, Scotland, UK, 2014, pp. 484

Course title: Telecommunication in Control Engineering, GEVAU415	**Number of credits:** 5
Name and position of course coordinator: Attila Károly Varga Phd	
Suggested semester: spring	
Weekly lecture + seminar hours: 2 + 2	
Assessment: colloquium	

Course objectives:

The aim of the program is to prepare specialists who are capable of participating in research and project works in the field of telecommunication in control engineering with special regard to the microwave transmission technology, wired and wireless telecommunication standards, remote data transmission, remote alarm, remote programming and monitoring systems used in control engineering-

Course content and structure:

Integration of telecommunications into control engineering. Introduction to Microwave Transmission Technique. Wired and wireless telecommunication systems. GSM point-to-point communication and GSM protocol. OPC control system and GSM connectivity, automated generation of SMS messages. Wireless LAN networks: WATM and mobile networks. WAP architecture and WAP protocols: WML, WTP, WDP. WAP based mobile Internet access and service model. Security of WAP Transmission. Connect Fixed (Wired) and Mobile (Wireless) Networks and Client-Server-Based Servicing. Connecting OPC and WAP. Control technology through mobile Internet: remote data transmission, remote alarm, remote programming, remote monitoring, image transfer, etc. Controls combined with a satellite communication system, GPS control applications.

Evaluation method:

Oral exam

Required reading:

Isidori, A., van Schuppen, J.H., Sontag, E.D., Krstic, M.: Communications and Control Engineering, ISSN: 0178-5354
Rajesh Singh, Sushabhan Choudhury, Anita Gehlot (Ed.): Intelligent Communication, Control and Devices, ISBN 978-981-10-5902-5

Suggested reading:

Sophie Tarbouriech, Chaouki T. Abdallah, John Chiasson (Ed.): Advances in Communication Control Networks, ISBN 3-540-22819-5
R.R. Tewari, Abhay Kumar Rai: Advances in Computing, Control and Communication Technology, ISBN 978-9385926204
S.M. Muyeen , Saifur Rahman (Ed.): Communication, Control and Security Challenges for the Smart Grid, ISBN 9781785611438

Course title: Theory of Logistics Systems	**Number of credits:** 5
Name and position of course coordinator: Dr. Péter Telek, associated professor	
Suggested semester: spring	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage: -	

Course objectives:

Presentation of the principles, operation, planning and control of logistic systems. Students attended this course gain knowledge on planning and operation of logistic systems and able to analyse different material-flow processes.

Course content and structure:

Structures and parameters of logistic systems. Mathematical description of events and activities occurring in logistic systems. Characterisations of material-flow systems. Automation of the elements of material-flow systems. Information systems of logistic processes. Principles of the design and control of supplying, distribution and production logistic systems. Logistic tasks of recycling processes and the closed-loop economy. Principles of service logistics. Mathematical description of the supply chain of logistics networks. Models of virtual logistic companies.

Evaluation method:

Requirements: fulfil of 2 tests and one project work.
Evaluation so the results:

85-100 points	excellent (5)
70-84 points	good (4)
55-69 points	average (3)
40-54 points	pass (2)
0-39 pointsinadequate (1)	

Required reading:

[5] Rushton, A., Croucher, P., Baker, P. (eds.): The handbook of logistics and distribution management. Kogan Page. London and Philadelphia. 2009.
[6] Gudehus, Timm, Kotzab, Herbert: Comprehensive Logistics. Springer-Verlag Berlin Heidelberg. 2012.

Suggested reading:

[5] Zheng, L., Possel-Dölken, F.: Strategic production networks. Springer-Verlag Berlin Heidelberg. 2002.
[6] Wing, G. M.: An introduction to transport theory. John Wiley & sons. New York-London. 1962

Course title: Theory of Material Flow Systems	**Number of credits:** 5
Name and position of course coordinator: Tamás Bányai PhD, assoc. prof.	
Suggested semester: autumn	
Weekly lecture + seminar hours: 2+0	
Assessment: colloquium	
Course webpage: n.a.	

Course objectives:

Mathematical models and methods to optimize in-plant logistic and external supply chain solutions.

Course content and structure:

Mathematical description of material flow. Evaluation methods of material flow systems. Basic facility location problems: single and multi-facility placement problems. Location analysis. Loading unit building concept. Route planning methods. Equipment selection. Simulation of material handling systems. Supermarket design. Design of just-in-time and just-in-sequence supply. Design of milkrun based in-plant supply. Heuristics in design of large scale systems.

Evaluation method:

presentation + exam

Required reading:

K. Simchi-Levi, X. Chen, J. Bramel: The logic of logistics. Springer, 1997
D. R. Sule: Manufacturing Facilities – location, planning and design. PWS-KENT, Boston, 1988.
W. L. Winston: Operation research – applications and algorithms. Duxbury Press, 1994

Suggested reading:

J. M. Apple: Material handling system design, J. Wiley and Sons, 1977.
Bányai, T., Telek, P., Landschützer, C. (2018) Milkrun based in-plant supply – An automotive approach. Lecture Notes in Mechanical Engineering, F12, 170-185.
Bányai, Á., Bányai, T., Illés, B. (2017) Optimization of consignment-store-based supply chain with black hole algorithm. Complexity, 2017, art. no. 6038973.
Bányai, T., Bányai, A. (2017) Modelling of just-in-sequence supply of manufacturing processes. MATEC Web of Conferences, 112, art. no. 06025.
Bányai, T. (2017) Supply chain optimization of outsourced blending technologies. Journal of Applied Economic Sciences, 12 (4), 960-976.
Bányai, T. (2009) Optimisation of U-shaped flexible manufacturing cells. Annals of DAAAM and Proceedings of the International DAAAM Symposium, 761-762.