Course Description

Advanced Mathematics A (I)
Course code: 130701X1
Date of completion: 20.01.2016
Local credits: 5.0
ECTS: 7.5
Hours: 80
Description: functions, graphs, exponentials and logarithms, trigonometric formulas, limits, rates of change, tangent, continuity and discontinuity; the derivative and its properties, high-order derivatives, implicit differentiation, approximations, error estimation, extreme values, the mean value theorem, Taylor and Maclaurin expansion, L'Hospital's rule, principles of differential and its applications, Newton's method; Riemann sums, the definite integral, the indefinite integral, the fundamental theorem of calculus, integration by substitution, integration by parts, integrating rational and irrational functions, geometric applications of integrals, area between curves, volumes by shells, initial-value problems, improper integrals; infinite sequences, alternating series, convergence and divergence tests (limit comparison and alternating series tests), power series and interval of convergence, Taylor series and applications, Fourier series.

Advanced Mathematics A (II)
Course code: 130701X2
Date of completion: 15.07.2016
Local credits: 5.0
ECTS: 7.5
Hours: 80
Description: this course is a rigorous introduction to multivariable calculus, and its key contents are: partial derivatives, directional derivative, gradient, the multivariable chain rule, Jacobian matrix and determinant, the implicit function theorem, Taylor's Formula, the method of Lagrange multipliers; double and triple integrals, multiple integrals, iterated integrals, curvilinear integrals, surface integrals, Green formula, Gauss formula, Stokes formula; vector algebra, dot product and vector product, vector spaces, space analytic geometry, vector analysis with applications to vector potentials, conservative vector fields, physical interpretations; ordinary differential equations, integrable systems, linear differential equations with constant coefficients, second-order linear differential equations, Laplace transforms, Bernoulli differential equations, Euler's ordinary differential equations.

Linear Algebra A
Course code: 130703X1
Date of completion: 15.07.2016
Local credits: 2.0

ECTS: 3.0
Hours: 32
Description: algebraic properties of matrices and their interpretation in geometric terms. The relationship between the algebraic and geometric points of view and matters fundamental to the study and solution of linear equations. Applications of Linear Algebra in science and engineering. Key contents of this course are: matrices, determinants, Cramer's rule, complex matrices, Adjugate matrices, inverse matrices; vectors, vector spaces, inner product space, vector geometry, eigenvectors, eigenvalues, projections, linear dependence, bases, change of basis, coordinate systems, linear transformations, similarity; linear equations, Gaussian elimination, matrix algebra; orthogonality, Gram–Schmidt process, diagonalization of matrices, Jordan normal form, spectral theorem; quadratic forms, Hurwitz's theorem.

Discrete Mathematics
Course code: 090401X1
Date of completion: 20.01.2017
Local credits: 3.0
ECTS: 4.5
Hours: 48
Description: propositional logic, fundamental concepts of mathematics including definitions, formal logic notation, predicates, quantifiers, rules of inference, proof methods, mathematical induction, recursion, well-ordering; sets, set operations, relations, equivalence relations, set-theoretical operations, bijections, injections, surjections, infinite sets, cardinal numbers; relations and their properties, representing relations, closures of relations, equivalence relations, partial ordering; counting, the pigeonhole principle, binomial coefficient and identities, basic enumeration (permutations and combinations), recurrences, generating functions, the principle of inclusion-exclusion; algebra, homomorphism, congruence, group theory, order of group elements, cyclic groups, subgroups, cosets, the theorem of Lagrange, the symmetric group, rings and fields, applications to combinatorics; Boolean algebra; graph theory, basic notions, representations of graphs, connectivity, paths and cycles, matchings, planar graphs, Eulerian graphs, Hamiltonian graphs, bipartite graphs, shortest-path problems, graph coloring, Kuratowski's theorem, Euler's polyhedron formula, conditions for hamiltonicity, trees, tree traversal, decision trees, spanning trees, matrix-tree theorem; finite-state machines.

Probability and Statistics A
Course code: 130704X1
Date of completion: 20.01.2017
Local credits: 3.5
ECTS: 5.25
Hours: 56

Description: counting, independent events, conditioning and independence, expectation and variance, discrete and continuous random variables and distributions, joint distributions and dependence, the law of total probability, Bayes' theorem, normal distributions, binomial distributions, Poisson distributions; multivariate random variables, marginal distributions, conditional distributions; Chebyshev's inequality, the central limit theorem, the laws of large numbers; estimation theory, point estimation, maximum likelihood estimation, confidence intervals; statistical hypothesis testing; linear regression, the method of least squares.

Object-Oriented Programming (C++)
Course code: 090498X1
Date of completion: 15.07.2016
Local credits: 3
ECTS: 4.5
Hours: 48
Description: syntax of programming language C++; arrays, pointers, and strings, collections; functions, function overloading, reference parameters, interfaces and implementations, principles of interface design; classes and objects, constructors and destructors, combination of classes; UML class diagrams; encapsulation; scope and visibility of identifiers, lifetime of objects, static members, friend classes, protecting shared data; inheritance, superclasses, subclasses, inheritance hierarchies, access control, type compatible rule; polymorphism, operator overloading, virtual functions, abstract classes; principles of data abstraction and modularity; introduction to generic programming and STL; formatted output and input, the I/O stream; exception handling.

Advanced Programming practice
Course code: 090499X1
Date of completion: 15.07.2016
Local credits: 2
ECTS: 3
Hours: 32
Description: this course contains the practical project of the Object-Oriented Programming (C++) course.

Java Language and System Design
Course code: 090405X1
Date of completion: 20.01.2017
Local credits: 3
ECTS: 4.5
Hours: 48
Description: syntax of Java, characteristics of Java, Java API packages; objects and

classes, visibility modifiers, data field encapsulation, composition, enumerations, garbage collection; superclasses and subclasses, constructors in subclasses, overriding methods; polymorphism, extensibility, abstract classes and methods, concrete classes; object-oriented design with the UML; exception handling, exception types, chained exceptions; GUI basics; files, streams and object serialization; Java collections, hash maps, linked hash sets and maps; generic programming; multithreading, life cycle of a thread, thread scheduling; networking, client/server interaction with stream socket connections; accessing databases with JDBC; introduction to system design (decomposing the system), object design, specification inheritance and implementation inheritance; MVC and Swing models; introduction to Design Patterns.

Course Design of Java
Course code: 090607Z1
Date of completion: 20.01.2018
Local credits: 2
ECTS: 3
Hours: 32
Description: this course contains the practical project of the Java Language and System Design course.

Database Principle
Course code: 090408Z1
Date of completion: 15.07.2017
Local credits: 3
ECTS: 4.5
Hours: 48
Description: the relational model, relations, keys, schema diagrams, relational operations, structure of relational databases, relational query languages, relational operations; data storage and querying, Structured Query Language, transactions, integrity constraints, SQL data types and schemas, joint expression, views, triggers, functions, procedures; the relational algebra, the tuple relational calculus, the domain relational calculus; atomic domains and first normal form, decomposition using functional dependencies, functional-dependency theory.

Large Database Technologies
Course code: 090404Z1
Date of completion: 20.01.2018
Local credits: 3
ECTS: 4.5
Hours: 48
Description: using Oracle Database to store and analyze large-scale data; accessing

SQL from a programming language; query optimization; transaction concept, concurrency control; data modeling and the entity-relationship model, requirements analysis, entry-relationship diagrams; database design, transforming a data model into a database design, representing entities with the relational model; database administration, concurrency control, cursor types, database security, database backup and recovery.

Integrated Course Design of Database
Course code: 090430Z1
Date of completion: 15.07.2018
Local credits: 2
ECTS: 3
Hours: 32
Description: this course contains the practical project of the Database Principle course.

Principle of Operating System
Course code: 090410Z1
Date of completion: 15.07.2017
Local credits: 3
ECTS: 4.5
Hours: 48
Description: system calls, operating system structures; process and threads, process states, interprocess communication, scheduling; principles of concurrency, semaphores, message passing, reader/writers problem; address spaces, memory organization and management, virtual memory, paging systems, page replacement algorithms (including FIFO, LRU, OPT, NUR, LFU); file systems, file organization, file directories, single-level directory systems, hierarchical directory systems, secondary storage, file system management; principles of I/O hardware and software, I/O buffering, disks, disk scheduling, clocks, user interfaces, power management; resources, introduction to deadlock detection, recovery, and prevention, dining philosophers problem; basics of operating system security.

Operating System Course Design
Course code: 090427Z1
Date of completion: 15.07.2018
Local credits: 2
ECTS: 3
Hours: 32
Description: this course contains the practical project of the Principle of Operating System course.

Computer Network
Course code: 090502Z1
Date of completion: 15.07.2017
Local credits: 3
ECTS: 4.5
Hours: 48
Description: application-layer protocols, HTTP, FTP, SMTP, DNS, socket programming; multiplexing and demultiplexing, UDP segment structure, principles of reliable data transfer (Go-back-N, Selective Repeat), the TCP connection, flow control, approaches to congestion control; forwarding and routing, virtual circuit and datagram networks, the Internet Protocol (IPv4 and IPv6), Internet Control Message Protocol, routing algorithms including the Link-State routing algorithm and the Distance-Vector routing algorithm, RIP, OSPF, BGP, broadcast and multicast routing; the link layer, error-detection and error-correction techniques, multiple access protocols, LANs, link-layer addressing, Ethernet, switches; wireless networks, CDMA, cellular Internet access; multimedia networking applications, streaming video and audio; network security.

Data Structure
Course code: 090402X1
Date of completion: 20.01.2017
Local credits: 5.25
ECTS: 3.5
Hours: 56
Description: the big O, big omega and theta notations, empirical estimates of complexity, amortized analysis; lists; stacks; arrays; queues, heaps; data structures for integers and strings, string-matching algorithms, especially the KMP algorithm; trees (including binary trees, Huffman trees, forests, Splay trees, B-Trees, red/black trees, 2-3 trees), tree traversals; graphs (undirected graphs, directed graphs, directed acyclic graphs, biconnectivity, Euler circuits, connected components), graph search algorithms (DFS and BFS), minimum spanning trees, the shortest path problem; sets, dictionaries, maps, hash tables; insertion sort, shellsort, heapsort, mergesort, quicksort, bucket sort and radix sort; techniques in the design, analysis, and implementation of data structures.

Data Structure Course Design
Course code: 090413X1
Date of completion: 20.01.2018
Local credits: 2
ECTS: 3
Hours: 32
Description: this course contains the practical project of the Data Structure course.

Algorithm Analysis and Design
Course code: 090409Z1
Date of completion: 15.07.2017
Local credits: 3
ECTS: 4.5
Hours: 48
Description: running time calculations, space complexity, measuring an input's size, orders of growth, worst-case, best-case, average-case efficiencies, logarithms, exponents, recapitulation of the analysis framework, asymptotic computational complexity, recurrences, proving an algorithm's correctness; algorithms for searching, sorting, and selection, tree algorithms, mathematical analysis of non-recursive algorithms and recursive algorithms; brute force and exhaustive search including selection sort, sequential search, brute-force string matching, closest-pair and convex-hull problems, depth-first search, breadth-first search; decrease-and-conquer, insertion sort, topological sorting, generating combinatorial objects, decrease-by-a-constant-factor algorithms, variable-size-decrease algorithms; divide-and-conquer, mergesort, quicksort, binary tree traversals; transform-and-conquer, balanced search trees (AVL trees and 2-3 trees), Gaussian elimination, heapsort, Horner's rule, problem reduction; space and time trade-offs, hashing, B-trees; dynamic programming, the knapsack problem, optimal binary search tree, Warshell's and Floyd's algorithm, optimal binary search tree, all-pairs shortest path, maximum subsequence sum problem; greedy algorithm, Prim's algorithm, Kruskal's algorithm, Dijkstra's algorithm, Huffman trees and codes; P, NP, and NP-complete problems, undecidable problems, reduction, lower-bound arguments; backtracking algorithms, branch-and-bound, approximation algorithms.

Computer Principle and Assembly Language
Course code: 090407Z1
Date of completion: 15.07.2017
Local credits: 4
ECTS: 6
Hours: 64
Description: computer components, bus interconnection, PCI; I/O modules, external devices; arithmetic and logic unit, integer and floating-point representation; machine instruction characteristics, types of operands, x86 operands and operations; addressing modes of instruction sets, instruction formats; processor, register, the instruction cycle, instruction pipelining, parallelism via instructions; memory technologies, cache memory principles, multilevel memory hierarchy, virtual machines, virtual memory; introduction to multiple processors, multicore organization. Data representation, Boolean operations, instruction execution cycle, x86 processor architecture, modes of operation; basic elements of assembly language, assembling, linking, and running

programs, intrinsic data types, data definition statement, symbolic constants; data transfer, operand types, instructions about addition and subtractions; defining and using procedures, stack operations; comparison instructions, conditional jumps, conditional loop instructions; macros; floating-point binary representation.

Course Design of Computer Principle and Assembly Language
Course code: 090411X1
Date of completion: 15.07.2017
Local credits: 2
ECTS: 3
Hours: 32
Description: this course contains the practical project of the Computer Principle and Assembly Language course.

Distributed Systems
Course code: 090424Z1
Date of completion: 15.07.2018
Local credits: 2
ECTS: 3
Hours: 32
Description: system models of distributed systems; remote invocation, request-reply communication, the remote procedure call and the remote method invocation approaches; group communication, publish-subscribe systems, shared memory approaches; distributed objects, components; Napster and its legacy, peer-to-peer middleware, routing overlays; security techniques used in distributed systems; distributed file systems, file service architecture; clocks, events, process states, logical time and logical clocks, global states; distributed mutual exclusion, elections, coordination and agreement in group communication; transactions, locks, concurrency control, timestamp ordering, flat and nested distributed transactions, atomic commit protocols, distributed deadlocks, transaction recovery.

Introduction to Parallel Computing
Course code: 090420Z1
Date of completion: 15.07.2018
Local credits: 2
ECTS: 3
Hours: 32
Description: the von Neumann architecture, fast networks, multicore, vector instruction sets, multithreading, multitasking, serial systems, instruction-level parallelism; parallel hardware, single instruction, single data (SISD) systems, single instruction, multiple data (SIMD) systems, multiple instruction, multiple data (MIMD)

systems, cache coherence; parallel software, load balance, communication, and synchronization among processes and threads, coordinating the processes/threads, shared-memory and distributed-memory programs, race condition, Message-passing interface (MPI); input and output; performance and efficiency, Amdahl's law, scalability; distributed-memory programming with MPI; shared-memory programming with OpenMP.

Digital Image Processing
Course code: 090417Z1
Date of completion: 20.01.2018
Local credits: 2
ECTS: 3
Hours: 32
Description: image sampling and quantization, relationships between pixels; basic intensity transformations, histogram processing, fundamentals of spatial filtering, spatial correlation and convolution, smoothing and sharpening spatial filters, the Laplacian, the gradient, fuzzy techniques; Fourier series and transform, the Fourier transform of sampled functions, the discrete Fourier transform, the basics of filtering in the frequency domain, image soothing and sharpening using frequency domain filters; spatial and frequency properties of noise, image denoising, image restoration and reconstruction; color models, pseudocolor and full-color image processing, image segmentation based on color; multiresolution expansions, wavelet transforms; erosion and dilation, opening and closing, basic morphological algorithms, gray-scale morphology; point, line, and edge detection; thresholding (especially Otsu's method), region-based segmentation.

Artificial Intelligence
Course code: 090702X1
Date of completion: 15.07.2017
Local credits: 2
ECTS: 3
Hours: 32
Description: the propositional calculus, the predicate calculus; strategies for state space search, representing reasoning with the predicate calculus; heuristic search, dynamic programming, the best-first search algorithm; stochastic methods, the Baye's theorem; recursion-based search; knowledge representation, conceptual graphs, alternative representations and ontologies, agent based and distributed problem solving; rule-based expert systems, fundamental characteristics of an expert system, frame-based expert systems; the stochastic approach to uncertainty; introduction to artificial neural networks; genetic algorithms, evolution strategies; fundamentals of machine learning, knowledge and learning, unsupervised learning, reinforcement learning.

*1 credit=1.5 ECTS