

Course Title	Advanced Mathematics (B) (1)
Semester	14-15/1
Credits	5
Description	functions, sequence, limits, continuity, derivative, differential, indefinite integral and definite integral of one variable; vector, coordinates, space line and plane equation, two surface classification; ordinary differential equations and elementary solutions.
Literature	Advanced Mathematics (B), Peking University Publishing House, by Zhong Li and Jianyin Zhou; Mathematical Analysis, by Zorich Godement.

Course Title	Linear Algebra (B)
Semester	14-15/1
Credits	4
Description	linear systems of equations, vectors and matrices, norms and scalar products, LU decomposition, vector spaces, linear transformations, eigenvalues and eigenvectors; bilinear function and quadratic form;
Literature	Linear Algebra (Fourth Edition). by Stephen H Fiedberg, Arnold J Insel and Lawrence E Spence.

Course Title	Linear Algebra (B)
Semester	14-15/1
Credits	4

Description	linear systems of equations, vectors and matrices, norms and scalar products, LU decomposition, vector spaces, linear transformations, eigenvalues and eigenvectors; bilinear function and quadratic form;
Literature	Linear Algebra (Fourth Edition). by Stephen H Fiedberg, Arnold J Insel and Lawrence E Spence.

Course Title	Mechanics
Semester	14-15/1
Credits	4
Description	kinematics, dynamic of a particle, non-inertial reference frame, momentum, moment of momentum, work and energy, conservative force field, oscillations, waves, relativistic space-time structure.
Literature	Mechanics, Peking University Publishing House, by Yousheng Shu

Course Title	Introduction to Computation (A)
Semester	14-15/1
Credits	3
Description	concept of computation: history of computers and the classification of computers, computer fundamentals, computer software and hardware system, information representation and storage, network, internet and security. Programming: fundamental types, control statements, algebra and arrays in C/C++; data organization, filtering and sort algorithm; the usage of function; the usage of pointer; stream and file; greedy algorithm and dynamic programming; structure and link.

Literature	C++ How to Program, by Paul Deitel and Harvey Deitel; The Fundamentals of Programming, Tsinghua University Publishing House, by Wenhui Wu and Mingxing Xu
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Course Title	Practice of Programming in C&C++
Semester	14-15/2
Credits	3
Description	basic problem solving methods, algorithms and advanced features of C++: Date processing and Base conversion, function pointer, high precision computation, string manipulation, linked lists, enumeration, recursion, search, dynamic programming; class and objects, inheritance, operator overloading, polymorphism and virtual function, flow and file I/O, standard template library
Literature	C++ How to Program, by Paul Deitel and Harvey Deitel.

Course Title	Advanced Mathematics (B) (2)
Semester	14-15/2
Credits	5
Description	limits, continuity, differential, partial derivative of vector and chain rule; implicit functions, inverse function theorem and minimal with constraints; double integral, vector fields, differential forms, path integrals, surface integrals, divergence theorem, Stokes' theorem; series, power series and Taylor series; Generalized integral and parametric variable integral; Triangle function, Fourier expansion and Fourier series
Literature	Advanced Mathematics (B), Peking University Publishing House, by Zhong Li and Jianyin Zhou; Mathematical Analysis, by Zorich Godement,

Course Title	Electromagnetism
Semester	14-15/2
Credits	4
Description	Basic electromagnetic phenomena, electrostatics, current field, magnetostatics and electromagnetic induction, dielectric, magnetic medium, electromagnetic field and wave, Maxwell's equation, Linear circuit and alternating current.
Literature	Electromagnetism, Peking University Publishing House

Course Title	Thermal Physics
Semester	14-15/2
Credits	3
Description	Basic conceptions and basic methods in thermal physics: thermodynamic statistics, equilibrium, the Maxwell distribution, the Boltzmann distribution, transport process, work and heat, laws of thermodynamics, Carnot theorem, absolute temperature, entropy, ideal gas, free energy, thermodynamic potentials, state of materials, phase transitions, multicomponent systems;
Literature	An Introduction to Thermal Physics, by Daniel V.Schroeder.

Course Title	Advanced Algebra (II)
Semester	14-15/2
Credits	4

Description	Euclidean space, orthogonal and symmetric transformation; unitary space and unitary transform; Jordan canonical form and minimal polynomial; the fundamental theorem of arithmetic, congruence, Euler function and theorem, Fermat theorem, the Chinese remainder theorem; Mod m residue class ring, finite field; polynomial rings, factorization, discriminant, resultant; multiple linear mapping, tensor
Literature	Advance Algebra, Peking University Publishing House, by Yizhong Lan; A First Course in Abstract Algebra (3rd Edition), by Joseph J. Rotman.

Course Title	Data Structure and Algorithm (A)
Semester	15-16/1
Credits	3
Description	Linear lists, stacks and queues, binary trees, trees and forests, graphs, internal sorting, file processing and external sorting, searching, indexing, advanced topics on data structures With online judge: http://dsa.openjudge.cn/
Literature	Introduction to Algorithms, by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein.

Course Title	Introduction to Computer Systems
Semester	15-16/1
Credits	5
Description	representing and manipulating Information, machine-level representation of programs, processor architecture, optimizing program performance, memory hierarchy, linking, exceptional and control flow, virtual memory, system-level I/O, network programming, concurrent programming

Literature	Computer Systems:A Programmer's Perspective, by Randal E. Bryant and David R. O'Hallaron.
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Course Title	Practice of Data Structure and Algorithm
Semester	15-16/1
Credits	3
Description	programming style, object-oriented techniques, interface principles, software engineering, project management. basic algorithms and enumeration, problem modelling, backtracking, greedy algorithm, divide and conquer, dynamic programming, problem modelling. string indexing (suffix trees, suffix arrays), search trees (balance trees, RB trees, splay trees), treaps, range queries (range trees), spatial data structures(kd trees), bipartite graph matching
Literature	Advanced Data Structures, by Peter Brass.

Course Title	Set Theory and Graph Theory
Semester	15-16/1
Credits	3
Description	Sets, relations , closures, equivalences, functions, orderings, nature numbers, cardinalities and (un-)countability; Basics, trees, paths , cycles, connectivity, Eulerian graphs, Hamilton graphs, incidence matrices, adjacency matrices, planar graphs, Euler's formula, chromatic polynomials, vertex colorings, edge colorings, dominating sets, vertex covers, independent sets, edge covers and matching, weighted graph and its application in some problems.

Literature	Discrete Mathematics, Peking University Publishing House., by Wanlin Qu, Suyun Geng, Hanpin Wang and Tian Liu; Set Theory, by Thomas Jech; Graph Theory, by Reinhard Diestel.
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Course Title	Probability Theory and Statistics (A)
Semester	15-16/1
Credits	3
Description	random events, the axiom of Kolmogorov, random variables and their numerical characteristic, densities, distribution functions, characteristic function, product spaces, transformations of probability distributions, conditional probabilities, Bayes' formula, conditional distribution, expectation of a random variable, variance, covariance and correlation, conditional expectation, law of large numbers, central limit theorem. estimation theory, hypothesis testing, Bayesian analysis.
Literature	Probability Theory and Statistics, Peking University Publishing House, by Shuyuan He; Introduction to Mathematical Statistics(Seventh Edition), by Robert V.Hogg, Joseoh W.McKean, and Allen T.Craig.

Course Title	Introduction to Stochastic Processes
Semester	15-16/2
Credits	2
Description	Probability Spaces and Random Variables, Expectations and Independence, Random Variables, Markov Chains, Limiting Behavior and Applications of Markov Chains, Stationary process, Poisson Processes, renew theory, Markov Renewal Theory.
Literature	An Introduction to Stochastic Processes, by Edward P C Kao.

Course Title	Algorithm Design and Analysis
Semester	15-16/2
Credits	5
Description	<p>Algorithm: sorting, ordering, median, matrix multiplication, FFT, Graph algorithm, shortest paths, minimal spanning trees, maximum flow and minimum cost flow, string matching.</p> <p>Paradigm: Recurrences, divide and conquer, sorting, amortized analysis, dynamic programming, greedy algorithm, backtracking, branch and bound. Complexity: P and NP, NP-completeness, Cook's theorem, reductions, approximation algorithm, randomized algorithm</p>
Literature	Introduction to Algorithms (Third Edition), by Thomas H.Cormen, Charles E.Leiserson, Ronald L.Rivest and Clifford Stein.

Course Title	Information Theory
Semester	15-16/2
Credits	2
Description	<p>Elements of Probability theory, source coding and entropy, entropy related concept, mutual information, typical sequences, Huffman coding ,entropy rate, differential entropy, Kolmogorov complexity, minimal description length and maximum entropy principle, Error correcting codes, Channel capacity</p>
Literature	Elements of Information Theory (2nd Edition), by Thomas M. Cover and Joy A. Thomas.

Course Title	Algebraic Structure and Combinatorial Mathematics
Semester	15-16/2
Credits	3

Description	Abstract algebra: Composition of algebraic system, Homomorphism, isomorphism, congruence, quotient algebra, semigroup and monoid, group, ring, field, lattice, Boolean algebra Combinatorics: Combinatorial existence theorems, basic combinatorial counting formulas, recursion equation and generation function, inclusion-exclusion principle, Polya theorem
Literature	Discrete Mathematics, by Wanlin Qu, Suyun Geng, Hanpin Wang and Tian Liu; A First Course in Abstract Algebra, by Joseph J. Rotman; Introductory Combinatorics, by Richard A. Brualdi.

Course Title	Introduction to Pattern Recognition
Semester	16-17/1
Credits	3
Description	Bayesian decision theory, Maximum likelihood and Bayesian parameter inference, probability density estimation, discriminant analysis, Regression(linear, ridge, LASSO, bias-variance dilemma), multilayer neural networks, statistical learning theory(VC dimension, structural risk minimization), support vector machine, dimension reduction(PCA), kernel methods, Ensemble methods(Bagging and Boosting), decision trees, feature selection and transformation, cluster analysis.
Literature	Pattern Recognition and Machine Learning, by Christopher M. Bishop; Pattern Classification, by Richard O. Duda and Peter E. Hart.

Course Title	Mathematical Logic
Semester	16-17/1
Credits	3

Description	Proposition, valid inference form, natural deduction systems , semantic of propositional logic , calculus of equivalence, conjunction and disjunction, normal form, soundness, consistency and completeness of propositional logic ; Predict sentences, free and bound variables, semantic of first order language, deduction systems of first order logic, soundness, consistency, completeness of first order logic of propositional logic;
Literature	Discrete Mathematics, by Wanlin Qu, Suyun Geng, Hanpin Wang and Tian Liu;

Course Title	Signals and Systems
Semester	16-17/1
Credits	3
Description	Basic concept for signal processing, time analysis on linear time-invariant system, Fourier transform, Laplace transform, Z transform, Discrete time Fourier transform and fast Fourier transform, Analysis on linear time-invariant system, design on digital filter, structure of digital filter, statistical analysis on finite word effect
Literature	Signals and Systems, by Alan V. Oppenheim and Alan S. Willsky.

Course Title	Numerical Methods (B)
Semester	16-17/1
Credits	3
Description	Methods for one variable equations, least square fitting, interpolation and extrapolation, numerical differentiation and integration, direct Methods for linear systems of equations, iterative techniques in matrix algebra, initial value problems for ODEs, approximation theory, approximating eigenvalues, iterative

	methods for non-linear systems of equations, boundary value problems for ODEs, methods for PDE
Literature	Numerical Analysis(Second Edition), by Timothy Sauer.

Course Title	Introduction to Data Analysis
Semester	16-17/2
Credits	2
Description	Introduction to multivariate analysis, matrix algebra, descriptive data analysis, regression analysis, principal component analysis, Factor analysis, Canonical correlation analysis, analysis of variance, Independent component analysis, Multidimensional scaling, Partial Least Squares Regression analysis
Literature	Introduction to Data Analysis, by Zhouchen Lin; Methods of Multivariate Analysis, Alvin C. Rencher and William F. Christensen.

Course Title	Data Warehousing and Data Mining
Semester	16-17/2
Credits	2
Description	Introduction to Data warehouse, data mining; Data Warehouse Design, Data representation, Data Preprocessing, Association Rule Mining, Frequent pattern mining, Complex pattern mining, Online Analytical Processing, Classification and Prediction, Clustering

Literature	Introduction to Data Mining, by Pang-Ning Tan and Michael Steinbach; Building the data warehouse, by William H Inmon.
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Course Title	Data Warehousing and Data Mining
Semester	16-17/2
Credits	2
Description	Background in parallel computing: synchronization, communication, and fairness; Methodology of exploiting parallelism, thread model, shared memory model, distributed memory model, CUDA model; Recent trends in parallel and distributed computing;
Literature	Introduction to Parallel Computing (2nd Edition), by Ananth Grama and George Karypis.

Course Title	Machine Learning
Semester	16-17/2
Credits	3
Description	Rule-based learning (Find-S, Candidate-elimination, sequential covering, decision tree), Bayes-Based learning (naïve bayes, Bayesian network), Hidden Markov Models, Topic Models (PLSA, LDA), conditional random fields, neural networks, deep learning (CNN, RNN, LSTM), SVM, Ensemble methods, Basic clustering (K-means family, agglomerative algorithms, divisive algorithms), Density-based clustering, Graph-based clustering, spectral clustering, EM algorithm and its application

Literature	Pattern Recognition and Machine Learning, by Christopher M.Bishop; Machine Learning, by Zhihua Zhou; Machine Learning, by Mitchell T.M..
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Course Title	Advanced Machine Learning: Online Learning and Optimization
Semester	16-17/3
Credits	2
Description	Minimax game, Minimax Regret, Expert Framework, Online Convex Optimization, Online Classification, Multi-armed Bandit Problem, Online-to-Batch Conversions
Literature	Online learning: Algorithms for Big Data (draft), by András György, Dávid Pál. and Csaba Szepesvári.

Course Title	Real Function and Functional Analysis
Semester	17-18/1
Credits	4
Description	Real Analysis and measure theory: Set, Euclidean space, Lebesgue measure, Lebesgue measurable function, Lebesgue integration, measure space and its measurable set, function and integration Functional Analysis: L-p space, L-2 space, convolution and Fourier transform, Hilbert space and its operators, Banach space, its bounded and linear operators, continuous and linear functionals in Banach space, congruent space and operators, convergence and compact of Banach space.
Literature	Real Function and Functional Analysis, Peking University Publishing House, by Maozheng Guo.

Course Title	Elements of Theoretical Computer Science
Semester	17-18/1
Credits	3
Description	Automata and Languages: Finite automata (DFAs and NFAs), regular language, context-free grammar, pushdown automata (PDAs and DPDAs) Computability theory: the Church-Turing thesis, decidability, reducibility, recursion, decidability of logical theories, Kolmogorov complexity Complexity theory: time complexity , space complexity, intractability, approximation theory, Probabilistic algorithm, Alternation, interactive proof systems, parallel computation, cryptography
Literature	Introduction to the Theory of Computation (Third Edition), by Michael Sipser.

Course Title	Intelligent Information Processing
Semester	17-18/1
Credits	3
Description	Fuzzy information processing, Neural network, genetic algorithms, fuzzy neural network, evolutionary intelligence, swarm intelligence, immune information processing.
Literature	Computational Intelligence: An Introduction, by Andries P. Engelbrecht.

Course Title	Elementary Number Theory and Its Application
Semester	17-18/2
Credits	2

Description	Divisibility: Euclidean algorithm, least common multiples, linear Diophantine equations, Fundamental theorem of arithmetic, Sieve of Eratosthenes, distribution of primes; Congruences: Euler and Mobius function, equations of linear congruences, Chinese remainder theorem, Pseudo primes and primality tests; RSA cryptosystem; Quadratic residues: Legendre symbol, Jacobi symbol; Primitive roots and their application.
Literature	Elementary Number Theory and Its Application, by Kenneth H Rosen

Course Title	Ordinary Differential Equations
Semester	17-18/2
Credits	3
Description	the basic knowledge of ordinary differential equations, including how to solve some simple equations, the existence and uniqueness for Cauchy problem, boundary value problems as well as the theory of linear differential equations.
Literature	Qualitative theory of differential equations, by Tongren Ding

Course Title	Theory of Functions of Complex Variables
Semester	17-18/2
Credits	3
Description	Complex numbers and complex planes, complex function and its property, Cauchy theorem, Laurent series, residues theorem and argument principle, analytical continuation, Riemann mapping theorem, harmonic functions

Literature	Complex Analysis, by Ahlfors, L.V, McGraw-Hill, New York.
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