Informatics

Course Code	Course	Credit	Content of Subject
40INF001**	Introduction to Mathematical Logic	2	Basic knowledge of mathematical logic, in particular, first-order logic will be explained.The aim is to be able to write proofs in first-order logic and explaining soundness theorem and completeness theorem, and explain Hoare logic, sequent system, and Peano arithmetic.
40INF002**	Introduction to Algorithms	2	Give an introduction to the algroithm theory, including complexity, order, sorting algorithm, data structres such as heap and binarytrees. We also show some optimization algroithms and string, enumeration algorithms.
40INF003**	High-Performance Computing	2	This course gives lectures on theory, implementation, application and future directions of the high performance computing technology utilizing supercomputers, PC clusters, on-chip multiprocessors and grid computing.
40INF004**	Information Sharing System Architecture	2	This course will discuss information and communication network architectures for a variety of telecommunication network services, including, (1) networking architecture, network protocol and network system architectures (2) security Technology, (3) technologies for authentication/authorization as an enabler of the Internet Trust, ZeroTrust and Trust in various environments including IoT and Blockchain.
40INF005**	Applied Linear Algebra	2	Linear algebra is significantly essential in natural science and engineering. Moreover, it becomes to play an important role in data science recent years. In this lecture, we will learn the basic properties and numerical methods of linear algebra. We will also learn about practical applications.
40INF006**	Introduction to Software Science 1	2	This course presents two main themes in Software Science, representation of software (programming and modeling) and software systems.
40INF007**	Introduction to Software Science 2	2	This course presents basic knowledge of Software Science, focusing on data management, data processing, and data analysis. Topics include data engineering, modeling, mining, and real-world data analysis.
40INF008**	Introduction to Multimedia Information Science	2	Faculty members in Multimedia Information Science will give lectures on various topics covered by multimedia information sciences. Through this course, students will acquire knowledge in the fundamental fields that make up multimedia information sciences and will be able to apply it for their own purposes.
40INF009**	Introduction to Intelligent Systems Science 1	2	This course gives knowledge on fundamental fields, AI, human-agent interaction, machine learning, natural language processing, and intelligent robotics.
40INF010**	Introduction to Intelligent Systems Science 2	2	This course gives knowledge on fundamental fields, such as machine learning, information geometry, natural language processing, deep learning, semantic web, data analytical methods, and computational social science for intelligent systems science.

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40INF011**	Introduction to Information Environment Science	2	As the progress of information technology, interaction of society, technology and information is facing great changes. This course introduces researches on creation, distribution, usage and storage of information. Participants are expected to understand the issues and trend of researches on the relationships between information and society.
40INF012**	Scientific Presentation	1	To improve your skills for scientific presentations in English
40INF013**	Scientific Writing	1	To improve your skills for scientific writing in English
40INF014**	Introduction to Information Security Infrastructure	2	This course provides an overview of information security in information and telecommunications services in terms of technology, systems, legal systems, and economics.
40INF015**	Introduction to Big Data Science	2	Learn about big data research in various fields of informatics.
40INF016**	Practical Data Science	2	To practice data science, several researchers take turns to present and discuss subjects such as data acquisition, data construction, data visualization and data analysis.
40INF017**	Robot Informatics	2	This course introduces the basic knowledge of informatics that is required to develop intelligent robot systems. It also focuses on real-time sensor information processing and system integration method for the development of robot systems.
40INF018**	Natural Language Processing	2	This course aims to introduce the fundamental techniques of natural language processing (NLP), i.e. the study of human languages from a computational and engineering perspective. Basic topics include part-of-speech tagging, lexical analysis, syntactic and discourse parsing, language modeling, and word sense disambiguation. Dialogue system and question answering are included as practical applications. We also learn about cutting-edge research and deepen understanding of current issues and future developments.
40INF019**	ICT-enabled Business	2	Recent topics related to ICT-enabled business will be discussed to deepen understanding of their impact on society and the economy.
40INF020**	Introduction to Statistical Methods in Bibliometrics	2	In this course, students learn basic statistical methods and multivariate analysis techniques, with the expectation of gaining insights into academic communities and educational activities through the statistical analysis of bibliographic data, and educational data.
40INF021**	Logic in Computer Science	2	Type theory gives a fundamental framework for programming languages and software specification. This course will introduce type theory and explain it in a mathematically rigorous way. The aim is complete mathematical understanding of the introductory part of type theory,and the ability of applying type theory to practical problems.

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40INF022**	Discrete Mathematics	2	Discrete mathematics has become popular in recent decades because of its applications to computer science. Concepts and notations from discrete mathematics are useful to study or describe objects or problems in computer algorithms and programming languages.
40INF023**	Computational Complexity Theory	2	In this lecture, we explain the basics of computational complexity theory. The topics include the P versus NP problem, the theory of NP-completeness, and the relativization barriers.
40INF024**	Computational Game Theory	2	Game theory is the mathematical theory that models the strategic interactions among self-interested agents. This course covers selected theoretical topics in algorithmic game theory that aims to understand the design of the algorithms in strategic environments. The course's topics include: solution concepts in game theory, such as Nash equilibrium and correlated equilibrium, and their computation; the price of anarchy in congestion games.
40INF025**	Computer System Design	2	This course focuses on computer architecture including high-performance microprocessors and LSI technologies, all of which are indispensable for designing highly-reliable high-performance computer systems.
40INF026**	Information and Communication Systems	2	This course provides an introduction of the principle, algorithms, system architecture, wireless communications basics, and performance evaluation methods of information and communication systems. (lecture)
40INF027**	Distributed Systems	2	Distributed systems are widely used from IoT to cloud computing nowadays. This lecture explains basic concepts on distributed systems, e.g., distributed algorithms and protocols and then advanced knowledges, e.g., distributed system architecture and distributed data processing, to understand distributed systems.
40INF028**	Software Engineering	2	In this lecture class, students learn software engineering techniques for efficient development and operation of large-scale, high-quality software. We have overview of activities and techniques for each phase in the development process is given. We also have discussion over various development paradigms as well as state-of-the-art topics.
40INF029**	Database Theory	2	This class overviews database theory, especially for database programming languages, and surveys this research area's state of the arts. Note that the use of relational databases is not treated in this class.

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40INF030**	Programming Languages and Theory	2	Learn about the basics of programming languages and implement a small language, using the book "Types and programming languages" as a textbook.
40INF031**	Mathematical Structures in Formal Methods	2	Model checking is a fundamental technique in software science. The course introduces its mathematical theory and practical algorithms. Our emphasis is especially on the mathematical theory of fixed points, formulated in lattice theory and category theory.
40INF032**	Software Verification	2	This course gives lectures on technologies for software verification. In particular, it introduces techniques based on type systems, which make it possible to verify software exhaustively and rigorously.
40INF033**	Fundamentals of Media Processing	2	Data structures and algorithms for handling various information media, as well as pattern recognition theory and signal processing theory as basic technologies related to media processing in general, will be outlined. These techniques are indispensable for efficiently handling large amounts of audiovisual and linguistic information, analyzing information media, extracting features, and converting them into desirable forms. If necessary, we will have time for exercises, and students will be able to deepen their understanding by actually processing visual information.
40INF034**	Applications of Multimedia Processing	2	Students will learn techniques for processing, analyzing, processing/editing, and presenting media such as audio and images as examples of media processing applications. Specifically, image processing, image analysis, image generation, and audio information processing will be studied, including mathematics and implementable algorithms. Advanced multimedia technologies combining these techniques will also be studied as needed. Students will acquire basic concepts and algorithms related to media processing and be able to apply them to their own work.
40INF035**	Deep Learning	2	In this course, we will study the basic techniques underlying Deep Learning and its main architectures, including Neural Networks, Convolutional Neural Networks, Recurrent Neural Networks, Transformers, and so on. We will also discuss practical examples of Deep Learning applied to intelligent drones and time series analysis.
40INF036**	Communication Environments	2	We exchange a variety of information with others and build relationships not only in face-to-face situations, but also via mobile phones and the Internet. To discuss such "communication environments" in our daily lives, this lecture comprehensively discusses the usefulness of related previous studies and their methodologies.
40INF037**	Data Mining	2	This course introduces data mining from theory to practice.

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40INF038**	Methodology of Scientometrics	2	To be able to quantitatively grasp the trends in science and analyze and judge the current situation and problems, after understanding the quantitative methods for science.
40INF039**	Sublinear Algorithms	2	"Efficient" algorithms have meant polynomial-time algorithms. As the data size is increasingly large, however, even polynomial-time algorithms could be too slow. To handle such large data, sublinear-time algorithms, especially, the framework of "property testing", have been developed in the last decades, where sublinear means less than linear. This course will cover theoretical foundations of sublinear-time algorithms.
40INF040**	Algorithmic Market Design	2	Market design is a field of research that considers how to design rules of markets, such as matching and auction markets. Through game-theoretic analysis, this field aims to design market rules that yield socially desirable outcomes, while each participant acts selfishly. In this course, we learn the theory and applications of market design, while laying emphasis on its algorithmic and discrete mathematical aspects.
40INF041**	Combinatorial Optimization for Machine Learning	2	Machine learning tasks often involve combinatorial structures. To design an efficient algorithm for these problems, techniques of combinatorial optimization are indispensable. This course will cover the theory of combinatorial optimization, such as submodular optimization and approximation algorithms, and its applications to machine learning.
40INF042**	Probabilistic Models in Informatics	2	This course focuses on probabilistic models in informatics, which play important roles in modeling real-world data. It includes the basics of probability theory, characteristics of probabilistic models, and challenges and evaluation issues in applying probability-based machine learning to real-world applications.
40INF043**	Interactive Media	2	In this lecture, we discuss human-machine interaction and human-human interaction as examples of media processing applications.
40INF044**	Knowledge Sharing System	2	The topics include the foundation and application of knowledge representation and sharing by introducing Semantic Web as a part of Artificial Intellgience
40INF045**	Computational Social Science	2	Learn about computational social science, which is an interdisciplinary field that combines informatics and social science.

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40INF046**	Embedded Real-Time Systems	2	IoT systems, autonomous vehicles, aircraft, and similar technologies must process various types of information within limited time and computing resources. Hence, foundational skills in embedded systems and real-time systems are extremely important for the construction and design of these systems. In this course, after studying the fundamental elements of embedded systems, real-time systems, and distributed embedded systems, we will discuss technical challenges related to cyber-physical systems (CPS), which are increasingly being implemented in society.
40INF047**	Quantum Algorithms	2	This lecture covers the basics of quantum algorithms and their implementation, extending to the physical aspects of the implementation. The lecture is divided into into input and output periods. During the input period, students will learn relevant content through video materials registered at the Quantum Academy. During the output period, they will prepare presentations based on this content. In each presentation session, students will present in front of their peers, followed by a discussion involving both the students and the lecturer.
40INF048**	Large Language Model	2	In this course, students will learn from basics to advanced topics related to large-scale language models, including corpus construction, model training, tuning, evaluation, inference, and multimodality, and will understand their mechanisms and current challenges.
80INF001**	Experiment and Seminar on Basic Knowledge in Informatics Ⅰ A	2	Under the close guidance of the faculty advisor, students will plan and conduct experiments, analyze the results of experiments, and conduct exercises to acquire the basic knowledge required for conducting research in informatics and the advanced knowledge needed to solve fundamental problems in informatics.
80INF002**	Experiment and Seminar on Basic Knowledge in Informatics Ⅰ B	2	Under the close guidance of the faculty advisor, students will plan and conduct experiments, analyze the results of experiments, and conduct exercises to acquire the basic knowledge required for conducting research in informatics and the advanced knowledge needed to solve fundamental problems in informatics.
80INF003**	Experiment and Seminar on Basic Knowledge in Informatics Ⅱ A	2	Under the close guidance of the faculty advisor, students will plan and conduct experiments, analyze the results of experiments, and conduct exercises to acquire the basic knowledge required for conducting research in informatics and the advanced knowledge needed to solve fundamental problems in informatics.
80INF004**	Experiment and Seminar on Basic Knowledge in Informatics Ⅱ B	2	Under the close guidance of the advisor, students will acquire the basic and advanced knowledge necessary for conducting research in informatics, and will plan and conduct experiments, analyze the results of experiments, and practice exercises in order to achieve a level at which they can summarize their progress and report on their research.
90DIFg18**	Research in Informatics for Master Thesis Ⅱ B	2	Registration possible only by the students enrolled in SOKENDAI in/before AY2022