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, including (1)advanced networking technologies and network systems technologies for a variety of telecommunication network services,(2)circuit switching and packet switching,network layering and each layer's function and (3)security technology.
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, including topics such as data engineering, data modeling, data 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	Lectures are given on the fundamentals of intelligent systems science, including artificial intelligence, human-agent interaction, machine learning, natural language processing and intelligent robotics, vision and language, recommender systems.
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	These lectures provide practical instruction for students to improve their presentation materials and presenting skills. We explore in detail the function, structure, form, and content of scientific presentations. Students also work together to provide feedback and suggestions for improving their scientific presentations.
40INF013**	Scientific Writing	1	Strategies for scientific writing will be examined. The students will be asked to read the titles, abstracts and introductions of several real research papers of varying quality, and to critique them in light of organizational principles. Students will be encouraged to supply samples of their own technical writing for analysis by the class.
40INF014**	Introduction to Information Security Infrastructure	2	Information security technology, service, system, rule, and law give a fundamental framework for providing ICT (information and communication technology) systems and services. This course will introduce information security and give its explain in an ICT governance way.
40INF015**	Introduction to Big Data Science	2	This course will introduce basic concepts and methodologies of large scale data processing, analysis, security, and visualization by discussing relevant applications.
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	Understanding the basic technology for ICT-enabled services and its application.This course focuses on how E-business including Electronic Commerce or Electronic Money affects the economic activity or social structure.
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.

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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.
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; computational social choice: procedures for fair division, such as cake cutting algorithms.
40INF025**	Computer System Design	2	This course will focus on (1) computer architecture including high-performance microprocessors and LSI technologies, and (2) system software stack, including communication mechanisms and parallel file systems, 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.

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40INF029**	Database Theory	2	This class introduce database theory based on database programming languages. Especially, Datalog, which is a logical foundation of query languages in relational databases, is used.
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 a lecture 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	This course explains the overview of the basic technologies related to whole aspect of media processing especially pattern recognition theory and signal processing theory. These technologies are indispensable for media analysis, feature extraction, media conversion, and so on. Project works such as video information processing will be assigned upon necessity to deepen the understanding.
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.

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40INF037**	Data Mining	2	This course introduces data mining from theory to practice.
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 the modeling of real-world data. The course includes the basics of probability theory, characteristics of probabilistic models, and challenges and evaluation issues in terms of applying probability-based machine learning for 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. Specifically, there are explanations of basic methods such as modeling, design methods, evaluation methods, and machine learning, as well as information retrieval, reading comprehension, large-scale processing, and security. *Students are required to have taken the course "Fundamentals of Media Processing" before taking this course.

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40INF044**	Knowledge Sharing System	2	This lecture will discuss the realization of knowledge sharing through knowledge representation techniques, a branch of artificial intelligence. First, the history of information sharing in society will be introduced by reviewing the development of the Internet to date. Then, the importance of the Semantic Web concept in the transition from information sharing to knowledge sharing will be explicated. The lecture will focus on how knowledge sharing on the Internet can be done with the Semantic Web. First, an overview of the Semantic Web will be presented,
40INF045**	Computational Social Science	2	Computational social science is the study of quantitative and theoretical understanding of human behavior and economic, social, and political phenomena by capturing, analyzing, and modeling large-scale economic, social, and political data through information technology. In this course, students will learn basic concepts of social science, applications of information technology, and social scientific interpretation, which are necessary for researchers in information science to tackle questions in social science. *Not open to students who have earned credits in "Econophysics" by FY2020.
40INF046**	Embedded Real-Time Systems	2	Real-time and embedded systems pervade many aspects of modern life ranging from mobile communications, robotics, medical systems and devices, motion control systems, transportation systems, energy generation and management, to aerospace and aircraft systems. This course covers both the core concepts underlying such systems and application-level concepts. First, the course focuses on the core concepts and principles, including resource management, task scheduling, dependability and system safety. Also, the course offers the application-level discussions for Cyber-Physical Systems (CPS) and Internet-of-Things (IoT), and real-time networks.
40INF047**	Quantum Algorithms	2	This lecture covers the basics of quantum algorithms and their implementation, extending to the physical aspects of the implementation. The lectures are structured into input and output sections. During the input sections, students will learn relevant contents through video materials registered at the Qantum Academy of Science and Technology Online Learning System (QOLS). During the output sections, they will prepare presentations based on these contents. The students will present in front of their peers, followed by a discussion involving both the students and the lecturer.
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.

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80INF002**	Experiment and Seminar on Basic Knowledge in Informatics ⅠB	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 ⅡA	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 ⅡB	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 ⅡB	2	Registration possible only by the students enrolled in SOKENDAI in/before AY2022