Interdisciplinary subjects of the perspectives in informatics

(For the underlined subjects, classes will be provided in English.)

Perspectives in Informatics 1

In the midst of ongoing IT revolution, our society is dependent on the Internet deeper and deeper. The Internet has enabled the distribution of information among digital devices to be held at an extremely high speed and at low cost. It has also made network connection among computers quite easy and simple. The Internet has become used also in an important field like e-Government and e-Commerce as ordinary people come to use it in daily life. As a result, however, the Internet exposes a number of people to its vulnerability. In this lecture, we will talk about basic technologies used to protect users from threats on the Internet, threats that can actually occur, and countermeasures. Through introduction of a wide range of contents covering from technical aspects to social phenomena and legal development, we outline the basics of information security and deepen our understanding with discussions among students.

Perspectives in Informatics 2

This subject provides an overview of several themes that cross the Courses and are characterized as frontiers of the informatics. Specifically, state-of-the-art of three themes of artificial intelligence, life and brain, and humanoid robots are introduced by professors of the School and visiting lecturers from an informatics point of view.

Perspectives in Informatics 3

This subject deals with differential equations arising in science and technology, which are also deeply connected to broad applications in engineering and social science.

The subject is divided into two parts.

The first part of this subject deals with nonlinear diffusive partial differential equations (PDEs) from physical and biological multispecies applications. A particular feature of these equations is their entropy or gradient-flow structure, which reveals their thermodynamic origin. The objective is to exploit the thermodynamic structure for the mathematical analysis. Topics of the first part of the subject include an introduction to entropy structures for the cross-diffusion systems, their formal derivation from on-lattice and kinetic models, and the numerical approximation by finite-volume methods that preserve the entropy structure. Students will learn how to apply these techniques to real-world models and how to discretize them numerically in an efficient way.

The second part of this subject starts with some preliminaries of advanced ordinary differential equations including existence theory, the dependence of initial data, stability analysis and Lyapunov function method. Next, we shall introduce the celebrated Kuramoto model, an ODE system which describes the synchronization phenomena. We then introduce a series of mathematical analysis on the Kuramoto model and its variations. We shall also introduce some open problems concerning this model.

Perspectives in Informatics 4

To be announced.

Perspectives in Informatics 5

The subject covers topics of many disciplines in the courses of the school from mathematical theory to application areas. It provides an introduction and state-of-the-art in each topic.

General subjects provided by the School

Perspectives in Platform Studies

The various type of ubiquitous information in society will be converted into digital data, and they will be collected extensively. Then they will be stored as large-scale data called “big data”. From the viewpoint of Intelligence Science and Technology, Advanced Mathematical Sciences, Applied Mathematics and Physics, Systems Science and Communications and Computer Engineering, we will introduce latest topics about themes related to "Platform Studies" while utilizing information and communication technology (ICT) that allows organizing, analyzing and sharing the data.

Computational Science, Introduction

It is the aim of this subject that attendees obtain the basic knowledge and skills for computational science. For this purpose, we give lectures and exercises as described below. In lectures, we give the following topics: numerical algorithms, computer architecture, basics of high precision computation and high performance computing, parallel computing techniques, and applications of computational science in various fields. In exercises using the C language, students acquire optimization techniques for serial computing which is the most important technique to utilize computers, parallel computing techniques for computers with multi-core CPUs, and parallel computing techniques for distributed memory parallel computer.

Computational Science, Exercise A

Through statistical processing for large-scale data, it is the aim of this subject that attendees obtain skills for computer science. For this purpose, we give lectures and exercises as described below. In lectures, we give the following topics: numerical algorithm, statistical processing, computer architecture, basics of high performance computing and parallel computing techniques. In exercises, students acquire optimization techniques for serial computing which is the most important technique to utilize computers and parallel computing techniques for computers with shared memory using OpenMP and for computers with distributed memory using MPI.

Information and Intellectual Property

This subject introduces the copyright law and copyrights of digital contents, the patent law and patents related to IT area (software patent, business model patent etc.), information technology for management and creation of intellectual properties, the protection of personal data. Students are required to acquire the fundamental knowledge of the copyright law, the patent law, information technology for management and creation of intellectual properties, and the protection of personal data.

Innovation and Information

This class overviews theories on research and development (R&D) in conjunction with

information management. Any students, either humanities or science, can take this class that lectures logic and background of innovations and value creation process. Topics are selected to foster in-depth understanding of how management theories and development (products or service innovation) interact; “Central Research Institute” today, definitions of R&D, product architecture theory, marketing and innovation, and knowledge management, innovation and management strategy, Japanese way of management and R&D ethics of engineers, and more.

Information Analysis and Management

Nowadays, analysis and management techniques for massive data has been essential to advance cutting-edge research work in any fields. In this class, we give lectures on selected topics from many fields such as data management, mining techniques to discover valuable information and knowledge, information analysis based on several kinds of algorithms and probabilistic models, and visualization of analysis. More specifically, we address foundations of computer science such as graph-based modeling and algorithms, data mining, database, information visualization, user interface and interaction techniques, information publishing, and so on. This class aims at learning how to apply these techniques to specific tasks and understanding basic idea of them, and applying them to each student's research fields.

Information Analysis and Management, Exercise

Nowadays, analysis and management techniques for massive data has been essential to advance cutting-edge research work in any fields. In this class, we provide exercises on selected topics from many fields such as data management, mining techniques to discover valuable information and knowledge, information analysis based on several kinds of algorithms and probabilistic models, and visualization of analysis. More specifically, we address foundations of computer science such as graph-based modeling and algorithms, data mining, database, information visualization, user interface and interaction techniques, information publishing, and so on. This class aims at acquiring skills on how to apply these techniques to specific tasks through computer exercises and applying them to each student's research fields.

Social Contributions through Informatics

This is a practical, hands-on subject in order to support the social contributions of students through knowledge gained in the subject of academic efforts in the informatics field, including social services and other activities based on knowledge derived from informatics.
The specifics regarding the implementation and credit approval processes of the subject are as follows:

1) Students who wish to take the subject shall prepare an implementation plan and submit it to the Dean of the School. The implementation plan shall include a specific plan stating i) what kind of knowledge related to informatics will be used in a social contribution activity, and how it will be used; ii) implementation schedule and location; iii) when the location is outside the University, information on preparation status, relevance to organizations (NPOs, etc.) outside the University, and student insurance coverage status; iv) whether the duration is long enough to cover 45 class hours required for credit approval; and v) observations by the student's supervisor.

2) When the implementation plan prescribed in paragraph 1 is submitted, the Dean of the School shall refer it to the Student Affairs Committee to deliberate on its appropriateness. When the Student Affairs Committee deems the implementation plan to be appropriate, the Dean of the School shall allow the subject to be taken. The Student Affairs Committee shall conduct a comprehensive deliberation on such issues as whether or not the plan falls into the category of social contribution through informatics; relevance to other organizations; and, when the hands-on learning activity is implemented outside the University, the possible dangers of the location, the status of insurance coverage and preparations.

3) After finishing the activity, students shall submit a report to the Dean of the School, which shall include implementation records of the 45-hour activity, an evaluation regarding the degree of achievement of the implementation plan prescribed in paragraph 1, and an account of expenses incurred during the activity.

4) When the report prescribed in paragraph 3 is submitted, the Dean of the School shall refer it to the Student Affairs Committee to deliberate on its appropriateness and shall assign a grade using a pass/fail method based on the evaluation of the Student Affairs Committee.

5) Students who take the practical, hands-on subject shall not be allowed to receive any compensation or reward (except actual travel and accommodation expenses) for the activity.

Note: If students knowingly provide incorrect information in the report prescribed in paragraph 3, such an act shall be deemed to constitute improper conduct provided for in Article 10 of the Graduate School of Informatics Academic Grading Regulations. The subject shall not be subject to Article 11 of the same Regulations.

Internship in the Field of Informatics

The purpose of the subject is to offer opportunities for graduate school students to deepen their understanding of social structures and carefully think about their future career paths through internship programs at private companies and other organizations.

The details regarding the implementation and credit approval processes of the subject are as follows:

1) Students who wish to take the subject shall, after detailed consultation with a host company, prepare an implementation plan and submit it to the Dean of the School. The implementation plan shall include a specific plan stating i) implementation schedule and location; ii) information on preparation status and student insurance coverage status; iii) whether the duration is long enough to cover at least 45 class hours required for credit approval; and iv) observations by the student's supervisor.

2) When the implementation plan prescribed in paragraph 1 is submitted, the Dean of the School shall refer it to the Course to which the applicable student belongs for deliberation on its appropriateness. Following deliberation at a meeting or other type of meeting, the chairperson of the applicable Course shall report to the Dean of the School on whether or not the student is allowed to take the subject.

3) When allowed to take the subject, students shall, after finishing the activity, submit a report to the Dean of the School, which shall include implementation records of the 45-hour activity, and an account of expenses incurred during the activity.

4) When the report prescribed in paragraph 3 is submitted, the Dean of the School shall refer it to the Student Affairs Committee to deliberate on its appropriateness and shall assign a grade using a pass/fail method based on the evaluation of the Student Affairs Committee.

5) Students who take the practical, hands-on subject shall not be allowed to receive any compensation or reward (except actual travel and accommodation expenses) for the activity.

Note: If students knowingly provide incorrect information in the report prescribed in paragraph 3, such an act shall be deemed to constitute improper conduct provided for in Article 10 of the Graduate School of Informatics Academic Grading Regulations. The subject shall not be subject to Article 11 of the same Regulations.

Intelligence Science and Technology Course

(For the underlined subjects, classes will be provided in English.)

Introduction to Cognitive Science

This subject provides an introduction to the major properties of human sensation, perception, and cognition as well as their underlying neural mechanisms. It also introduces the principles of neural networks and the computational theory of human cognition.

Introduction to Information Science

This subject provides students with a basic understanding of advanced research in Information Science. It explains the elements and structures of information as well as the theories of modeling and abstraction. It also explains methods of analyzing, understanding, and generating information in the areas of language processing media, speech media, and visual information media.

Introduction to Bioinformatics

This subject introduces and discusses various information-scientific methods and findings for analyzing the information flow from genomic sequence, the blue print of life, to a variety of biological phenomena. The subject provides an overview of the basics of bioinformatics through discussions of the foundations of life sciences, introduction of fundamental algorithms, statistical analyses, machine learning approaches, and probabilistic models.

Seminar on Cognitive Science

This seminar explores empirical and theoretical research in cognitive science. Seminar discussions will focus on recent topics and current problems.

Computational Cognitive Neuroscience

The wellspring of human intelligence is the brain, or more accurately, information processing (i.e., calculation) by the brain. This subject explores acquisition of fundamental knowledge about information processing by the brain, which is required for purposes such as understanding human brain function and learning about human intelligence in order to develop novel intelligent systems. Starting with the importance of looking at things from the perspective of brain processing, this subject explains how experiment and theory in cognitive neuroscience (i.e., experimental knowledge of the relationship between action and brain activity, and mathematical neuroscience models based on statistical information science and machine learning) work in tandem to advance our understanding of brain mechanisms and information processing by the brain. Specific topics to be covered include those related to a relatively microscopic level of understanding, such as the encoding of external information by the activity of neuronal populations and the use of information geometry to conduct group interaction analysis; functions in brain areas such as basal ganglia circuits; as well as topics related to macroscopic understanding, such as higher-order cognitive functions in humans including caution, decision-making (enforced learning), and social decision-making (psychological theory). All of the above will be explained in terms of brain processing, and recent studies will be introduced as well.

Pattern Recognition (Advanced)

The subject introduces fundamentals of pattern recognition, clustering methods with several

distance measures, and feature extraction methods. It gives a review of state-of-the-art classifiers such as Gaussian Mixture Models (GMM), Hidden Markov Models (HMM), and Deep Neural Networks (DNN) as well as learning theories which include Maximum Likelihood Estimation (MLE), Bayesian learning, and Deep learning. It also focuses on modeling and recognition of sequential patterns.

Speech Processing (Advanced)

This subject covers fundamentals of speech, audio, and music processing. After a brief review of the mechanism of human hearing, the basics of the nature of speech and its analysis are introduced. Then, speech synthesis, coding, and recognition as well as spoken dialogue systems are reviewed. Next, audio signal processing, specifically source localization, separation, and recognition, is explained. Finally, we introduce methods for processing such as automatic transcription and source separation using music.

Language Information Processing (Advanced)

This subject focuses on morphological analysis, syntactic analysis, semantic analysis, and context analysis, which are necessary to process natural language texts. The subject also explains their applications such as machine translation, information retrieval, and natural language man-machine interface.

Computer Vision

This subject covers the basics and applications of visual information processing necessary for computational analysis and understanding of real-world images/videos of objects and scenes. Students will learn the theory and its applications of fundamental and applied computer vision topics, also through hands-on implementation experience, ranging from optical and geometric camera models, projective geometry, and image processing, to 3D reconstruction including photometric stereo and structure from motion, motion analysis and object recognition.

Visual Interface

This subject focuses on the interface between humans and computers based on human sensing. The subject explains the basic concepts of human interface, virtualization of the real world, input and output devices for interface, fundamental ideas for physiological measurements, and useful techniques for measuring or recognizing gaze, facial expression, motion, etc.

Bioinformatics (Advanced)

This subject covers advanced topics in bioinformatics and biological sciences. In particular, the subject will focus on discrete algorithms for bioinformatics and discrete mathematical models for biological networks. The Introduction of Bioinformatics subject is a prerequisite for taking this subject.

Advanced Study in Intelligence Science and Technology 1

In this class, students obtain advanced knowledge related to their research themes in Intelligent Science and Technology from exercises that are based on a systematic teaching of basic material previously learned. The subject consists of seminars, internships, and invited lectures.

Advanced Study in Intelligence Science and Technology 2

This subject provides students with systematic exercises for studying various advanced

research related to their research themes in Intelligent Science and Technology. The subject consists of seminars in which students review recent research papers and discuss the methods and results published in the papers.

Seminar on Intelligence Science and Technology I and II

The goal of this subject is to introduce students to the different aspects, methodological and applied, that form the field of Intelligence Science and Technology. Students following this subject will be given opportunities that may include: visit other laboratories than that to which he/she is originally attached to, and possibly attend a subject, a seminar or a practical training session; hear about the latest research carried out by members in other laboratories; carry out an internship within a relevant industrial partner or research institute. This subject is intended for students of the IST Course, but may accept, if conditions allow for it, students coming from outside the Course.

Seminar on Intelligence Science and Technology III and IV

The goal of this subject is to introduce students to the different aspects, methodological and applied, that form the field of Intelligence Science and Technology. Students following this subject will be given opportunities that may include: hear about the latest research carried out by members in other laboratories in the Course; attend lectures provided by a lecturer from a different research institute or in the industry; carry out an internship within the industry or in another research institute. This subject is intended for students of the IST Course, but may accept, if conditions allow for it, students coming from outside the Course.

Social Informatics Course

Subjects whose name is underlined will be provided in English in principle. For subjects provided in both Japanese and in English, the credits can be earned from either of them.

Information and Society

(Class given both in English and Japanese, at the same time, in separate classrooms)
This subject introduces social issues dealing with the impact of information technology on society: information policy, information and law, information and economics, information ethics, and information and education. Students will learn the social aspects of information technology from multi-disciplinary viewpoints: the history and trends of information technology; problematic issues regarding an information society; social revolution brought on by information technology, privacy, and security issues; policies concerning information, intellectual properties, and the way IT experts think and the responsibilities they bear.

Information System Analysis

(Class taught in Japanese with English language support in the classroom)
This subject introduces fundamental theories and technologies for analyzing and evaluating information and information systems. Students will learn several statistical processing methods: experimental design, systems analysis, data analysis, and data mining. In conjunction with lectures, students of the Social Informatics Course will complete exercises on information system analysis so that they may understand information system analysis theory and technology through the practice of applying them to real data.

Practice of Information Systems

(Japanese and English lectures will be held in the same classroom)
Students will learn the fundamentals of analyzing and designing information systems through practical application of theories and technologies learned in lectures to real-world issues.

Multiagent Systems

(Class taught in English with Japanese language support in the classroom)
This subject introduces fundamental concepts, methodologies and underlying technologies on multiagent systems for analyzing, designing and implementing social information systems. In particular, the subject presents fundamental concepts and methodologies regarding the basics for collective intelligence, crowd computing, mechanism design, and real-world system implementations and deployments. Students will examine multiagent methodology and implementing/operation technologies to learn how multiagent systems are designed, implemented and operated.

Biosphere Informatics

(Class taught in Japanese with English language support in the classroom)
In this subject, students will learn about basic methods for analyzing data obtained in the biosphere, primarily using R. In addition, students will give a presentation on the results of their data analyses related to biological and environmental problems.

Human-Robot Interaction

Intelligent robots are becoming more and more common in people's everyday lives. An increasing number of robots are designed with a variety of interactions as its primary function; for example, human-like robots capable of social interaction with humans, robots performing duties and activities alongside humans without getting in the way, and robots controlled by humans such as telepresence robots or drones. To build robots with a capacity for interactions requires not only information processing technology and artificial intelligence robotics technology but also an academic thought process for understanding the characteristics of human recognition and psychology. In this lecture, objective views of human-robot interactions in a variety of forms are presented and students will learn to acquire an academic thought process so that they can design and build new forms of interactions.

Disaster Information

This subject presents an outline of disaster prevention and reduction countermeasures both inside and outside Japan, with special reference made to disaster-information-related topics. The subject introduces concrete examples of disaster information systems to show that the psychological aspect of information users under critical social conditions is carefully taken into account in such current disaster information systems.

Emergency Management

Damage from disasters is defined by two factors: scale of hazard and social resiliency. Two strategies and losses exist to reduce damage and losses from disasters—namely, crisis management as a post-event countermeasure and risk management as a pre-event measure. This subject introduces an integrated research for disaster reduction, consisting of response, recovery, mitigation, and preparedness.

Medical Informatics

This subject covers the applications of information science and technology in the field of medicine as well as recent topics. Additionally, the subject covers what information science and technology provided for the field of medicine.

Business Information

This subject introduces the theory, practice and state-of-the-art solutions regarding various phenomena related to a ubiquitous network society, as viewed from the perspective of ICT businesses. Topics include, for example, e-businesses, ubiquitous networks, communication policies, corporate information systems, knowledge management, community IT, etc.

Information Education

This subject will teach how to design, develop, and evaluate information systems to support education and learning using artificial intelligence, information retrieval technology, and network technologies. This subject also focuses on recent related technologies such as learning analytics using educational big data and ubiquitous learning environments, and understands theories and practical research methods in educational informatics by designing educational learning support systems.

Distributed Systems

A distributed system consists of numbers of computers liaising via LAN, Internet and wireless networks. This subject teaches large scale distributed systems such as Web services supported by hundreds of servers and Internet-scale systems involving millions of computers. Students learn today's and coming network computing through lectures on related technologies, cases and literature.

Cryptography and Information Society

This subject covers basic security technologies, including encryption and authentication as well as their applications in our information society. In particular, the subject introduces various issues that arise in the operation of public-key cryptography used in PKI, which is the infrastructure for authentication and digital signatures on the Internet. The subject also presents new applications of cryptography such as e-cash and e-voting as well as the current situation in e-trading and operation in actual networking infrastructures.

User Experience (UX)

(Japanese and English lectures will be held in the same classroom)
In this subject, students will learn about methodologies for improving User Experience (i.e. the experience that users gain through their interaction with technologies). Drawing on recent studies, students will investigate user interfaces they find difficult to use or technologies they think are harmful to people/society, propose technologies to improve these problems, create simple prototypes, evaluate them, and make presentations.

Service Modeling

Intangible phenomenon, assets, and processes are valuable on “service”. Service visualization is effective for multiple stakeholders to recognize such service appropriately and share its information. This subject examines the methods and intent of service modeling from multiple perspectives. The scope of the subject is not limited to the service industry represented by consumer services, but includes the whole industry such as servitization on the manufacturing industry.
Thus, lectures are interdisciplinary, involving the fields of business administration and informatics.

Advanced Study in Social Informatics 1

Students propose research topics dealing with the social applications of information and network technologies. Moreover, they conduct research on their topics, which includes systematic surveys, exercises, and experiments.

Advanced Study in Social Informatics 2

Students will select their research themes and then conduct research (including technology development, survey work, and a research discussion) dealing with the social applications of information and network technologies. Finally, they will present their research results in the form of a research paper. Through their research, students will learn ways of evaluating and critiquing research.

Applied Mathematics and Physics Course

(The underlined subjects will be provided in English.)

Operations Research, Advanced

This subject examines optimization methods for various mathematical models that arise in engineering, the social sciences, and the natural sciences, with particular emphasis given to the theory of nonlinear optimization and the design of discrete optimization algorithms.

Mathematical Physics, Advanced

This subject deals with various problems that appear in mathematical physics by focusing on mathematical aspects. In particular, the topics include applications of perturbation theory, calculus of variations, singularity analysis to some physical models including forced pendulum, billiard mapping, and celestial mechanics.

Systems Analysis, Advanced

This subject deals with fundamentally important issues related to dynamical systems modeling and algorithms. Specifically, the subject covers the system identification schemes such as the prediction error method and the subspace method, as well as the relationship between computational algorithms and integrable systems.

Mathematical Analysis, Advanced

The aim of this subject is to provide students with knowledge of advanced mathematical analysis methods used with nonlinear models. This subject covers the theory of integrable systems as precisely solvable nonlinear models and orthogonal polynomials. Specifically, topics such as stochastic processes and quantum communication related to integrable systems are discussed from various viewpoints. The usage of computer algebra systems is also introduced.

Discrete Mathematics, Advanced

This subject focuses on the fundamental techniques for designing algorithms such as dynamic programming, divide-and-conquer, the greedy method, the local search and min-max property (duality) in discrete optimization. The subject also introduces some new topics from the areas of graph network theory, and approximation algorithms.

Control Systems Theory, Advanced

This subject covers fundamental issues on control systems analysis and synthesis including recent trends. The importance of system model uncertainty is discussed after reviewing subjects taught in standard undergraduate control subjects. Topics include: robust control theory, application of convex optimization and polynomial methods, distributed control for multi-agent systems, and the effects of stochastic noises in control systems.

Optimization Theory, Advanced

The subject focuses on basic optimization theory and algorithm design for solving convex optimization problems. Topics include duality in nonlinear optimization, interior point methods

for linear and convex programming problems, and convex optimization approaches to real-world problems.

Physical Statistics, Advanced

This subject focuses on basic spectral theory of stochastic processes based on ergodic theory, statistical mechanics of deterministic chaos, and physical statistics with special attention given to the application of stochastic processes and stochastic physics to communications systems, energy-information integrated networks, physical, biological and sociological model systems.

Dynamical Systems, Advanced

The knowledge of dynamical systems is extremely important in mathematical sciences and applied mathematics. This subject provides an outline of dynamical systems theory, which is a tool to analyze nonlinear phenomena such as bifurcations and chaos, and enables you to gain better understandings of these phenomena and applications by using a numerical bifurcation analysis software.

Introduction to Mathematical Finance

This subject introduces the topic of mathematical finance with asset-price processes modeled by stochastic processes.

Financial Engineering

Researchers familiar with the real world of finance teach this subject on financial engineering, with particular emphasis given to the understanding and solution of financial problems in economics and management from the viewpoint of mathematical science.

Topics in Applied Mathematics and Physics A

The purpose of this program is to understand how scientific achievements in mathematical engineering are transferred into real world applications in relation to an information society. Requirements for practical applications of mathematical engineering are explained by primarily focusing on OSs, networks, body area networks (BANs) as well as optical blood analysis technologies and mathematical designs in related fields. As examples, we delve into contemporary issues such as next generation mobile networks and energy efficient and security-related BAN technologies, mainly in the medical and health care application fields.

Topics in Applied Mathematics and Physics B

Based on their experiences pursuing actual corporate research incorporating system architecture theory as defined by international standards, corporate researchers present lectures on construction theory for mathematical models, which is indispensable for planning, evaluating, and operating systems. As an application example, they teach modeling theory for IT systems, especially manufacturing systems, and also explain in concrete terms the use trend of the modeling technique used in the social infrastructure field (particularly, so-called lifelines such as railways, electric power, communication, and water service).

Seminar in Mathematical Analysis

The goal of this subject is to understand and acquire basic mathematical methods and

techniques for advanced study on mathematical analysis. In particular, taking the students' request, basic academic ability and research experience into consideration, we will choose textbooks and hold seminars.

Seminar in Discrete Mathematics

In this subject, we study how algorithm design techniques such as branch-and-bound method, dynamic programming, and integer program are used to solve actual problem instances of discrete optimization. For this, we use solver tools such as CPLEX and MATLAB and write program codes in C language to conduct computational experiments.

Seminar in System Optimization

In this subject, we study mathematical optimization models, optimization theories and algorithms such as robust optimization, conic optimization, dual theory, and the first- and second-order methods. Moreover, we learn to write program codes in Python/Matlab/C language to conduct numerical experiments for mathematical optimization.

Seminar in Control Systems Theory

This seminar focuses on the design of control systems using up-to-date research as well as fundamental theories. The seminar content includes optimal control, robust control, stochastic control, networked control, estimation, and system identification. Applications to industrial as well as social systems are also discussed.

Seminar in Physical Statistics

The Central Limit Theorem (CLT) is deeply related to statistics of various kinds of data. In this seminar, we study the fundamental theory of CLT, the Generalized Central Limit Theorem (GCLT) and its applications to data analysis in Finance, Engineering, and Physics.

Seminar in Dynamical Systems

The goal of this subject is to understand and acquire several theories and techniques required for advanced level studies related to dynamical systems by reading textbooks and discussing various topics treated there. The textbooks will be chosen by taking students' requests into account.

Advanced Study in Applied Mathematics and Physics 1

In the fields of applied mathematics and physics, recent topics are addressed in each seminar along with computer simulations or exercises according to the themes covered.

Advanced Study in Applied Mathematics and Physics 2

Each seminar deals with topics from the above-mentioned Advanced Study I subject or with advanced topics connected to those addressed in Advance Study I, with computer simulation if necessary.

Systems Science Course

(For the underlined subjects, classes will be provided in English.)

Systems Sciences, Advanced I

This subject covers a wide range of research topics in systems science including the topics such as synthesis and evaluation of various systems, analysis of system stability and reliability, and the relation of systems to humans and society. In this lecture, we will describe most-advanced research topics in each field of the Course with its methodology.

Systems Sciences, Advanced II

This subject covers a wide range of current research topics and future directions in systems science. This subject covers synthesis and evaluation of various systems, their stability and reliability, and the relation of systems to humans and society. Student presentations are required during this subject.

Control Theory for Mechanical Systems

Multi-agent systems are systems composed of multiple autonomous systems which interact each other. This subject presents modeling techniques and fundamental theory for analysis and control of multi-agent systems.

Theory of Human-Machine Systems

Various interactions observed in human-machine systems, especially interactions involving human behavior and roles are discussed with respect to human recognition ability, their actions, errors, inferences, feelings of affection, and biological characteristics. Theories and methodologies for constructing reliable human-machine systems are taught. Lectures that discuss the application methods involving these systems are held with practical examples.

Theory of Integrated Dynamical Systems

In this subject, we will study optimal control theory of nonlinear systems as a general methodology for modeling, analysis, design, and control of various kinds of systems integrating humans, machines, societies, and environments. After an overview of the fundamentals of optimization, we will discuss various settings of problems, numerical solution techniques, applications, and recent research trends of optimal control problems.

Systems Theory of Learning Machines

This subject covers the methodologies required for a machine with a physical body, such as a robot, to learn dynamic tasks through interaction with the external environment. Specifically, mathematical frameworks to derive the physical model (kinematics and dynamics) of a multi-degree-of-freedom robot and the robot motion learning methods are introduced.

Integrated Systems Biology

This subject aims to present information processing models of biological phenomena and human intelligence systems. Particular topics include the mathematical models of reinforcement learning and sensory information processing, their potential implementations in

the brain, and applications to artificial intelligence problems such as automatic playing of multi-agent games.

Medical Information Systems

This subject explains information technologies, imaging methods and systems related to medicine and clinical treatment. In addition to the basics of biomedical engineering and medical imaging, this lecture introduces the principles of medical imaging device, medical image analysis, machine learning methods and applications to clinical medicine.

Modeling and Problem-Solving of Complex Systems

This class aims to provide frameworks for solving various problems of complex systems. The methodologies consist of modeling target systems, feedback control to achieve our objectives, and formulation of optimization problems by taking account of constraints.

Computational Neuroscience

The brain and neural systems are special in that they are information processing systems build from natural components. Computational neuroscience, as a research discipline, studies the brain from an information processing viewpoint. This subject addresses the brain's ability to operate in uncertain environments and its capacity to learn (adapting to the environment) by discussing various models of the brain and their applications to engineering tasks.

Computational Intelligence

Thanks to advances in information technology, we are able to accumulate vast amounts of real-world data, making data mining, the task of efficiently extracting meaningful information from such data, increasingly important. This subject presents computational intelligence methods based on statistical science (such as statistical learning theory), and describes their applications to various information extraction problems.

Systems Biology

This subject will introduce interdisciplinary knowledge, techniques, and concepts covering a wide range of areas related to developmental, cellular, and mathematical biology, as well as information science. Students will deepen their understanding of the structure, function, and dynamics of cells, as well as their molecular actions, and learn systems biology that considers cells as systems.

Advanced Study in Systems Science 1

Seminars and workshops on various current research themes in systems science are held. Also, experimental practices and exercise on respective research themes are carried out.

Advanced Study in Systems Science 2

Seminars, workshops, experimental practices and exercise on further and advanced research themes are carried out.

Communications and Computer Engineering Course

(For the underlined subjects, classes will be provided in English.)

Theory of Discrete Algorithms

This subject covers recent topics within the field of discrete algorithms. It describes the basic concepts of computational theory, outlines of the basic algorithmic techniques for the divide-and-conquer method and dynamic programming, and covers practical techniques for approximating algorithms and online algorithms. Furthermore, the subject introduces advanced algorithmic techniques for efficiently manipulating large-scale discrete structural data such as logics, sets, sequences, and permutations.
Required background: algorithms and data structure, logic systems, graph theory

Introduction to Algorithms and Informatics

Algorithms are strictly defined methods for solving problems based on calculations. Highly reliable algorithms are vital for daily human life; for example, the internet or smartphones would not exist without algorithms. This introductory subject discusses algorithmic design and analysis of its efficacy through examples of general algorithms that are important and widely used in society.

Digital Communications Engineering

This subject explains fundamental technologies in digital communications engineering such as matched filter theory, modulation and demodulation schemes, convolutional coding, and maximum-likelihood decoding. It also discusses how these techniques will be applied to actual wireless communication systems. It moreover introduces representative anti-multipath fading techniques and the recent technical trend of broadband wireless communications.

Information Networks

This subject introduces fundamental architectures and technologies for the design of information networks, which include packet switching based networks and communication protocols such as internet protocol (IP). Mobile networks and security are also discussed as their applications.

Integrated Circuits Engineering, Adv.

An integrated circuit is a key device that enables functionality enhancement, performance increase, and cost reduction of an electronic system. Steady progress in fabrication technology leads to an exponential increase in integration scale.
This subject focuses on the design methodology of a very large-scale integration (VLSI), with CMOS fabrication and characteristics. Topics covered by the subject include the current status and future directions regarding VLSI design technology, VLSI design flow, VLSI fabrication technology, CMOS layout design, MOS device characteristics, delay and power of CMOS circuits, and clock and power distribution.
Required background: electronic circuits, digital circuits, logic circuits

Design in ICT

Computers and communication networks are representative complex technical artifacts, but it is

not an easy task to perceive their construction principles because their design processes are invisible for us. In this subject, we study design principles for information and computer technology (ICT) in terms of (1) hierarchical abstraction, (2) tradeoff, and (3) human and social analogy, being the computers and the communication networks as specific examples. Recent advances and directions for the design of future ICT will be also discussed using the above design principles.

Theory of Computational Complexity

The main purpose of Theory of Computational Complexity is to categorize the issues with its complexity. In this subject, the first half covers the basics of complexity theory, especially NP-completeness. The second half is comprised of the advanced current topics on the theory.
Required background: design and analysis of algorithms

Parallel Computer Architecture

In this lecture, we first learn instruction-level parallelism in a single processor and its limitations, and then learn data-level parallelism, thread-level parallelism etc., as well as various parallel and domain-specific computer architectures.
Required background: computer architecture, compiler

Hardware Algorithm

Various dedicated circuits are equipped in VLSI systems for high-speed and low-power processing. In development of such circuits, design of their underlying hardware algorithms, i.e., procedures suitable for hardware implementation, is crucial.
In this lecture, we learn hardware algorithms and their design methods mainly for arithmetic operations.
Required background: computer architecture, logic circuit, algorithm

System Verification

This subject lectures methods for verifying that a system conforms to a given specification. We will cover the theory and the tools for model checking, interactive theorem provers, abstract interpretation, and monitoring.
Required background: propositional logic and first-order logic; regular languages and automata; computational complexity; and basic mathematical concepts such as sets, relations, and functions.

Formal Semantics of Computer Programs

The subject discusses formal semantics of computer programs including that of advanced constructs (such as pattern matching and exceptions) found in high-level programming languages and theoretical frameworks to ensure safety of program execution, such as type systems, and type inference.
Required background: programming languages

Transmission Media Engineering, Adv.

This subject introduces link budget design, wireless network design, characteristic analysis, and radio resource management required for using integrated-media communications. Additionally,

the relationship of transmission technologies to optimization theory, game theory, stochastic geometry analysis, and machine learning will be discussed.
Required background: information theory, modulation theory, and basic knowledge of communication networks.

Integrated System Architecture and Synthesis

This subject first introduces algorithms for application-specific domains such as image and video processing. Students then study integration methodologies for multi-media systems. Considering the different levels of parallelism, this subject covers basic algorithms, VLSI architectures, taxonomy of system integration, and evaluation.
Required background: computer system, logic circuits, image processing

System-Level Design Methodology for SoCs

This subject introduces state-of-the-art design methodologies for system-on-a-chip (SoC). The subject covers high-level synthesis, verification technologies, low-power design, design for testability, and other design technologies used in computer-aided design of SoC.
Required background: computer system, logic circuits, programming languages

Atmospheric Measurement Techniques

Various interactions between electromagnetic waves and the Earth's atmosphere, such as scattering, delay, refraction, and radiation, are applied to design novel atmospheric measurement techniques. This lecture explains the fundamental processes occurring in the Earth's atmosphere and introduces various atmospheric probing techniques such as radar, lidar, and earth observation satellite. It also elucidates the advantages and disadvantages of these techniques. This subject is offered to the Inter-Graduate School Program for Sustainable Development and Survivable Societies (GSS) of the Center for Educational Program Promotion in Graduate School.

Required background: Radio engineering, fundamentals of light quantum theory, spectral analysis, mathematical statistics

Remote Sensing Engineering

Remote sensing is a generic term covering a variety of technologies with which physical parameters of interest are measured and/or estimated from a distance. This is a type of inverse problem that suffers essential difficulties by the facts that only some parts of, integrated and/or mixture of the objective values can be observed. In order to solve such a problem, it is necessary to apply an adequate mathematical formulation, and a corresponding solution algorithm to it. In this subject, the theoretical frameworks needed for remote sensing problems are systematically lectured.
This class is offered to the Inter-Graduate School Program for Sustainable Development and Survivable Societies (GSS) of the Center for Educational Program Promotion in Graduate School.
Required background: radio-wave propagation, Fourier transform, probability and statistics

Computer Network, Advanced

Technologies for end-to-end communication and quality-of-service assurance, virtualization technologies, multimedia data representation formats and delivery technologies, algorithms and

protocols for secure communication, and legal systems related to privacy protection and copyrights will be discussed in detail, including the latest trends.

Supercomputing, Advanced

This lecture is for learning architectural and software issues in supercomputing focusing on parallel high-performance scientific computing. The students will use the supercomputer in ACCMS to learn how a real supercomputer works. The lecture is open to students from any graduate schools whose convenience to attend the lecture is regarded by assigning the fifth period for the lecture.

Advanced Study in Communications and Computer Engineering 1

This subject will provide students with the necessary skills to conduct research and development in this area by understanding cutting-edge technologies in computer hardware/software as well as information and communication technology, which constitute the infrastructure of an information society.

Advanced Study in Communications and Computer Engineering 2

This subject will provide students with the necessary skills to conduct research and development in this area by tackling new challenging research topics in computer hardware/software as well as information and communication technology, which constitute the infrastructure of an information society.

Data Science Course

(For the underlined subjects, classes will be provided in English.)

Foundations of Statistical Science

This lecture aims to provide students with the theoretical background of statistical models, which play a central role in recent data science, and to master the implementation of statistical inference. Considering students who need a more fundamental knowledge of statistics, the first half of the lecture starts from the basics of probability and stochastic processes, introduces various statistical models as generalizations of linear regression models, and explains the inference of the models with data examples. In the second half, the basic theory of Bayesian inference and its application to machine learning will be explained.

Digital Transformation

The 2018 Ministry of Economy, Trade and Industry (METI) report "Digital Transformation (DX) Report - Overcoming the IT Systems "2025 Cliff" and Full-Scale Deployment of DX" reported on the need for DX in Japan's economic development and the current status and challenges. However, the "DX White Paper 2021" published in 2021 reported that rigid organizational culture in Japanese organizations and existing structures such as legacy systems are holding them back, and that they are not fully capable of responding to necessary changes. The digitization of society as a whole is considered essential for further economic growth and productivity improvement through the realization of Society 5.0. The government is also promoting digital transformation (DX), as exemplified by the establishment of the Digital Agency, and the benefits of streamlining original operations through DX will be significant. In this lecture, we aim to deepen the discussion on the current status, issues, and direction of solutions for DX in society, using healthcare as an example.

Secondary Usage of Data

The digitization of society as a whole is considered essential for further economic growth and productivity improvement through the realization of Society 5,0. Japanese governments are also promoting digital transformation (DX), as exemplified by the establishment of the Digital Agency, and the secondary use of data accumulated as a benefit of DX offers even greater potential. This lecture aims to deepen the discussion on the current status, issues, and direction of solutions for the utilization of data in society, using healthcare as an example.

Seminar in Data Science (Master’s program)

This subject covers a wide range of research topics in data science, including statistical modeling, as well as theories, methods, and applications of data analysis and machine learning. We discuss most advanced research topics and their foundations and methodologies in relevant academic fields, and discuss future directions of data science. Student presentations are required during this subject.

Statistical Signal Processing

Signal Processing is one of theoretical frameworks to extract useful information from raw observation data. This lecture focuses mainly on the estimation problem of an unknown vector from the observation data, and provides detailed explanations on the approaches of linear inverse problem and Bayesian inference problem from basic theory to practical algorithms including least squares, minimum mean-square-error estimation, adaptive signal processing,

array signal processing, compressed sensing, Kalman filter, particle filter and belief propagation.

Computational Learning Theory

This subject provides lectures on machine learning for discrete data. Neural networks have become one of the most influential machine learning methods for real-valued data and had a big impact on our daily life. However, they are not suitable for discrete data; therefore, the subject will focus on other methods. In the first part of this subject, we will introduce the formal and mathematical foundation of machine learning and discuss machine learning methods for string patterns and finite-state automata in the model of language identification in the limit. In the next part of the subject, we will also introduce machine learning methods for tree-structured data. For discovering frequent patterns from binary vectors, we will discuss methods for itemset mining and closed itemset mining. As extensions of this topic, methods for frequent pattern mining on string and tree data will also be discussed. In the final part of this subject, we will introduce the PAC learning model and discuss the possibility and computational complexity of learning Boolean functions.

Statistical Learning Theory

This subject explains statistical methods for and mathematical perspectives of inferences, predictions, and decisions from data based on probability models. In the first half of the subject, there is an emphasis on model selection and resampling methods using information criteria, while in the latter half, the focus is on dynamic decision-making using bandit algorithms.

Information-theoretic Systems Theory

This subject discusses mathematical approaches, based on probability and statistics, to inference and learning under uncertainty, which form the basis of technologies of machine learning and artificial intelligence. The main focus will be on relations with high-dimensional probability and statistics, as well as with information theory.

Statistical Systems Theory

This subject explains statistical methods for and mathematical perspectives of inferences, predictions, and decisions from data based on probability models. In the first half of the subject, there is an emphasis on model selection and resampling methods using information criteria, while in the latter half, the focus is on dynamic decision-making using bandit algorithms.

Advanced Study in Data Science 1

In this subject, students obtain basic knowledge required to conduct research in respective fields of data science, and conduct exercises and experiments according to their research themes.

Advanced Study in Data Science 2

The objective of this subject is to facilitate students for deepening their study along their respective research themes, and for acquiring skills for evaluation and criticism on researches, with the aim of writing their own thesis.

Subjects for Design course

Information Design

Methodologies of designing artifacts and social activities from the perspective of Informatics are lectured and discussed with students.
Specifically, students will learn about the design of language and expression, design of interaction, design of business, design of ideas, design of discussion, and understanding and reliability of information in order to make information and functions understandable and acceptable.

Field based Learning/Problem based Learning (FBL/PBL) 1, 2

This subject is designed to enable students to put design theories and design methods into practice and to acquire these theories and methods. In Field based Learning (FBL), students can experience the process of finding the problems to be solved from a given real-world fields as a team project. In Problem based Learning (PBL), students can experience the process of solving a given real-world problem as a team project.

Subjects for Platform Studies

Seminar in Platform Studies

From the perspective of social information and utilization in the fields of agriculture, medical care, disaster prevention, this subject will focus on the actual usage of “platforms” and the latest research trends in “platforms” utilization, as well as the case studies by companies use “platforms”, on their themes related to "platforms" using information and communications technology (ICT). Also, practical trainings on how to collect the various type of ubiquitous information in society into the cloud with devices of information and communication, and process and utilize collected data will be performed.

Other subjects provided by the School

Computational Science, Exercise B

This lecture is for learning high-performance and parallel programming for scientific computing. Students will develop their own programs of a given typical scientific problem in C or Fortran according to their preference, and parallelize the program with MPI and OpenMP to run it on the supercomputer in ACCMS. The given problem, such as an explicit differential solver of diffusion equations, is not only fundamental and commonly acquainted by students, but also useful for their research of computational science because the programming and parallelization technique for it is widely applicable. The lecture is open to students from any graduate schools whose convenience to attend the lecture is regarded by offering it as a summer school seminar.

1) Introduction to supercomputers and parallel computing
2) Finite difference method for diffusion equations
3) Program coding of an explicit differential solver
4) Multi-thread parallel programming (OpenMP)
5) Multi-process parallel programming (MPI)

Computational Science for Big Data (Not provided for this year)

Because of the recent progress in a computer or the maintenance of intelligence infrastructure technology, the increase of the quantity of the data generated from the social activity performed through the Internet such as cloud computing and the quantity of the data obtained through the computer simulation which is an important technique of computational science, is being enhanced every day. The purpose of this subject is to study the techniques for handling big data. In particular, data analysis methods using eigenvalues and single value analysis of large sparse matrices, optimization methods for big data, and methods to visualize big data are discussed.

Information Security

Information technology and networks have advanced to the point that they have become necessary for industrial and academic activities. However, the vulnerabilities hidden in these technologies have led to new dangers to society. This lecture series will discuss knowledge such as ensuring safety, defense against attacks, data recovery, and the legal system, with respect to the use of the internet or intranet, from the perspective of the user as well as the latest technologies.

Practice on Informatics in Business

Information Technology (IT) has become an indispensable part of industry and digital transformation (DX) is a key component of staying competitive in business. After learning the significance of IT in business management, students will deepen their understanding through case studies applying IT strategies founded on business strategies. Furthermore, DX will be explored in several types of industries and learned through practical applications. This subject is a general summary of the subject for graduate students within the Business Informatics Practicum, and is an excellent opportunity to gain hands-on experience with IT in business management.

In cooperation with multiple companies, this subject allows students to experience how IT is used in business to capture the importance of information, which improves the competency of skills required in society. Because information and IT are also required in a variety of research areas and occupations, this course targets a wide range of students without restrictions on the field of study. By recognizing the connection of IT to their own field, we hope this course will play a big role for the students' future success in society.

Artificial Intelligence, Advanced

Artificial intelligence (AI) has found its way into everyday life through tools such as those used for translation and image recognition, and is expected to undergo further development. AI is also expected to play an extremely important role in providing a competitive advantage to industries that adopt AI technologies. On the other hand, humans have not yet clearly defined intelligence, and the definition of the term artificial intelligence has yet to be clarified. In this lecture series, AI will be discussed from a historical perspective, beginning with its birth and its evolution. The technological and practical considerations of AI will be discussed systematically through the lenses of system recognition, analysis, and control. The future of AI will also be discussed.

Practice of Design Thinking

The process of system and software development can be broken down into the following steps:

A. Identify issues and needs and develop solutions

B. Define these solutions for implementation into systems and software

Design thinking is an effective tool to accomplish A. The other class called "Practice of system design from users' perspective" is designed to accomplish B. The process of B is called business requirement definition and is vital for accurately informing requirements to the developer. In real business, programmers then implement these business requirement definitions. This subject allows students to learn design thinking through lectures and practicums.

Design thinking is one effective method for bringing about innovation in society and is a problem-solving approach that has recently garnered much attention. It is difficult to accurately grasp true intentions in a rapidly changing modern society, in addition to responding to client or user desires and requests. This lecture series will discuss design thinking and its processes from two broad perspectives: problem discovery and problem resolution. These discussions will equip students with the skills to uncover the true issues and resolve them.

Practice of Business Requirements Definition

("Practice of system design from users' perspective" in the Graduate School of Management)

The process of system and software development can be broken down into the following steps:

A. Identify issues and needs and develop solutions

B. Define these solutions for implementation into systems and software

The other class called "Practice on Design Thinking" is designed to accomplish A. The process of B is called business requirement definition and is vital for accurately informing requirements to the developer. In real business, programmers then implement these business requirement definitions. This subject allows students to focus on business requirements definitions as "user perspectives on system design" through lectures and practicums.

The importance of clearly defining requirements such as functionality to be implemented during system and software development can be said to determine the success of a given project. Defining business requirements begins with identifying the problem that a system or software is being designed to solve. This lecture series aims to provide an understanding of the business requirements, philosophies, processes, advantages/disadvantages, and characteristics of development methods such as the waterfall and agile methods. Focusing more on agile method, it discusses the importance of defining business requirements and common pitfalls from the perspectives and experiences of the user and system developer through case studies.

Practice of Business Data Analysis

Society is moving towards resolving social issues in a data-driven manner through all things connected to the internet. In such an environment, it will be extremely important to determine how best to manage the large amount of data, and to pick out the relevant resolution to social issues. In this practical lecture series, students will learn how to effectively use data analysis to resolve issues in a business setting.

Practice of Frontier Technology Application

The speed of technological evolution represented by AI is occurring at an astonishing pace as the world accelerates towards digitization. Thus, how a businessperson interacts with and uses this new technology will become vitally important. This lecture series will focus on new technologies such as AI and how they can be used in business, including methods and mindsets through practicums. The lectures will also discuss current trends and future developments of advanced technologies.

Courses for the Doctoral Program 2024

Students who enrolled in or before October 2022, please refer to the Course page which has the same name as your current department.

Explanatory notes

1. Faculty member (s) and class schedules are subject to change during this academic year.
2. Seminars in English are given as required.
3. When necessary, the supervising professor may approve the seminar subject offered in the second semester (subject title ending with B) to be considered as the subject from the first semester (title ending with A), or conversely, the first semester subject (title ending with A) to be considered as the second semester subject (title ending with B).
4. For the subjects of the Advanced Mathematical Sciences Course, refer to the Japanese “Guide to Graduate Degree Programs (学修要覧)”.

Conditions to complete the degree

- Doctoral Thesis: Mandatory
- To earn at least 6 credits* from the subjects of the Doctoral Program specified by the school; to receive the appropriate instructions through the classes; and to pass the examinations and the assessment of a Doctoral thesis.

  * 4 credits of Seminars provided by the Course are mandatory.

Intelligence Science and Technology Course

Subject title	Instructors	hours/week		Credits	Remarks
		1st semester	2nd semester		
Seminar on Intelligence Science and Technology, Advanced	Kamitani, Kumada, Nishida, Yamamoto (Akihiro), Kashima (Hisashi), Taniguchi, Kurohashi, Kawahara (Tatsuya), Nishino, Akutsu, Mori (Shinsuke), Nakamura			2	Mandatory, Intensive
Seminar on Brain and Cognitive Sciences, Advanced A	Kamitani, Kumada, Nishida, Nakashima	(2)		2	
Seminar on Brain and Cognitive Sciences, Advanced B	Kamitani, Kumada, Nishida, Nakashima		(2)	2	
Seminar on Cognitive System, Advanced A	Kashima (Hisashi), Yamamoto (Akihiro), Taniguchi, Takeuchi	(2)		2	
Seminar on Cognitive System, Advanced B	Kashima (Hisashi), Yamamoto (Akihiro), Taniguchi, Takeuchi		(2)	2	
Seminar on Intelligence Media, Advanced A	Kurohashi, Kawahara (Tatsuya), Nishino, Sakurada	(2)		2	
Seminar on Intelligence Media, Advanced B	Kurohashi, Kawahara (Tatsuya), Nishino, Sakurada		(2)	2	
Seminar on Application of Multimedia, Advanced A	Mori (Shinsuke), Nakamura, Kondo	(2)		2	
Seminar on Application of Multimedia, Advanced B	Mori (Shinsuke), Nakamura, Kondo		(2)	2	
Seminar on Bio-system Informatics, Advanced A	Akutsu, Tamura	(2)		2	
Seminar on Bio-system Informatics, Advanced B	Akutsu, Tamura		(2)	2	

Seminar on Intelligence Science and Technology, Advanced

In this seminar we review and discuss, from broad perspectives, the latest topics in the field of information processing mechanisms in human and animal organic systems and the field of artificial mechanisms in advanced intelligent information processing.

Seminar on Brain and Cognitive Sciences, Advanced A, B

This seminar provides a broad overview of biological and cognitive processing. It will discuss a number of selected issues and different views with regard to the topic.

Seminar on Cognitive System, Advanced A, B

In this seminar, students learn about state-of-the-art research topics in the field of cognitive systems.

Seminar on Intelligence Media, Advanced A, B

This seminar explains the modelling and controlling methods of the intelligence media systems in the various aspects.

Seminar on Application of Multimedia, Advanced A, B

In this seminar, students examine the multimedia technologies used for intelligent systems, which integrate the functions of recognizing, understanding, generating and authoring multimedia data, such as images, videos and speech. Students also review the methodologies used for flexible human-machine interfaces and communication systems that use the above technologies.

Seminar on Bio-system Informatics, Advanced A, B

Through this seminar, students learn about the latest worldwide research activities concerning various topics in the field of bioinformatics.

★ For students who enrolled in or before October 2022

The requirements for completion of the doctoral program are those specified at the time of your enrollment. The students who enrolled in the Department of Intelligence Science and Technology (in or before October 2022) must take the subjects in the table below. The subjects in the table above can be taken only by the students who enrolled in the Intelligence Science and Technology Course (in or after 2023).

Subject title	Instructors	hours/week		Credits	Remarks
		1st semester	2nd semester		
Seminar on Intelligence Science and Technology, Advanced	Kamitani, Kumada, Nishida, Yamamoto (Akihiro), Kashima (Hisashi), Kurohashi, Kawahara (Tatsuya), Nishino, Akutsu, Okabe, Mori (Shinsuke), Nakamura	(2)	(2)	4	Through the academic year
Seminar on Brain and Cognitive Sciences, Advanced	Kamitani, Kumada, Nishida, Nakashima	(2)		2	Same content in the first and second semester
Seminar on Brain and Cognitive Sciences, Advanced	Kamitani, Kumada, Nishida, Nakashima		(2)	2	
Seminar on Cognitive System, Advanced	Kashima (Hisashi), Yamamoto (Akihiro)	(2)		2	Same content in the first and second semester
Seminar on Cognitive System, Advanced	Kashima (Hisashi), Yamamoto (Akihiro)		(2)	2	
Seminar on Intelligence Media, Advanced	Kurohashi, Kawahara (Tatsuya), Nishino, Yoshii, Nobuhara	(2)		2	Same content in the first and second semester
Seminar on Intelligence Media, Advanced	Kurohashi, Kawahara (Tatsuya), Nishino, Yoshii, Nobuhara		(2)	2	
Seminar on Application of Multimedia, Advanced	Okabe, Mori (Shinsuke), Nakamura, Kondo	(2)		2	Same content in the first and second semester
Seminar on Application of Multimedia, Advanced	Okabe, Mori (Shinsuke), Nakamura, Kondo		(2)	2	
Seminar on Bio-system Informatics, Advanced	Akutsu, Tamura	(2)		2	Same content in the first and second semester
Seminar on Bio-system Informatics, Advanced	Akutsu, Tamura		(2)	2	

Social Informatics Course

Subject title	Instructors	hours / week		Credits	Remarks
		1st semester	2nd semester		
Seminar on Social Informatics, Advanced	Kanda, Ito, Ohte, Doi, Tajima, Tatano, Kuroda, Yamori, Hatayama, Ogata, Shudo			2	Mandatory Intensive
Seminar on Social Information Model, Advanced A	Kanda, Tajima, Yamashita (Naomi)	(2)		2	
Seminar on Social Information Model, Advanced B	Kanda, Tajima, Yamashita (Naomi)		(2)	2	
Seminar on Social Information Network, Advanced A	Abe, Kanda, Ito	(2)		2	
Seminar on Social Information Network, Advanced B	Abe, Kanda, Ito		(2)	2	
Seminar on Biosphere Informatics, Advanced A	Ohte, Koyama, Doi	(2)		2	
Seminar on Biosphere Informatics, Advanced B	Ohte, Koyama, Doi		(2)	2	
Seminar on Regional Disaster Prevention Information Systems, Advanced A	Tatano, Yamori, Hatayama	(2)		2	
Seminar on Regional Disaster Prevention Information Systems, Advanced B	Tatano, Yamori, Hatayama		(2)	2	
Seminar on Medical Informatics, Advanced A	Kuroda	(2)		2	
Seminar on Medical Informatics, Advanced B	Kuroda		(2)	2	
Seminar on Social informatics Analytics Infrastructure, Advanced A	Ogata, Shudo	(2)		2	
Seminar on Social informatics Analytics Infrastructure, Advanced B	Ogata, Shudo		(2)	2	

Seminar on Social Informatics, Advanced

In this seminar, we focus on advanced topics concerning technologies used for gathering and analyzing information, which is necessary for modeling social information systems and their problems from the viewpoint of informatics. In addition, we discuss those topics from multi-disciplinary viewpoints.

Seminar on Social Information Model, Advanced A, B

In this seminar, students will learn several social information systems, such as e-governments, e-commerce, digital libraries, and e-learning systems, as well as the fundamental technologies used to construct those social information systems, such as digital document processing, Web information searching, data mining, contents

archiving, digital rights processing, and database management, human interface and social computing.

Seminar on Social Information Network, Advanced A, B

In this seminar, we will discuss the most advanced topics related to basic theories in interdisciplinary areas (including computer science and social science) such as computational organization theory and computational economics. We will also examine the most advanced topics regarding application systems in social information networks.

Seminar on Biosphere Informatics, Advanced A, B

In this seminar, we will discuss the topic of bio-resources, which includes the global environment and food. We will also discuss methods of analysis for assessing valuable information about the environment and bio-resources in the biosphere using integrated approaches.

Seminar on Regional Disaster Prevention Information Systems, Advanced A, B

Taking into account human behavior and organizational features, this seminar focuses on advanced topics in disaster-prevention information systems to enhance the effective management of disaster risk and response.

Seminar on Medical Informatics, Advanced A, B

After discussing the current situation surrounding the medical information field, students will complete an exercise on medical information. The aim of the subject is to understand the field of medical informatics systematically and to obtain an ability to discuss matters in the field of medical informatics.

Seminar on Information Education, Advanced A, B

Information education is a field connecting computer science, information technology, information society, educational methodologies, and the use of information and communication technologies in education. From a variety of points of view, this seminar studies both theoretical and practical topics in the area of information education. Furthermore, the cutting-edge topics related to the of large-scale data processing, Internet and distributed systems will be discussed.

Seminar on Social informatics Analytics Infrastructure, Advanced A, B

Information education is a field connecting computer science, information technology, information society, educational methodologies, and the use of information and communication technologies in education. From a variety of points of view, this seminar studies both theoretical and practical topics in the area of information education. Furthermore, the cutting-edge topics related to the of large-scale data processing, Internet and distributed systems will be discussed.

★ For students who enrolled in or before October 2022 ★

The requirements for completion of the doctoral program are those specified at the time of your enrollment.

Those who have not taken the subjects provided by the Department of Social Informatics must take the newly introduced subject accordingly.

However, as shown in the table below, the subject titles have been changed and divided, therefore students who have not yet taken the old subjects must take the newly introduced ones.

For those subjects that have been divided, students must take two new subjects, A and B.

Note that for the students who have already taken the subjects, the newly introduced subjects' credits will not be counted as the required credits for completion of the Doctoral program.

Table of dividing/changing of subject's name

Academic year of 2021 or earlier			Academic year of 2022	Academic year of 2023 and later		
Old subject name	Term	Credits	Old subject name	New Subject name	Term	Credits
Seminar on Information Education, Advanced	Though the academic year	4	Seminar on Information Education, Advanced A	Seminar on Social informatics analytics infrastructure, Advanced A	First semester	2
			Seminar on Information Education, Advanced B	Seminar on Social informatics analytics infrastructure, Advanced B	Second semester	2

Table of dividing subjects name

Academic year of 2021 and earlier			Academic year of 2022 and after		
Old subject name	Term	Credits	New Subject name	Term	Credits
Seminar on Social Information Model, Advanced	Though the academic year	4	Seminar on Social Information Model, Advanced A	First semester	2
			Seminar on Social Information Model, Advanced B	Second semester	2
Seminar on Regional Disaster Prevention Information Systems, Advanced	Though the academic year	4	Seminar on Regional Disaster Prevention Information Systems, A	First semester	2
			Seminar on Regional Disaster Prevention Information Systems, B	Second semester	2

Applied Mathematics and Physics Course

Subject title	Instructors	hours / week		Credits	Remarks
		1st semester	2nd semester		
Seminar on Applied Mathematics and Physics, Advanced A	Yamashita (Nobuo), Umeno, Yagasaki, Nonaka	(2)		2	
Seminar on Applied Mathematics and Physics, Advanced B	Yamashita (Nobuo), Umeno, Yagasaki, Nonaka		(2)	2	
Seminar on Applied Mathematics, Advanced	Tsujimoto (Satoshi), Haraguchi		(2)	2	
Seminar on Applied Mathematical Systems, Advanced	Nonaka, Yamashita, Kashima (Kenji), Takahashi, Fukuda		(2)	2	
Seminar on Mathematical Physics, Advanced	Umeno, Yagasaki, Shibayama	(2)		2	

Seminar on Applied Mathematics and Physics, Advanced A, B

This subject discusses some of the current topics in the mathematical sciences from a broad perspective across various specialties with wide experience including internships at industrial laboratories and overseas research institutes.

Seminar on Applied Mathematics, Advanced

This seminar selects and surveys some of the current topics in applied mathematics.

Seminar on Applied Mathematical Systems, Advanced

In this seminar, students study and discuss state-of-the-art research and related literature on various subjects in applied mathematical systems.

Seminar on Mathematical Physics, Advanced

This seminar discusses some of the current topics in mathematical physics.

★ For students who enrolled in or before October 2022 ★

The requirements to complete the Master's program are those specified at the time of enrollment.

Those who have not taken the subjects provided by the Department of Applied Mathematics and Physics must take the relevant ones by the Applied Mathematics and Physics Course.

Systems Science Course

Subject title	Instructors	hours / week		Number of credits	Remarks
		1st semester	2nd semester		
Seminar on Systems Science, Advanced	Azuma, Kano, Ohtsuka, Tanaka, Shimodaira, Morimoto, Ishii			2	
Seminar on Human Machine Symbiosis, Advanced A	Azuma, Kano, Ohtsuka, Nishihara	(2)		2	
Seminar on Human Machine Symbiosis, Advanced B	Azuma, Kano, Ohtsuka, Nishihara		(2)	2	
Seminar on Systems Synthesis, Advanced A	Tanaka, Shimodaira, Obuchi, Honda	(2)		2	
Seminar on Systems Synthesis, Advanced B	Tanaka, Shimodaira, Obuchi, Honda		(2)	2	
Seminar on Systems Informatics, Advanced A	Morimoto, Ishii, Shimazaki, Amemori	(2)		2	
Seminar on Systems Informatics, Advanced B	Morimoto, Ishii, Shimazaki, Amemori		(2)	2	

Seminar on Systems Science, Advanced

We will discuss advanced topics in all areas of systems science, with a wide range of view, free from area of expertise.

Seminar on Human Machine Symbiosis, Advanced A, B

We will study research on the most advanced topics in human machine symbiosis in Japan and all over the world.

Seminar on Systems Synthesis, Advanced A, B

We will study research on the most advanced topics in systems synthesis in Japan and all over the world.

Seminar on Systems Informatics, Advanced A, B

We will study research on the most advanced topics in systems informatics in Japan and all over the world.

★ For Students who enrolled in or before October 2022 ★

Requirements for completion of the doctoral program are those specified at the time of enrollment.

Students who have not yet taken the subjects provided by the Department of Systems Science must take the relevant subjects provided by the Systems Science Course. “Seminar on Applied Informatics, Advanced A, B” is a part of Subjects provided by the Course.

Communications and Computer Engineering Course

Subject title	Instructors	hours/week		Credits	Remarks
		1st semester	2nd semester		
Seminar on Communications and Computer Engineering, Advanced A	Minato, Igarashi, Harada (Hiroshi), Oki, Sato (Takashi), Niitsu, Hashimoto, Yamamoto (Mamoru), Hashiguchi, Iwashita, Okabe	(1)		1	
Seminar on Communications and Computer Engineering, Advanced B	Minato, Igarashi, Harada (Hiroshi), Oki, Sato (Takashi), Niitsu, Hashimoto, Yamamoto (Mamoru), Hashiguchi, Iwashita, Okabe		(1)	1	
Seminar on Computer Engineering, Advanced A	Minato, Igarashi, Kawahara (Jun), Jansson, Suenaga	(2)		2	
Seminar on Computer Engineering, Advanced B	Minato, Igarashi, Kawahara (Jun), Jansson, Suenaga		(2)	2	
Seminar on Communication Systems Engineering, Advanced A	Harada (Hiroshi), Oki, Sato (Takehiro), Mizutani	(2)		2	
Seminar on Communication Systems Engineering, Advanced B	Harada (Hiroshi), Oki, Sato (Takehiro), Mizutani		(2)	2	
Seminar on Integrated Systems Engineering, Advanced A	Sato (Takashi), Niitsu, Hashimoto, Awano	(2)		2	
Seminar on Integrated Systems Engineering, Advanced B	Sato (Takashi), Niitsu, Hashimoto, Awano		(2)	2	
Seminar on Radio Atmospheric Science, Advanced A	Yamamoto (Mamoru), Hashiguchi, Yokoyama, Nishimura	(2)		2	
Seminar on Radio Atmospheric Science, Advanced B	Yamamoto (Mamoru), Hashiguchi, Yokoyama, Nishimura		(2)	2	
Seminar on Information and Communication Infrastructure, Advanced, A	Iwashita, Okabe, Fukazawa	(2)		2	
Seminar on Information and Communication Infrastructure, Advanced, B	Iwashita, Okabe Fukazawa		(2)	2	

Seminar on Communications and Computer Engineering, Advanced A, B

From a broad perspective independent of the area of expertise, this seminar will introduce and discuss the latest topics in computer hardware/software as well as information and communication technology, which constitute the infrastructure of an information society.

Seminar on Computer Engineering, Advanced A, B

This seminar will introduce hot topics in computer engineering, including computer architecture that enables high-performance computation, the algorithms, and basic software systems such as programming language systems.

Seminar on Communication Systems Engineering, Advanced A, B

This seminar includes intensive discussion on the current status, issues, and future directions regarding telecommunication systems engineering such as highly reliable information transmission over severe

wireless channels and architectures of various wired/wireless information networks.

Seminar on Integrated Systems Engineering, Advanced A, B

This seminar includes intensive discussion on the current status, issues, and future directions regarding integrated systems engineering such as design methodologies for digital and analog LSIs, advanced signal processing, etc.

Seminar on Radio Atmospheric Sciences, Advanced A, B

A variety of remote-sensing technologies based on radio waves and light are used for the study of the Earth's atmosphere. This seminar will introduce recent results from a wide area of radio atmospheric science --- i.e., advanced observation technology, recent signal processing technique, and scientific achievements from advanced observations.

Seminar on Information and Communication Infrastructure, Advanced A, B

This seminar includes intensive discussion from the theoretical and implemental point of view on the latest researches of the high-performance computation with the supercomputer and the technology of the Internet.

★ For Students who enrolled in or before October 2022 ★

Requirements for completion of the doctoral program are those specified at the time of enrollment.

Students who have not yet taken the subjects provided by the Department of Communications and Computer Engineering must take the relevant subjects provided by the Communications and Computer Engineering Course.

Data Science Course

Subject title	Instructors	Hours/week		Number of credits	Remarks
		1st semester	2nd semester		
Seminar on Data Science, Advanced	Shimodaira, Hara, Tanaka (Toshiyuki), Hayashi, Yamamoto (Akihiro), Kashima (Hisashi), Tamura			2	Intensive
Seminar on Statistical Modeling, Advanced A	Shimodaira, Hara, Honda	(2)		2	
Seminar on Statistical Modeling, Advanced B	Shimodaira, Hara, Honda		(2)	2	
Seminar on Machine Learning, Advanced A	Tanaka (Toshiyuki), Hayashi, Obuchi	(2)		2	
Seminar on Machine Learning, Advanced B	Tanaka (Toshiyuki), Hayashi, Obuchi		(2)	2	
Seminar on Applied Data Science, Advanced A	Yamamoto (Akihiro), Kashima (Hisashi), Tamura, Takeuchi	(2)		2	
Seminar on Applied Data Science, Advanced B	Yamamoto (Akihiro), Kashima (Hisashi), Tamura, Takeuchi		(2)	2	

Seminar on Data Science, Advanced

This seminar selects current topics from various fields in data science, and review and discuss them from interdisciplinary viewpoints.

Seminar on Statistical Modeling, Advanced A, B

In this seminar, students study and discuss state-of-the art research subjects on statistical modeling and deepen their knowledge on them.

Seminar on Machine Learning, Advanced A, B

In this seminar, students study and discuss state-of-the art research subjects on machine learning and deepen their knowledge on them.

Seminar on Applied Data Science, Advanced A, B

In this seminar, students study and discuss state-of-the art research subjects on applied data science and deepen their knowledge on them.

Design courses

(Enroll after passing the Qualifying Examination (QE).)

For the students of the School, credits not counted towards completing the doctoral degree.

Subject title	Instructors	hours / week		Credits	Remarks
		1st semester	2nd semester		
Open Innovation Practice 1	Faculty members of the Design course			2	General Design Courses (Intensive subject through the academic year)
Open Innovation Practice 2	Faculty members of the Design course			2	General Design Courses (Intensive subject through the academic year) Prerequisite is Open Innovation Practice 1
Field Internship	Faculty members of the Design course			2	General Design Courses (Intensive subject through the academic year)
Research Internship	Faculty members of the Design course			2	General Design Courses (Intensive subject through the academic year)

Open innovation practice 1

Design activities to discover and solve real social issues by consulting related specialists or stakeholders to assemble a team for open innovation, and offering a series of workshops to achieve the objectives. The role of the students in this subject is not to participate as a specialist to solve or discover issues, but to assemble and manage a team for the purpose of the aforementioned open innovation. Through this activity, students' communication and management skills are developed and students gain the knowledge about the basics of design theories and methods to successfully lead design activities through practical experience.

Open innovation practice 2

Design activities to discover and solve real social issues by consulting related specialists or stakeholders to assemble a team for open innovation, and offering a series of workshops to achieve the objectives. Students in this subject develop their knowledge of design theories and methods learned in Open Innovation Practice 1 to further improve their communication and management skills, and acquire a deeper understanding of design theories and methods to successfully lead design activities through practical experience.

Field internship

Students in this program form a group to tackle international/social challenges encompassing several fields of specialties, and apply their knowledge in the field inside or outside Japan to foster their leadership abilities through group activities. In this internship program, students are required to create a strategic solution in the field, where the situation can truly be understood for the first time. Students will do this by structuring the information obtained, defining solvable issues, and interacting seamlessly with stakeholders on the scene and members from different fields within a limited timeframe.

Research internship

The research internship aims to cultivate students' leadership skills while staying at an overseas/domestic research laboratory. Students will form and lead a team in a new research field by conducting multidisciplinary research from the design perspective through planning and executing a research project in collaboration with local researchers. A research plan must be submitted and assessed by program professors before the internship begins.

Platform Studies

For the students of the School, credits not counted towards completing the doctoral degree.

Subject title	Instructors	hours / week		Credits	Remarks
		1st semester	2nd semester		
Seminar in Platform studies, Advanced, I	Faculty members of Doctoral Program of Platform		2	2	Platform studies
Seminar in Platform studies, Advanced II	Faculty members of Doctoral Program of Platform	2		2	Platform studies

Seminar in Platform studies I

This seminar discusses topics associated with “platforms” using information and communication technology (ICT), through case studies of platform development strategies and business models using platforms. Additionally, methods for how to access information, information formats, and methods for using information that are necessary in real-world applications such as in agriculture, health care, and disaster prevention, will be discussed in a seminar format. This seminar will be given by faculty members of the Doctoral Program of Platforms.

Seminar in Platform studies II

This seminar discusses topics associated with “platforms” using information and communication technology (ICT), through seminars on the fundamental knowledge necessary for social and international development of platforms. This seminar will be given by faculty members of the Doctoral Program of Platforms.

Other subject provided by the School (Doctoral Program)

For the students of the School, credits not counted towards completing the doctoral program.

Subject title	Instructors	hours / week		Credits	Remarks
		1st semester	2nd semester		
Long-term Internship in the Field of Informatics	Dean			(2)	Practice (more than 120 hours for credit approval)