E-mail is only available for contacting Department Administration Office:
office@office.keisu.t.u-tokyo.ac.jp

2022 Admission Guide

Department of Information Physics and Computing

Graduate School of Information Science and Technology,

The University of Tokyo

Master's Program

Doctoral Program

Contact [Department Administration Office]

7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656

Department administration office (Department of Information Physics and Computing), Graduate School of Engineering / Information Science and Technology Administrative Group, The University of Tokyo

office@office.keisu.t.u-tokyo.ac.jp

Visit: https://www.i.u-tokyo.ac.jp/edu/course/ipc/index_e.shtml

Note: This guide should be read together with the graduate school's admission guide: "2022 Admission Guide: {Master's / Doctoral} Program, Graduate School of Information Science and Technology, The University of Tokyo." The details of this guide may be changed. In that case, it will be posted on the Department's admissions page.

This document is a translation from the Japanese version.

I. Master's Program

Based on the interdisciplinary nature of the Department of Information Physics and Computing, this Department seeks applicants from a wide range of fields, both inside and outside The University of Tokyo, with a fundamental understanding and knowledge of informatics, mathematics, physics, electrical or mechanical engineering. Examination subjects have been selected to ensure that applicants from diverse disciplines who are not students of The University of Tokyo can take the Examinations under fair conditions for all, with no priority or advantages offered to persons already registered at The University of Tokyo. As described in Section C, examinees can choose other specialized subjects not conducted within this Department.

A. Preference Card

Fill in boxes to the right of the names of the Faculty Advisors listed on the Preference Card (for Master's Program) enclosed with this Guide, using either an 'X' if not preferred or a number to order the preference for up to nine choices. When indicating your preferred field, please write a detailed description being as specific as possible. Your application will be rejected if you do not fall under the supervision of any of the particular Faculty Advisors you have put a number for, or if you keep the boxes empty. Submit the Preference Card together with the other application document. Laboratories in this Department conduct research closely together. Therefore, students can pursue cross-section studies about Information Physics and Computing in any laboratory.

B. Reasons for Application

Submit a three-page document describing the reasons for applying to the Department of Information Physics and Computing, with references if necessary, based on what you have learned and experienced. The document should be written either in Japanese or English.

The font size should be around 11 pt. The document should be on three A4-sized pages. Figures can be included. Please put your name on every sheet.

Since the document is used for the document screening and evaluation, it should include necessary and sufficient information.

C. Examination Schedules

(Document screening)

Document screening will be conducted based on the submitted documents. Regarding the notification of the screening, refer to the Graduate School Application Guidelines.

(Written and oral examinations)

Written and oral examinations will be conducted for examinees who have passed the Document screening. Enrolled students will be selected by using these results comprehensively.

1. Regular education subjects

Please refer to the Graduate School Application Guidelines.

2. Guidance for Online Examinations

Date and Location	Time	Notes:
August 20, 2021 (Friday) Online	13:00 – 14:30	Guidance will be provided regarding all processes to be used during Online Examinations.

Please attend Guidance for Online Examinations for "Information Physics and Computing". Those who were absent from Guidance for Online Examinations are considered to have withdrawn from the entrance examination. For information on Examination for "Computer Science," and "Information and Communication Engineering," please refer to the Admission Guide for the Department in question.

3. Specialized subjects

For Examinations on Specialized Subjects, students shall choose one subject among the following: "Information Physics and Computing", "Computer Science", and "Information and Communication Engineering". Please note that dates, times, and locations differ depending on the subject.

Specialized Subjects	Examination Dates, Times, and Locations	Scope of Questions
Information Physics and Computing	August 23, 2021 (Monday) 10:00 – 12:00 Online	Students will be required to select and solve two among five problems: "signal processing", "electronic circuits", "control", "computer systems", and "dynamics." The total time for answering the problems is 50 minutes.
Computer Science	Please refer to the "Guide to Department Entrance Examinations" for the Department of Computer Science.	
Information and Communication Engineering	Please refer to the "Guide to Department Entrance Examinations" for the Department of Information and Communication Engineering.	

The log-in information of "Website for Examinees (Master & Doctor)" will be sent for

the applicants who have passed the document screening. The details on the Examination for “Information Physics and Computing” may be changed. In that case, it will be posted on the Department’s admissions page. For information on Examination for “Computer Science,” and “Information and Communication Engineering,” please refer to the Admission Guide for the Department in question.

Those who were absent from the specialized subjects examinations are considered to have withdrawn from the entrance examination.

4. Oral Examination

Between 9:00 a.m. and 6:00 p.m. on Tuesday, Wednesday, Thursday and Friday, August 24, 25, 26, and 27, 2021.

Detailed schedules will be posted or distributed during the Examination period. The Oral Examination schedule for examinees who take the subject of the written exam other than “Information Physics and Computing” will be adjusted to avoid overlapping.

D. Notes of Caution

1. Persons who have not graduated from University by September 2021 and wish to enter the school in October are required to confirm their eligibility with the Department Team (the Department of Information Physics and Computing), Academic Affairs Group, Graduate School of Engineering / Information Science, The University of Tokyo.

2. Please read websites for examinees carefully.

II. Doctoral Program

A. Persons wishing to apply to the Doctoral Program should refer to the "2022 Admission Guide: Doctoral Program, Graduate School of Information Science and Technology," and must contact the persons named below before submitting the application. Please call or write well in advance.

Contact:

Department of Information Physics and Computing, Graduate School of Information Science and Technology, The University of Tokyo

7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656

Department of Information Physics and Computing Administration Office

+81 (0)3-5841-6889

office@office.keisu.t.u-tokyo.ac.jp

B. Preference Card

Indicate your preferences concerning Faculty Advisors, etc., on the "Preference Card" (Doctoral Program) included with this Guide, and submit this card together with the application documents. Students admitted to the doctoral program carry out research under the guidance of a designated faculty member who serves as the student's research and thesis advisor. Applicants must identify a faculty member with whom they propose to conduct their research and then contact the faculty member to arrange a face-to-face or online interview in which the applicant describes his or her academic achievements, research experience, research abilities, and research plans before submitting the

application form. The interview must be conducted from April 23 to May 31, 2021, for Summer Examinations or from October 14 to November 17, 2021, for Winter Examinations. Applicants may not be allowed to take the examinations if they fail to complete this procedure.

C. Outline of past research results and Research Plan for Doctoral Program

Submit the following reports together with the other application documents:

1. Describe the content and results of past research as well as the positioning of that research in the field in question. The summary should be either in English or Japanese, on no more than four A4-sized pages.

2. Provide a concrete plan for research to be conducted after admission to the Doctoral Program and describe how this research will contribute to the field in question. Summary should be either in English or Japanese, on no more than two A4-sized pages.

3. Provide the list of research achievements on A4-sized pages. Original articles, review articles, oral presentations, and others should be categorized. If there is no corresponding research achievement, describe as “not applicable”.

The above documents will be used as the basis for the Oral Examinations and subject to scoring. The documents are also used for preliminary screening for exemption from Oral Examination I, so please ensure to prepare these documents carefully in terms of length and content.

D. Examination Schedules

At the time of application, please select either the Summer Entrance Examination or the Winter Entrance Examination. Please note that the periods for acceptance of applications differ for the summer and winter Examinations.

1. Summer Examinations

(Primary Examinations)

Examination Dates and Locations	Examination Times	Examination Subjects	Notes:
August 23, 2021 (Monday) 15:00 –, or August 24, 2021 (Tuesday) 10:00 – Online	Detailed schedules will be posted at 10:00 on August 23.	Oral Examination I	Examinees will be required to answer questions related to the fundamentals of Information Physics and Computing and to the applicant's research field.
August 25, 2021 (Wednesday) Online	Detailed schedules will be posted at 17:00 on August 24.	Oral Examination II	Examinees will be required to answer questions on their research results and research plan submitted beforehand.

TOEFL scores will be used to determine English ability. No written English Examination will be administered. For details, refer to the School Application Guidelines of Graduate School of Information Science and Technology.

Persons who have completed or are expected to complete The University of Tokyo Graduate School Master's Program will not be required to submit TOEFL scores. Also persons who have completed, are expected to complete a Master's Program of Graduate School of Information Science and Technology in The University of Tokyo, or have passed the preliminary screening for exemption will be exempt from Oral Examination I.

Examinees who are rejected in Oral Examination I cannot take Oral Examination II. The passing status of Oral Examination I will be posted with the schedules of Oral Examination II.

(Secondary Examinations)

As a rule, Secondary Examinations will be conducted during the period from late January to mid-February, 2022. Applicants will be notified later regarding details of schedules and

locations. Applicants should bring their Master's thesis (or equivalent document) to the Secondary Examinations. For persons wishing to start the school program in October and for persons already holding a master's degree at the time of application, the Secondary Examination will be conducted based on the schedule for the Oral Examinations II.

2. Winter Examinations

As a rule, primary and secondary Examinations will be conducted during the period from late January to mid-February, 2022. Acceptance will be limited to a few students. Examination methods will be in accordance with those used for Summer Examinations. Applicants will be notified regarding details of schedules and locations after applications have been received.

E. Notes of Caution

1. Persons wishing to start school in October 2021, but have not been conferred Master's degree by September 2021, are required to confirm their eligibility with the Department Team (the Department of Information Physics and Computing), Academic Affairs Group, Graduate School of Engineering / Information Science, The University of Tokyo.

2. Persons wishing to be included in the "Special Selection for Professionals" MUST contact the Administration Office described above before submitting the application. Additional documents will be needed for the "Special Selection for Professionals."

3. Please read websites for examinees carefully.

[Preference card (for Master's Program)]

Department of Information Physics and Computing, Graduate School of Information Science and Technology, The University of Tokyo

Program	Master's Program		
Examinee's name		Examination admission number (leave blank)	
Graduating university (only if applicable)	University / School / Department :		
Phone number and e-mail where examinee can be contacted during the Examination period	Address: Tel: Mobile phone: E-mail:		

Preferred Faculty Advisor (in order of preference)
Fill in boxes with numbers indicating order of preference up to ninth choice.
Fill in each box with an 'X' if not preferred.
Note that your application will be rejected if you do not fall under the supervision of any of the Faculty Advisors you number or if you keep the boxes empty.

Prof. Hiroshi Saruwatari		Associate Prof. Ryoichi Hirosaki	
Shoichi Koyama (Lecturer)		Prof. Hiroshi Nakamura	
Prof. Kenji Kawashima		Associate Prof. Hideki Takase	
Prof. Takaaki Nara		Masashi Ikeuchi (Lecturer)	
Keisuke Hasegawa (Lecturer)		Prof. Masahiko Inami	
Prof. Hiroyuki Shinoda		Associate Prof. Yasuaki Monnai	
Associate Prof. Yasutoshi Makino		Prof. Hiroshi Saito	
Prof. Masayuki Fujita		Prof. Yuji Sekiya	
Associate Prof. Koji Tsumura		Prof. Hiroki Ueda	
Prof. Kaoru Amano		Associate Prof. Takahiro Shinagawa	
Prof. Makoto Naruse		~~Tomoki Koriyama (Lecturer)~~	

Specialized subjects to be tested on the Examination (Please circle the appropriate responses)	Information Physics and Computing / Computer Science / Information and Communication Engineering	
Preferred start date (Please circle the appropriate response)	October 2021 / April 2022	
Residence Card	□ Retain Status: student / other( ) Expiration date:	□ Not Retain

◆Submit this form together with your application.

◆Persons who have not graduated from university by September 2021 wishing to enter the school in October are required to confirm the eligibility with the Department Team (the Department of Information Physics and Computing), Graduate School of Engineering / Information Science and Technology, Academic Affairs Group, The University of Tokyo, and circle "October 2021" in the appropriate column above.

Department of Information Physics and Computing, Graduate School of Information Science and Technology, The University of Tokyo

Program	Master's Program

Reasons of application

Submit a three-page document describing the reason for application for the Department of Information Physics and Computing, if necessary with references, based on what you have learned and experienced. The document should be written either in Japanese or English.

The font size should be around 11 pt. The document should be on three A4-sized pages. Figures can be included. Please put your name on every sheet.

Since the document is used for the document screening and evaluation, the document should include necessary and sufficient information.

[Preference card (for Doctoral Program)]

Department of Information Physics and Computing, Graduate School of Information Science and Technology, The University of Tokyo

<table>
<tr><td>Program</td><td colspan="3">Doctoral Program</td></tr>
<tr><td>Examinee’s name</td><td></td><td>Examination admission number (leave blank)</td><td></td></tr>
<tr><td>Graduating university or graduate school</td><td colspan="3">University: _____
School: _____
Department: _____
Graduate School: _____
School: _____
Department: _____</td></tr>
<tr><td>E-mail and phone number where the examinee can be contacted during the Examination period</td><td colspan="3">Address:
Tel: Mobile phone:
E-mail:</td></tr>
<tr><td>Preferred Faculty Advisor</td><td colspan="3">Advisor: (Interview Date:)</td></tr>
<tr><td>Application Category</td><td>SUMMER Entrance Examination / WINTER Entrance Examination</td><td>Circle “Professionals” if you wish to apply based on the Special Selection for Professionals.</td><td>Professionals</td></tr>
<tr><td>Preferred time of entry (Please circle the appropriate response)</td><td colspan="3">October 2021 / April 2022</td></tr>
<tr><td>Residence Card</td><td colspan="2">☐ Retain
Status: student / other( )
Expiration date:</td><td>☐ Not Retain</td></tr>
<tr><td colspan="4">Outline of past research results and Research Plan for Doctoral Program</td></tr>
<tr><td colspan="4">Submit the following reports together with the other application documents.
1. Describe the content and results of past research as well as the positioning of that research in the field in question. The summary should be either in English or Japanese, on no more than four A4-sized pages.
2. Provide a concrete plan for research to be conducted after admission to the Doctoral Program and describe how this research will contribute to the field in question. The summary should be either in English or Japanese, on no more than two A4-sized pages.
3. Provide the list of research achievements on A4-sized pages. Original articles, review articles, oral presentations, and others should be categorized. If there is no corresponding research achievement, describe as “not applicable”.
The above documents will be used as the basis for the Oral Examinations and subject to scoring. The documents are also used for preliminary screening for exemption from Oral Examination I, so please ensure to prepare these documents carefully in terms of length and content.</td></tr>
</table>

◆ Submit this form together with your application.

◆ Please note that the acceptance period of applications differs for the summer and winter Examinations. Application documents that arrive outside of the applicable period for acceptance of applications shall be deemed invalid.

◆Persons who have not earned Master’s degree by September 2021 wishing to enter the school in October via the Summer Examination are required to confirm the eligibility with the Department Team (the Department of Information Physics and Computing), Graduate School of Engineering / Information Science and Technology, Academic Affairs Group, The University of Tokyo, and circle “October 2021” in the appropriate column above.

Faculty members and laboratories

Sound Media Informatics Lab. (Saruwatari and Koyama Lab.) http://www.sp.ipc.i.u-tokyo.ac.jp/	
Professor Hiroshi Saruwatari[1)] Lecturer Shoichi Koyama	This laboratory mainly innovates in new signal processing and information processing systems, focusing our attention on understanding, processing, and controlling sound media (speech, music, etc.). For example, theories on new statistical modeling and machine-learning-based algorithms are of interest for solving optimization problems under acoustical generative models and physical constraints. Through our research, we extend human hearing systems, create new human-machine interface systems, and bring our innovative contribution to music creation. (1) Auditory Communication Augmentation via Unsupervised Learning We realize versatile unsupervised source separation combining statistical estimation theories and low-rank modeling. Also, we address a new combination of deep learning and spatial acoustics, which can be applied to semi-supervised source separation. Thanks to these methods, new human-machine interfaces, auditory communication augmentation systems, and user-oriented music information systems can be developed. (2) Inverse Problems for Acoustic Field, Sound Field Control, and Their Applications We tackle with inverse problems for acoustic field, such as sound field imaging, analysis, source localization, and estimation of room acoustic parameters, as well as sound field control problems for reproducing a desired sound space. We explore new methodologies with various approaches (signal processing, optimization, statistical modeling, machine learning, etc.) and develop new systems for telecommunication, virtual reality, and so on. (3) Augmented Speech Communication Based on Machine Learning We address signal processing and machine learning theories for speech synthesis and conversion towards human-human and human-machine communication. We interpret speech from the perspectives of physics and informatics and deal with accurate modeling of speech signals and speech information. We also develop speech-based virtual reality systems by human-in-the-loop speech modeling that integrate humans into machine learning.

1) Department of Creative Informatics

Biomechanical system Lab. (Kawashima Lab) http://www.bmc.ipc.i.u-tokyo.ac.jp/	
Professor Kenji Kawashima	We research and develop novel medical systems, robotic systems, and human-machine systems useful to reach a healthy and long-lived society, such as surgical support and motion assistance. Our original technique is to combine a measurement control technology based on distributed parameter models of fluid drive systems with a system design that utilizes actuator characteristics. Besides, we integrate medical engineering and information science to develop highly smart and functional systems to implement them into our society. (1) Surgical assistant robots We are researching robots that assist in minimally invasive surgery. We aim to improve system intelligence and function by autonomous control of specific operations using machine learning, and we improve the safety of surgery by showing multimodal information to the operator. (2) Motion assist systems By utilizing the advantages of direct-drive of soft actuators such as pneumatic artificial rubber muscles, we realize motion assistive systems that estimate a wearer's motion from control information on the actuator without mounting sensors directly on the wearer's body. (3) Measurement and control of fluid systems We propose applications to state estimation and prediction problems in fluid-driven medical systems by using morphological computation that utilizes non-linearly distributed state quantities of the fluid-driven systems.

Physical Informatics & Inverse Problem Lab. (Nara and Hasegawa Lab.) http://www.inv.ipc.i.u-tokyo.ac.jp/	
Professor Takaaki Nara Lecturer Keisuke Hasegawa	Inverse problems are recovering problems of physical information from indirect measurements with mathematical reconstruction. Our laboratory develops basic and unified theories and measurement/actuating systems for inverse problems. (1) Development of direct reconstruction and measurement methods for inverse problems: for inverse source/coefficients/boundary value/governing-equation problems, theories to express physical information in a closed form in terms of data are developed based on mathematical physics tools such as complex analysis, potential theories, and tensor analysis. (2) Application to non-invasive measurements, non-destructive inspection, disaster relief, and tissue engineering: novel measurements and mathematical methods are developed and applied to diagnosis of epilepsy based on magnetoencephalography (MEG) and electroencephalography (EEG), imaging of electrical and mechanical properties inside the human body based on magnetic resonance imaging (MRI), non-destructive testing using electromagnetic field and ultrasonic waves, search for victims buried in rubble in earthquake disasters, and design of cellular alignment. (3) Construction of physical information systems based on midair acoustic fields designed via inverse-problem formulation: airborne acoustic fields with desired spatiotemporal structures are designed by solving inverse problems derived from physical models, so as to realize novel functions such as remote airflow control, non-contact acoustic measurement, and midair communication with spatial selectivity.

Real-World Informatics Lab. (Shinoda and Makino Lab.) https://hapislab.org/?lang=en	
Professor Hiroyuki Shinoda[2)] Associate Professor Yasutoshi Makino[2)]	We realize a real-world informative environment that goes beyond conventional barriers by introducing new physical phenomena and physical structures into the system. In particular, we propose technologies from hardware to applied systems for sensing humans, environments, and their interactions, and for supporting humans through haptic and other human senses. Research topics include basic and universal discoveries based on novel ideas and the process of solving social problems and using them for practical technologies. (1) Haptic Interface: A system that supports human life and behavior by stimulating the sense of touch simultaneously with audiovisual information. Clarify the relationship between the tactile sensation and the mind and emotions that support the base of human intelligence, and apply it to real systems. (2) 2D Communication: Information and electricity transmission through a thin sheet using electromagnetic waves to realize wireless power supply and high-speed signal transmission without interfering with conventional wireless LAN. (3) Use of human behavior：Based on the features of human behavior, we predict near-future motion and estimate haptic characteristics of the object in touch. This technology can be used for preventing fall and for sports. (4) Other topics such as physical informatic devices, human-machine interfaces, non-contact measurement of haptic information, artificial robot skin, wearable computing, etc.

2) Department of Complexity Science and Engineering, Graduate School of Frontier Sciences

Systems & Control Laboratory (Fujita Laboratory) http://www.scl.ipc.i.u-tokyo.ac.jp/	
Professor Masayuki Fujita	Control and Autonomy in Cognitive Cyber-Physical Systems (1) Cooperative Control in Networked Robotics We are conducting research on cooperative control of multi-robot and multi-agent network systems. Our goal is to explore the fundamental principles for designing totally optimal motions from distributed information exchanges. (2) Autonomy in Cognitive Cyber-Physical Systems via ML/AI-based Control We are studying autonomous systems which can make a decision on their motion by environmental perception and cognition. Our goal is to create a novel control theory which realizes robust and intelligent action via learning of uncertainties in systems and environments. (3) Cyber-Physical & Human Systems We are working on cyber-physical systems with human interventions in decision-making. In particular, our interest is on a system design for realizing Human-Machine Teamings.

Control Theory Lab. (Tsumura Lab.) http://www.cyb.ipc.i.u-tokyo.ac.jp/	
Associate Professor Koji Tsumura	Control engineering is involved for the design of the behavior of systems and we aim to develop its corresponding theories and applications widely. Research themes are divided into three categories; cybernetics, control system analysis & synthesis, and modeling/system identification/estimation/learning, which are explained below: (1) Cybernetics: By employing new fusion of system control theory with information theory/physics/optimization/system biology, we aim to establish theories of analysis and synthesis for large scale complex system/multi-agent system/networked system/networked AI/bio-system/quantum control system. (2) Control System Analysis & Synthesis: We aim to develop advanced control theories including robust control, nonlinear control, hybrid control, learning control and so on. (3) Modeling/System Identification/Estimation/Learning: We aim to establish theory for the modeling of dynamical systems, in particular system identification for uncertain modeling or modeling for large-scale complex systems.

Neural Information Lab. (Amano Lab.) https://www.brain.ipc.i.u-tokyo.ac.jp/	
Professor Kaoru Amano	We are investigating the neural mechanisms underlying human sensory perception and cognition using non-invasive neuroimaging techniques such as magnetoencephalography (MEG), functional magnetic resonance imaging (fMRI). In particular, we are developing methods for non-invasive manipulation of brain information to elucidate the neural process that causally contributes to human perception and behavior. In recent years, we have been focusing on the functional roles of neural oscillations in information integration. We are also interested in how the individual differences in brain activity and perception are related to the individual differences in brain structure. (1) Development and application of brain information control technology We are developing techniques for non-invasive manipulation of brain information based on transcranial electrical/magnetic stimulation and neurofeedback. Using those techniques, we investigate the changes in perception, cognition, and behavior associated with the changes in brain information. (2) Neural oscillations as a clock for visual processing Neural oscillations such as alpha (8-13 Hz) and theta (4-8 Hz) oscillations are thought to work as a clock for information processing in the brain. For example, we have shown that an illusion called motion-induced spatial conflict, in which a figure that is actually moving smoothly is perceived to be moving while jittering at around 10 Hz, is tightly coupled with alpha oscillations. The results suggest that alpha oscillations might determine the timing of communication across different visual areas for integrating information. We will investigate this clock function by combining functional brain imaging such as electroencephalography (EEG) and magnetoencephalography (MEG) with non-invasive manipulative techniques. (3) Functional roles of the white matter tracts The brain tissue called white matter is responsible for information transmission between brain regions. By investigating the relationship between the characteristics of white matter pathways measured by diffusion-weighted/quantitative MRI and perception, cognition, or behavior, we intend to clarify the function of information transmission in the brain.

Systems Information Physics Lab. (Naruse and Horisaki Lab.) http://www.inter.ipc.i.u-tokyo.ac.jp/	
Professor Makoto Naruse Associate Professor Ryoichi Horisaki	Photonics is playing crucial roles in the frontier of innovative computing, imaging, and communications. Our research group pushes three complementary directions. One is *photonics-for-computing,* where the aim is to develop novel architectures for computing, including decision making, in which we benefit from the unique physical attributes of photons. The second is *computing-for-photonics*, such as computational imaging, where novel algorithms and mathematical modeling significantly expand imaging functions. The third is to extend our information physics systems approach to new domains such as beyond 5G communications. (1) AI Photonics －Decision Making by Photons This project physically resolves decision-making problems in dynamically changing uncertain environments by utilizing the photon's unique nature. The topic includes the design of ultrafast decision-making using chaotic lasers, and collective decision-making using entangled photons. (2) Computational Imaging Computational imaging aims to provide novel imaging functionalities by unifying optics and computing. For example, we develop novel architectures for imaging through scattering media via insights into physical processes and state-of-the-art signal processing, including machine learning. Such *computing-for-photonics* research plays critical roles in medical, astronomical, and security applications. (3) Novel System Design Utilizing Natural Processes Novel system architecture design is critical to deal with the growing demands for computing and communications. We are developing strictly delay-bounded information networks based on precision time-and-space synchronization technology, vital in real-time and reliable communications in the post 5G era.

Computing System Lab. (Nakamura and Kondo Lab.) http://www.hal.ipc.i.u-tokyo.ac.jp/	
Professor Hiroshi Nakamura Associate Professor Hideki Takase	Our goal is to establish design methodology of high-quality computing in which advanced interaction between the physical world and the cyber world is realized. The quality includes performance, responsiveness, power consumption, reliability, and security. These are in a trade-off relationship, and the system needs to be optimized according to its characteristics and requirements. We are researching the comprehensive system-level design methodology to optimize the entire system, from edge devices including sensors and robots to servers, by coordinating device, circuit technology, architecture, and software. (1) Cyber-physical systems: Cyber-physical systems connect everything in the physical world to the Internet, process enormous amounts of obtained data in the information or cyber world, and work on the physical world. We are conducting research to improve performance, responsiveness, power efficiency, reliability, and security of cyber-physical systems through advanced orchestration of widely distributed edge devices, networks, and servers by making use of characteristics of the target processing. (2) Ultra-low power computing: We are researching an innovative computing that dramatically reduces power consumption by coordinating and cooperating devices, circuit technologies, architectures and system software across design layers. For this purpose, we extract and utilize the characteristics of processing, such as parallelism and locality, to realize innovative computing that enables optimization of processing according to the characteristics of devices and circuits. (3) Lightweight runtime environment and cooperative optimization for robot systems: To realize the development platform that supports the cloud robotics era, we are researching a runtime environment that can operate on lightweight embedded devices, and a cooperative system design methodology that improves real-time performance and power efficiency. We are also working on design methods and development technologies that utilize virtual environments for robot applications in large-scale IoT environments. (4) Comprehensive IoT system design optimization technology: The IoT system is composed of a large number of diverse computers. We are researching a comprehensive design environment that realizes high performance and lower power consumption while improving the design productivity of the entire system by optimizing both the vertical direction of the architecture hierarchy and the horizontal direction of the IoT components.

Biomedical Process Control Lab. (Ikeuchi Lab.) http://micro.ipc.i.u-tokyo.ac.jp/	
Lecturer Masashi Ikeuchi	We are exploring to understand and control biomedical processes by using microsystem engineering, such as minimally invasive medical devices and microscale cell analysis devices based on micro/nano fabrication and manipulation technologies. (1) Microrobotic System for Assisted reproductive technology In recent years, the number of cases of assisted reproductive technology has increased rapidly in the world. However, the process from ovum collection and sperm collection to pregnancy has many medically unexplained steps, causing the success rate of the treatment to be kept around 30%. We aim to improve the overall success rate of assisted reproductive technology by using microrobots and microfluidic devices while studying the biological mechanism of the processes. (2) On-chip Cell Processing for Regenerative Medicine Low-cost mass-production and quality assurance technology of cells and tissues is indispensable for the spread of regenerative medicine. In contrast to the conventional robotic cell processing technology, we utilize micro-fluidics technology to realize a benchtop regenerative medicine factory by eliminating compatibility with traditional manual experiment. (3) Minimally Invasive Treatment System Based on Mechanobiology We elucidate how cells and tissues sense and respond to mechanical stimuli at the single-cell level by using improvised microscale cell manipulation devices. Moreover, based on the cellular response to mechanical stimulation, we are developing new minimally invasive medical treatment without using drugs.

Information Somatics Lab. (Inami and Monnai Lab.) https://www.star.rcast.u-tokyo.ac.jp	
Professor Masahiko Inami Associate Professor Yasuaki Monnai*	In the Information Somatics Lab, our work is built upon a foundation of psychology, cognitive science, and physics to understand the mechanisms of the human body from a systems perspective and to use the insights we gain to augment its innate sensory, physical, and intellectual capabilities. (1) Jizai Technology: To enable free (jizai) control of their bodies, including any augmentations, both the user and system require awareness of the world and each other. We integrate biological (e.g., gaze, EMG) and environmental (e.g., vision, acoustic) sensing, intention interpretation and action prediction (e.g., using machine learning), and actuation (e.g., EMS, mechanisms) to achieve human augmentation. (2) Human Augmentation Engineering: Employing VR, XR, robotic, wearable, wireless, and telexistence technologies, we augment human abilities to achieve novel forms of embodiment (e.g., superhuman, disembodied, transformed, cloned, fused) to address social issues such as hyperaging. (3) Experience Transferral: We aim to provide experiential "supplements" which improve the quality of everyday life. These supplements are formed and administered by systems capable of recording, replaying, and transferring first-person audio-visual-haptic bodily and spatial experiences. We are working towards applying our work in the areas of entertainment computing, superhuman sports, and skill transferal. (4) Experience Design: Building on a foundation of psychology and physiology, we design methods that make use of information technologies to enable the composition of arbitrary perceptual and emotional experiences by transforming a user's self perception as well as their perception of others. (5) Wireless interaction: We set a goal to assist humans physically and cognitively in a stress-free manner using wireless technology in the broadest sense of the word. Our approach is based on wireless transmission of information, energy, and materials using electromagnetic, acoustic, and fluid systems, aiming for wirelessization of everything.

* Appointed in October 2021

Information Transfer System Mathematics Laboratory http://www9.plala.or.jp/hslab/SaitoLab.html	
Professor Hiroshi Saito[3)]	Research Theme: Research on mathematical methods for implementing advanced networks, such as for Internet of Things (IoT), and applications based on sensory data obtained with such networks. Implementing advanced networks, such as for IoT, and application services based on sensory data obtained from such networks requires many mathematical methods. Research on those methods requires understanding both these mathematical methods and advanced networks/application services. This laboratory is conducting research on new applications of the mathematical methods to advanced networks and application services and developing core algorithms of these networks and services. Examples of research (i) Using online weather information such as for typhoons, we developed a disaster avoidance control method for relocating network function blocks on the network and cloud to avoid disasters. We also developed a physical network design method for determining the geometrical and geographical shape of a network to minimize the possibility of encountering disasters. Such research aims at implementing the "disaster-free network." (ii) The dual use of radio frequency signals to deliver energy and transfer information was recently proposed. Although wireless power transfer has been studied for some time, it was discussed independently of information transfer. We theoretically analyze the harvested radio signal energy and develop algorithms to realize wireless mobile networks transferring information and energy. (iii) Many devices that have sensing capabilities, such as smartphones, are widely used. By analyzing sensory data from such devices as time-series data or ensemble data, we are developing new applications such as for health management, person identification, risk management.

3) Mathematics and Informatics Center

Information Communication System Architecture Laboratory https://www.sekiya-lab.info/	
Professor Yuji Sekiya[4)]	In this laboratory, we research communication infrastructure technology and its architecture using software and virtualization, and the methods for detection and countermeasures against cybersecurity threats using machine learning. This laboratory cooperates with the Information Technology Center and Security Informatics Education and Research Center at the University of Tokyo. We aim to contribute to improving the system architecture using software technology and cybersecurity measures based on actual operations. (1) Virtualization and software technologies have been introduced as fundamental technologies for information communication systems (ICT) such as cloud computing and 5G. In recent years, flexibility and promptness are required on ICT systems. Therefore, virtualization and software technology are introduced in the architecture. In this laboratory, we research software technologies for ICT systems and their new architecture. (2) Nowadays, cybersecurity is a big problem for ICT systems. Attackers steal confidential information and hijack systems through organized and sophisticated attacks. In this laboratory, we research methods to detect cyber threats using machine learning technologies with various types of datasets from communication infrastructure to social trends. This research improves the safety of ICT systems that support society's infrastructures.

4) Security Informatics Education and Research Center

Systems Pharmacology (Prof. Ueda) http://sys-pharm.m.u-tokyo.ac.jp/	
Professor Hiroki Ueda[5)]	**Our goal: Understanding and controlling sleep and consciousness through the integration of medicine and information science** Whole-brain & whole-cell analysis Our laboratory has developed a whole-brain clearing and imaging method (CUBIC) which can make brain samples look transparent, such that all cells in the brain can be analyzed at a single-cell resolution, including the position of all cells. Aiming at understanding brain functions, we will develop analysis and visualization methods for large image data (14 terabytes per brain) obtained by CUBIC, and apply it to the study of sleep/wake rhythm. **Keywords**: Cloud computing, Brain function analysis, Image analysis Chemoinformatics-driven Drug discovery Chemoinformatics is becoming more and more widespread such as for drug discovery research, but it still requires developments in many aspects such as activity prediction and structure prediction. In our laboratory, we will develop algorithms to predict drug discovery and experimental reagent candidates by predicting compounds with specific activities, and apply it to the study of sleep/wake rhythm. **Keywords**: Machine learning, Bayesian optimization, Drug screening Development of sleep classification algorithm using biological data Accurate sleep classification of humans is performed by measuring brain waves. Based on easily acquired time-series data such as breathing and arm movements, we have developed a simple and high-performance sleep classification algorithm using machine learning. By improving this algorithm, we will carry a big data analysis of sleep and understand sleep/wake rhythm. **Keywords**: Machine learning, Time series analysis, Biological data

5) Department of Systems Pharmacology, Graduate School of Medicine

Operating System Laboratory (Shinagawa Laboratory) https://www.os.ecc.u-tokyo.ac.jp/	
Associate Professor Takahiro Shinagawa	Our research is about low-layer (deep) system software located on the boundary between computer hardware (physical world) and software (information world). We primarily focus on core system software such as operating systems (OS) and virtual machine monitors (VMM) as well as system software in general, from middleware to distributed systems. From the perspectives of performance, functionality, security, reliability, manageability, and abstraction, we are conducting leading-edge research and development that contributes to the realization of next-generation system software based on new concepts. We use existing OSes such as Linux, Windows, macOS, iOS, and Android, and our original virtualization software called BitVisor developed in our laboratory. The target hardware is a variety of computer systems from large-scale systems such as servers, clouds, and data centers to small systems such as desktops, smartphones, and embedded devices such as IoT devices. (1) Operating system: we are conducting researches to improve functionalities and performance based on existing OS kernels. We also aim to research and develop our own OS for next-generation computers. (2) Virtualization software: we have been conducting several kinds of research based on “BitVisor” made in Japan. By exploiting modern virtualization technology, we aim to realize new functionalities, such as security and system management, without depending on specific OSes. (3) Secure computing: we aim to provide a secure computing environment as a whole by combining OS kernels, virtualization software, compilers, and applications organically.

6) Information Technology Center

Spoken Language Modeling Laboratory (Koriyama Laboratory) https://hyama5.github.io/	
Lecturer Tomoki Koriyama3)	Speech processing and spoken language processing is a technology for computers to recognize, understand, and generate human speech. Machine learning with speech data enhanced the quality of speech processing. In this laboratory, we study not only the effective modeling method of speech but also a new paradigm of machine learning through speech modeling. Examples of research (i) Exploration of latent factors of spoken language Speech is affected by a variety of factors, such as languages, dialects, emotional expressions, intentions, and speakers. Using mathematical models based on machine learning, we infer the latent representation of speech and apply it to applications such as speech synthesis and speaker verification. (ii) Stability and Reliability of Machine Learning In machine learning with large databases, it needs to be flexible for unknown data from the physical world. We aim to achieve stability and reliability in machine learning by using mathematical models that take into account the uncertainty of prediction, such as Gaussian processes, deep Bayesian models, and moment matching.

3) Mathematics and Informatics Center

* We will not accept students for 2022 Admission.

Required Document (Department of Information Physics and Computing)

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<tr><td rowspan="2"></td><td colspan="2">Summer Examination</td><td colspan="2">Winter Examination</td></tr>
<tr><td>Documents to be Submitted</td><td>Who to Submit</td><td>Documents to be Submitted</td><td>Who to Submit</td></tr>
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<tr><td>Reason for Application (three A4-sized pages, either in English or Japanese)</td><td>All Applicants</td></tr>
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