**Education Program of Advanced Information Technology Leaders**

Degree: Master’s degree and Doctoral degree (2 years and 3 years)

Participation Departments:
Department of Computer Science
Department of Mechanical and Environmental Informatics
Department of Mathematical and Computing Sciences

1. Program Outline
Japan is a world leader in both research and practical application in many areas of information science & technology including embedded software, multi-media processing, human interface, robot informatics, large-scale computational technology and environmental information technology such as consumer electronics, computer games and industrial intelligent robotics. The aim of this program is to offer enrollment in master’s and doctoral programs to overseas students qualified in information science & engineering subjects, and to educate them to engineering, research and teaching leaders who will actively contribute to the research and development system to cope with the globalization of these Japanese information technologies. This program includes practice oriented courses in these areas. Students will be trained using Japan’s most advanced computing environments, and will also be able to participate in industrial internships.

2. Guide to Study
* Education program focused on Japan’s cutting edge information technology
This program focuses on the six disciplines of Japan’s most cutting-edge academic and industrial research fields in information sciences; i.e., embedded software, multi-media processing, human interface, robot informatics, regional planning, and computing and mathematics. The aim of this program is to foster engineering, research, and teaching leaders who will actively contribute to information sciences.

* Confers master’s and doctoral degrees
In this program, we seek master’s and doctoral students. In transition from the master’s program to the doctoral program, the students’ ability to conduct research needs to be ensured through master’s theses and/or other academic activities.

* Practice-oriented program
It is essential to acquire practical skills for the development of software in the above six disciplines. In the lectures we spare significant amount of time on computer exercises. Furthermore, we facilitate the students acquiring high practical skills through the courses of “Projects”, “Seminars” and “Special Experiments” by doing practical projects with other Japanese students in an interactive way. In these projects, students are allowed to use the Tokyo Tech’s state-of-the-art facilities such as TSUBAME Supercomputer. Furthermore, for practical training purposes we also provide opportunities for the students to participate in industrial internships so that they can experience projects of software development in the software industry and robot development at HRI.

* Six disciplines in the program
We categorize the courses of this program into the six disciplines, i.e., embedded software, multi-media processing, human interface, robot informatics, regional planning and computing and mathematics, so that one can focus on one of the six disciplines to go through both basic and advanced topics in the specified
discipline by the student. The six disciplines and their course names are listed below. Even though students are encouraged to focus on one of the disciplines, it is possible to take courses from two or more disciplines according to the students’ areas of interest. For example, if a student is interested in humanoid technology, then he/she can take courses from both disciplines of human interface and robot informatics. Students can also take courses other than the courses listed below in consultation with their academic advisers.

1. **Multi-media processing discipline**
   Advanced Coding Theory, Advanced Data Engineering, Pattern Information Processing, Computer Graphics, Speech Information Processing,

2. **Human interface discipline**
   Advanced Data Engineering, Human Computer Interaction, Machine Learning, Advanced Data Analysis, Pattern Information Processing, Computer Graphics, Speech Information Processing, Complex Networks, Introduction to Neural Engineering,

3. **Embedded software discipline**
   Advanced Coding Theory, Distributed Algorithms, Advanced Data Engineering, Concurrent System Theory, Advanced Data Analysis, Pattern Information Processing, Software Design Methodology, Linear Systems and Control, Mathematical Processing of Measurement Information, Advance Operating Systems,

4. **Robot informatics discipline**

5. **Regional Planning discipline**
   Mechanical and Environmental Informatics Project I, Mechanical and Environmental Informatics Project II, Theory and Applications of Urban Spatial Data, Analysis of Vibration and Elastic Wave, Intellectual Infrastructure Systems, Air Quality Engineering, Regional Information Analysis, Advanced Course on Coastal Environments, Econometric Analysis,

6. **Computing and mathematical science discipline**

* The official language of this program is English.
* Follow-up system after graduation

We provide assistance for the students in the case where one seeks job opportunities related to the above six areas in Japanese companies by using the existing job placement system for Japanese students at Tokyo Tech.
3. Graduation Requirements

[Degree Requirements]

Students must take enough coursework, based on rules of Tokyo Tech to get their degrees. The rules are as follows.

Master’s Degree

(a) Total credits (Lectures from the departments other than listed below can be included)
   - Department of Mathematical and Computing Sciences: 30 credits or more
   - Department of Computer Science: 30 credits or more
   - Department of Mechanical and Environmental Informatics: 36 credits or more

(b) Research Courses
   - Department of Mathematical and Computing Sciences: 4 credits for seminars and 8 credits or more for Advanced Exercises and Experiments
   - Department of Computer Science: 4 credits for seminars and 4 credits for Special Experiments
   - Department of Mechanical and Environmental Informatics: 4 credits for seminars and 8 credits or more for Mechanical and Environmental Informatics Research Process

(c) Courses by Departments (Lectures of the department that the student belongs to and lectures of the other two departments in the 8 subject areas shown below)
   - Department of Mathematical and Computing Sciences: 10 credits or more. The students must take subjects of 3 subject areas or more out of the 8 areas.
   - Department of Computer Science: 16 credits or more. The students must take subjects of 3 subject areas or more out of the 8 areas.
   - Department of Mechanical and Environmental Informatics: 16 credits or more including 5 credits for Mechanical and Environmental Informatics Project I&II. The students must take subjects of 3 subject areas or more out of the 8 areas.

(d) Project Based Learning Subjects:
   - Department of Mathematical and Computing Sciences: 2 credits. The students must take "System Development International Project".
   - Department of Computer Science: 2 credits. The students must take either "System Development International Project" or "Human Centered Informatics Exercise".
   - Department of Mechanical and Environmental Informatics: No requirement (Project Based Learning Subjects are included in Special Subject in (c)).

(e) Liberal Arts and General Education: 2 credits or more

Doctoral degree

(The following rules are applied to the students of this international graduate program only.)

(a) Seminar Courses: 12 credits or more

(b) The students that are from other universities must take the lectures of their departments at 8 credits or more. Note that, the lectures in the 8 subject areas shown below are included regardless to the department that the students belong to.

(c) The students must take "Forum on Global Informatics I", "Forum on Global Informatics II", "Doctoral Career Design II-S-E", and "Doctoral Career Design II-F-E."

[Subject Area]

1. **Computer System**
   - Advanced Coding Theory, Distributed Algorithms, Advanced Data Engineering
2. **Software**  
Concurrent System Theory, Logic and Software, Software Design Methodology, Advanced Operating Systems

3. **Artificial Intelligence**  
Machine Learning, Complex Networks

4. **Cognitive Engineering**  

5. **System Control**  
Mechanical and Environmental Informatics Project I, Mechanical and Environmental Informatics Project II, Linear Systems and Control, Control Theory for Robot Intelligence, Nonlinear and Adaptive Control, Advanced course in nonlinear dynamics

6. **Measuring/Monitoring/Modeling**  

7. **Socio-Environmental Informatics**  
Theory and Applications of Urban Spatial Data, Air Quality Engineering, Regional Information Analysis, Advanced Course on Coastal Environments, Econometric Analysis

8. **Mathematical and Computing Sciences**  

Some of the other subjects in the three participation departments can be delivered with English by request from the students. These lectures might be counted as the credits of the above requirements (b) of master’s and of doctoral course. Please consult your academic adviser(s) and lecturer(s) for the details in advance.

If there are any questions or anything that is not clear about the curriculum, please see the web pages of the departments,  
4. Table of Course Subjects

1. Dept. of Computer Science

Courses by Departments

<table>
<thead>
<tr>
<th>Class</th>
<th>Credits</th>
<th>Lecturer</th>
<th>Semester</th>
<th>Note</th>
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<tr>
<td>Advanced Coding Theory</td>
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<td>Distributed Algorithms</td>
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<td>Advanced Data Engineering</td>
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<td>Human Computer Interaction</td>
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<td>Machine Learning</td>
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<td>Pattern Information Processing</td>
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<td>Speech Information Processing</td>
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<td>Logic and Software</td>
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<td>Software Design Methodology</td>
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<td>Advanced Operating Systems</td>
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<td>Chikako Morimoto</td>
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<td>Human Centered Informatics Exercise</td>
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<td>Haruhiko Kaneko</td>
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Research Courses

<table>
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<tr>
<th>Class</th>
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<th>Lecturer</th>
<th>Semester</th>
<th>Note</th>
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<td>Master’s, 1st year</td>
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<td>Special Experiments II on Computer Science</td>
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<td>Seminar V on Computer Science</td>
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<td>Seminar VII on Computer Science</td>
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2. Dept. of Mechanical and Environmental Informatics

Courses by Departments

<table>
<thead>
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<th>Lecturer</th>
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<td>Linear Systems and Control</td>
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<td>Tomohisa Hayakawa</td>
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<td>Advanced Course of Inverse Problems</td>
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<td>Kenji Amaya</td>
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<td>Mathematical Processing of Measurement Information</td>
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<td>Control Theory for Robot Intelligence</td>
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<td>Nonlinear and Adaptive Control</td>
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<td>Introduction to Neural Engineering</td>
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<td>Introduction to Biomedical Instrumentation</td>
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<td>Advanced Course in Nonlinear Dynamics</td>
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<td>Advanced Course of Digital Human</td>
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<td>Theory and Applications of Urban Spatial</td>
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<td>Analysis of Vibration and Elastic Wave</td>
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<td>Intellectual Infrastructure Systems</td>
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<td>Air Quality Engineering</td>
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<td>Advanced Course on Coastal Environments</td>
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<td>Kazuo Nadaoka</td>
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**Research Courses**

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<tr>
<th>Class</th>
<th>Credits</th>
<th>Lecturer</th>
<th>Semester</th>
<th>Note</th>
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<tr>
<td>Seminar I in Mechanical and Environmental Informatics</td>
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<td>Seminar III in Mechanical and Environmental Informatics</td>
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<td>Seminar IV in Mechanical and Environmental Informatics</td>
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<td>Seminar IX in Mechanical and Environmental Informatics</td>
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<td>Seminar X in Mechanical and Environmental Informatics</td>
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<tr>
<td>Mechanical and Environmental Informatics Research Process I</td>
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<td>Spring</td>
<td>Master’s, 1st year</td>
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<td>Mechanical and Environmental Informatics Research Process II</td>
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<td>Autumn</td>
<td>Master’s, 1st year</td>
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<td>Mechanical and Environmental Informatics Research Process VI</td>
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### 3. Dept. of Mathematical and Computing Sciences

#### Courses by Departments

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<th>Credits</th>
<th>Lecturer</th>
<th>Semester</th>
<th>Note</th>
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<tr>
<td>Topics in Mathematical Optimization</td>
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<td>Mituhiro Fukuda</td>
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<td>Fundamentals of Mathematical and Computing Sciences:</td>
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<td>Masaaki Umehara, Sadayoshi Kojima, Shinya Nishibata</td>
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<tr>
<td>Mathematics</td>
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<td>Naoto Miyoshi, Mituhiro Fukuda, Taiji Suzuki</td>
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<td>Applied Mathematical Sciences</td>
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<td>Computer Science</td>
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<td>Special Lecture on Mathematical and Information Sciences I</td>
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<td>Visiting (Assoc.) Professor</td>
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<td>Osamu Watanabe, Tsuyoshi Murata, Tohru Yagi</td>
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<td>Doctoral, 1st year</td>
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<tr>
<td>Forum on Global Informatics II</td>
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<td>Osamu Watanabe, Tsuyoshi Murata, Tohru Yagi</td>
<td>Autumn</td>
<td>Doctoral, 1st year</td>
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<td>Doctoral Career Design II-S-E</td>
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#### Research Courses

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<th>Credits</th>
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<th>Semester</th>
<th>Note</th>
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<td>Master’s, 1st year</td>
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<td>Advanced Exercises and Experiments in Mathematical Science II</td>
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<td>Each Prof.</td>
<td>Autumn</td>
<td>Master’s, 1st year</td>
</tr>
<tr>
<td>Advanced Exercises and Experiments in Mathematical Science III</td>
<td>0-1-1</td>
<td>Each Prof.</td>
<td>Spring</td>
<td>Master’s, 2nd year</td>
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<tr>
<td>Advanced Exercises and Experiments in Mathematical Science IV</td>
<td>0-1-1</td>
<td>Each Prof.</td>
<td>Autumn</td>
<td>Master’s, 2nd year</td>
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<tr>
<td>Advanced Exercises and Experiments in Computing Science I</td>
<td>0-1-1</td>
<td>Each Prof.</td>
<td>Spring</td>
<td>Master’s, 1st year</td>
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<tr>
<td>Advanced Exercises and Experiments in Computing Science II</td>
<td>0-1-1</td>
<td>Each Prof.</td>
<td>Autumn</td>
<td>Master’s, 1st year</td>
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<tr>
<td>Advanced Exercises and Experiments in Computing Science III</td>
<td>0-1-1</td>
<td>Each Prof.</td>
<td>Spring</td>
<td>Master’s, 2nd year</td>
</tr>
<tr>
<td>Class</td>
<td>Class Credits</td>
<td>Lecturer</td>
<td>Semester</td>
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<tr>
<td>Advanced Exercises and Experiments in Computing Science IV</td>
<td>0-1-1</td>
<td>Each Prof.</td>
<td>Autumn</td>
<td>Master’s, 2nd year</td>
</tr>
<tr>
<td>Seminar I on Mathematical and Computing Sciences</td>
<td>0-1-0</td>
<td>Academic Advisor</td>
<td>Spring</td>
<td>Master’s, 1st year</td>
</tr>
<tr>
<td>Seminar II on Mathematical and Computing Sciences</td>
<td>0-1-0</td>
<td>Academic Advisor</td>
<td>Autumn</td>
<td>Master’s, 1st year</td>
</tr>
<tr>
<td>Seminar III on Mathematical and Computing Sciences</td>
<td>0-1-0</td>
<td>Academic Advisor</td>
<td>Spring</td>
<td>Master’s, 2nd year</td>
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<tr>
<td>Seminar IV on Mathematical and Computing Sciences</td>
<td>0-1-0</td>
<td>Academic Advisor</td>
<td>Autumn</td>
<td>Master’s, 2nd year</td>
</tr>
<tr>
<td>Seminar V on Mathematical and Computing Sciences</td>
<td>0-2-0</td>
<td>Academic Advisor</td>
<td>Spring</td>
<td>Doctoral, 1st year</td>
</tr>
<tr>
<td>Seminar VI on Mathematical and Computing Sciences</td>
<td>0-2-0</td>
<td>Academic Advisor</td>
<td>Autumn</td>
<td>Doctoral, 1st year</td>
</tr>
<tr>
<td>Seminar VII on Mathematical and Computing Sciences</td>
<td>0-2-0</td>
<td>Academic Advisor</td>
<td>Spring</td>
<td>Doctoral, 2nd year</td>
</tr>
<tr>
<td>Seminar VIII on Mathematical and Computing Sciences</td>
<td>0-2-0</td>
<td>Academic Advisor</td>
<td>Autumn</td>
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<tr>
<td>Seminar IX on Mathematical and Computing Sciences</td>
<td>0-2-0</td>
<td>Academic Advisor</td>
<td>Spring</td>
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<tr>
<td>Seminar X on Mathematical and Computing Sciences</td>
<td>0-2-0</td>
<td>Academic Advisor</td>
<td>Autumn</td>
<td>Doctoral, 3rd year</td>
</tr>
</tbody>
</table>

4. Courses by Departments common for all the three departments

<table>
<thead>
<tr>
<th>Class</th>
<th>Class Credits</th>
<th>Lecturer</th>
<th>Semester</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internship on Information Science &amp; Engineering 1A</td>
<td>0-0-1</td>
<td>Chair of Dept. of Computer Science</td>
<td>Spring</td>
<td>Consult the academic supervisor(s)</td>
</tr>
<tr>
<td>Internship on Information Science &amp; Engineering 2A</td>
<td>0-0-2</td>
<td>Chair of Dept. of Computer Science</td>
<td>Spring</td>
<td>Consult the academic supervisor(s)</td>
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<tr>
<td>Internship on Information Science &amp; Engineering 1B</td>
<td>0-0-1</td>
<td>Chair of Dept. of Computer Science</td>
<td>Autumn</td>
<td>Consult the academic supervisor(s)</td>
</tr>
<tr>
<td>Internship on Information Science &amp; Engineering 2B</td>
<td>0-0-2</td>
<td>Chair of Dept. of Computer Science</td>
<td>Autumn</td>
<td>Consult the academic supervisor(s)</td>
</tr>
<tr>
<td>Forum on Global Informatics I</td>
<td>0-1-0</td>
<td>Osamu Watanabe, Tsuyoshi Murata,</td>
<td>Spring</td>
<td>Doctoral, 1st year</td>
</tr>
<tr>
<td>Forum on Global Informatics II</td>
<td>0-1-0</td>
<td>Osamu Watanabe, Tsuyoshi Murata,</td>
<td>Autumn</td>
<td>Doctoral, 1st year</td>
</tr>
<tr>
<td>Doctoral Career Design II-S-E</td>
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<td>Spring</td>
<td>Doctoral, 2nd year</td>
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<tr>
<td>Doctoral Career Design II-F-E</td>
<td>0-1-0</td>
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<td>Autumn</td>
<td>Doctoral, 2nd year</td>
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5. Liberal Arts and General Education

<table>
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<tr>
<th>Remarks</th>
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<tr>
<td>Refer to VI. Liberal Arts and General Education</td>
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</table>

<table>
<thead>
<tr>
<th>Subjects</th>
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<tr>
<td>International Communication</td>
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<tr>
<td>Interdisciplinary Courses</td>
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<tr>
<td>Interdepartmental Courses</td>
</tr>
<tr>
<td>Arts and Humanities</td>
</tr>
<tr>
<td>Career Development Courses</td>
</tr>
<tr>
<td>Courses for Developing Creativity</td>
</tr>
<tr>
<td>Courses for International Students</td>
</tr>
</tbody>
</table>
5. Syllabus of Program Subjects

76019
Advanced Coding Theory
Lecturer Haruhiko Kaneko
Spring Semester, Odd year
Credits: 2-0-0
The objective of this course is to introduce an application of coding theory to digital systems, and to give how to design excellent codes to improve computer system reliability.

76015
Distributed Algorithms
Prof. Takehiro Tokuda
Autumn Semester
Credits: 2-0-0
The objective is for students to understand design principles of concurrent/distributed algorithms and their applications to computing environments.

76029
Advanced Data Engineering
Prof. Haruo Yokota
Autumn Semester
Credits: 2-0-0
The data engineering is an active research area for manipulating a large amount of persistent data sophisticatedly, such as processing databases. This class focuses on advanced approaches for the mechanism, algorithm and architecture in data engineering. Topics include transaction models, data warehousing, OLAP, indexing methods, parallel database operations, data replication, failure recovery, storage systems, workflow management system, XML databases.

76006
Concurrent System Theory
Prof. Naoki Yonezaki
Spring Semester
Credits: 2-0-0
In this course, concepts and techniques for formalizing concurrent systems are introduced. Fundamental algebraic and logical approaches are described. We also used the formalism to analyze and verify properties of concurrent systems. Concurrency, Process algebra, trace, Bi-simulation, Co-induction, Observational congruence, CSP, CCS, \( \pi \)-calculus, Process logic, Dynamic logic.

76017
Machine Learning
Assoc. Prof. Tsuyoshi Murata
Autumn Semester, Even year
Credits: 2-0-0
This course introduces machine learning concepts as well as practical advice on applying machine learning tools and techniques in real-world data mining situations.
76033
Advanced Data Analysis
Assoc. Prof. Masashi Sugiyama
Spring Semester, Odd year
Credits: 2-0-0
The objective of this course is to introduce basic ideas and practical methods of discovering useful structure hidden in the data.

76013
Pattern Information Processing
Assoc. Prof. Masashi Sugiyama
Spring Semester, Even year
Credits: 2-0-0
Inferring an underlying input-output dependency from input and output examples is called supervised learning. This course focuses on a statistical approach to supervised learning and introduces its basic concepts as well as state-of-the-art techniques.

76018
Computer Graphics
Spring Semester (not offered in 2014)
Credits: 2-0-0
The objective of this course is to introduce basic ideas and practical methods of Computer Graphic theory and its application.

76027
Speech Information Processing
Prof. Koichi Shinoda
Spring Semester
Credits: 2-0-0
This course aims to discuss various issues related to speech information processing.

76016
Logic and Software
Assoc. Prof. Shinya Nisizaki
Spring Semester, Odd year
Credits: 2-0-0
Proofs in formal logic can be regarded as programs. This course will introduce mathematical logic as a fundamental theory of programs. Several formal systems in logic are explained from the viewpoint of computer science.

76007
Software Design Methodology
Prof. Motoshi Saeki
Autumn Semester, Even year
Credits: 2-0-0
In this course, you learn the techniques on requirements engineering such as goal-oriented requirements analysis and software design, e.g. object-oriented design methods, and practice them through small
development case studies.

**76025**  
**Human Computer Interaction**  
Prof. Hideki Koike  
Spring Semester  
Credits: 2-0-0  
This course aims to discuss man-machine interface design and its evaluation techniques. Topics include multimodal interface, cognitive engineering, ergonomics, and modeling of human information processing.

**76053**  
**Complex Networks**  
Prof. Tsuyoshi Murata  
Autumn Semester, Odd year  
Credits: 2-0-0  
Basic knowledge for analyzing network data is introduced. Topics include metrics of networks, common properties of real networks, algorithms for processing networks, models of networks, visualization of networks, and tools for analyzing networks.

**76010**  
**Advanced Operating Systems**  
Prof. Takuo Watanabe  
Autumn Semester  
Credits: 2-0-0  
The objective of this course is to introduce the state of the art in operating systems and related technologies. Topics are chosen from Distributed Operating Systems, Realtime Operating Systems, Embedded Systems, System-Level Security Mechanisms, Virtual Execution Environment, System Description Languages, Formal Approaches to System Software, and so on.

**76060**  
**System Development International Project**  
Prof. Katsuhiko Gondow and Lecturer Chikako Morimoto  
Spring Semester  
Credits: 0-2-0  
This class focuses on the social value of the computing system. The aim is to learn business dynamics and the software life cycle by the project-based learning. Through the analysis of a sample system the students learn the followings; 1) requirements process, 2) service management, 3) project management of the system development.

**88029**  
**Human centered informatics exercise**  
Prof. Koichi Shinoda and Lecturer Haruhiko Kaneko  
Autumn Semester  
Credits: 0-2-0  
This course is Project-based learning to acquire knowledge and skills for human centered informatics. Students make a group to carry out a project related to human centered informatics using new technologies and equipment such as human motion capturing systems, biosensors, virtual reality systems.
**76711-76712**
*Special Experiments I, II on Computer Science*
Advisor
I: Spring Semester  Credits: 0-0-2
II: Autumn Semester  Credits: 0-0-2
These courses provide the opportunities of high-level experiments in the field of computer science.

**76701-76704**
*Seminar I, II, III, IV on Computer Science*
Advisor
I: Spring Semester  Credits: 0-1-0
II: Autumn Semester  Credits: 0-1-0
III: Spring Semester  Credits: 0-1-0
IV: Autumn Semester  Credits: 0-1-0
In these courses, all students read papers and textbooks related to their research fields and discuss each other about them.

**76801-76806**
*Seminar V, VI, VII, VIII, IX, X on Computer Science*
Advisor
V: Spring Semester  Credits: 2-0-0
VI: Autumn Semester  Credits: 2-0-0
VII: Spring Semester  Credits: 2-0-0
VIII: Autumn Semester  Credits: 2-0-0
IX: Spring Semester  Credits: 2-0-0
X: Autumn Semester  Credits: 2-0-0
In these courses, all students read papers and textbooks related to their research fields and discuss each other about them.

**77602**
*Mechanical and Environmental Informatics Project I*
Assoc. Prof. Yusuke Miyazaki et al.
Autumn Semester
Credits: 0-1-2
In this class, all students are expected to do the followings: 1) through the investigation, analysis and proposal about various projects existing in the real world, 2) development of the ability to integrate and utilize the information and technologies that straggle in various fields, 3) building the ability to make an appropriate decision based on environmental informatics, 4) analysis, design and implementation of a software system using Java language applying object-oriented programming through the problem-based-learning style group work to develop creative power.

**77663**
*Mechanical and Environmental Informatics Project II*
All faculty members of the Department of Mechanical and Environmental Informatics
Spring Semester
Credits: 0-1-1
Although this class consists of two courses, students in International Graduate Program must select “software development course”. Each student is expected to do analysis, design and implementation of a software system for any topic related to his/her master’s thesis individually, using object-oriented programming language.

77713-77716
Mechanical and Environmental Informatics Research Process I, II, III, IV
All faculty members of the Department of Mechanical and Environmental Informatics
I: Spring Semester Credits: 0-1-1
II: Autumn Semester Credits: 0-1-1
III: Spring Semester Credits: 0-1-1
IV: Autumn Semester Credits: 0-1-1
This course provides the opportunities of discussion about the research process, presentation skills and discussion with other research field researchers. The abilities of problem settings and resolution about the research and communication will be improved.

77807-77808
Mechanical and Environmental Informatics Research Process V, VI
Each Prof.
V: Spring Semester Credits: 0-1-1
VI: Autumn Semester Credits: 0-1-1
This course provides the opportunities of discussion about the research process, presentation skills and discussion with other research field researchers. The abilities of problem settings and resolution about the research and communication will be improved.

77701-77704
Seminar in Mechanical and Environmental Informatics I, II, III, IV
Supervisor
I: Spring Semester Credits: 0-1-0
II: Autumn Semester Credits: 0-1-0
III: Spring Semester Credits: 0-1-0
IV: Autumn Semester Credits: 0-1-0
In these courses, all students read papers and textbooks related to their research fields and discuss each other about them.

77705-77710
Seminar in Mechanical and Environmental Informatics V, VI, VII, VIII, IX, X
Supervisor
V: Spring Semester Credits: 0-1-1
VI: Autumn Semester Credits: 0-1-1
VII: Spring Semester Credits: 0-1-1
VIII: Autumn Semester Credits: 0-1-1
IX: Spring Semester Credits: 0-1-1
X: Autumn Semester Credits: 0-1-1
In these courses, all students read papers and textbooks related to their research fields and discuss each other about them.
77054
Linear Systems and Control
Assoc. Prof. Tomohisa Hayakawa
Autumn Semester
Credits: 1-0-0
Introduction to linear systems theory and feedback control. This course provides a foundation of modern control theory and also covers several advanced topics in linear dynamical systems.

77006
Advanced Course of Inverse Problems
Prof. Kenji Amaya
Autumn Semester
Credits: 1-0-0
This course will provide full details on a variety of inverse problem-solving techniques, including examples and algorithms.

77037
Mathematical Processing of Measurement Information
Assoc. Prof. Seiichiro Hara
Autumn Semester, Even year
Credits: 2-0-0
Recently, because of the improvements of measuring instruments and computers, enormous measurement data can be acquired very easily. However it is not easy to interpret the information contained in such data correctly. In this course, mathematical processing method of extracting and recognizing the information contained in 1D and 2D measured data are explained comprehensively and practically.

77059
Control Theory for Robot Intelligence
Prof. Jun-ichi Imura
Spring Semester
Credits: 2-0-0
Modeling and control methods of hybrid systems, which are dynamical systems composed of continuous variables and discrete (logical) variables, are discussed as one of the mathematical approaches to control for realizing robot intelligence.

77055
Nonlinear and Adaptive Control
Assoc. Prof. Tomohisa Hayakawa
Autumn Semester
Credits: 1-0-0
Theory and application of adaptive control systems. Discussed are methods of on-line parameter identification and adaptive control for nonlinear systems with uncertain parameters. To this end, Lyapunov stability theory and Lyapunov functions for general nonlinear systems is examined in the first half of the course.

77060
Introduction to Neural Engineering
Assoc. Prof. Tohru Yagi  
Autumn Semester, Even year  
Credits: 2-0-0  
Introduction to neural interface, a technology to link the nervous system and a machine. This course provides a foundation of neuroscience and also covers several update topics in neural engineering.

77053  
Introduction to Biomedical Instrumentation  
Assoc. Prof. Tohru Yagi  
Spring Semester, Odd year (Offered in summer 2013)  
Credits: 2-0-0  
Introduction to biomedical instrumentation, a technology for medicine and health care. This course provides basics of physiology and covers several update topics in biomedical instrumentation.

77066  
Advanced Course in Nonlinear Dynamics  
Assoc. Prof. Hiroya Nakao  
Spring Semester, Even year  
Credits: 2-0-0  
Nonlinear dynamical systems are used to model various real-world phenomena. In this lecture, starting with basic facts on dynamical systems theory, dynamical processes that lead to self-sustained rhythms, chaotic behavior, and spatiotemporal pattern formation will be explained, with applications in physics, chemistry, and engineering.

77067  
Advanced Course of Digital Human Modeling  
Assoc. Prof. Yusuke Miyazaki  
Autumn Semester, Even year  
Credits: 2-0-0  
This lecture provides updated topics regarding biomechanical models of human body. The topics include method to measure and model biomechanical characteristics of human body such as the anatomical structure, motion, material properties, tolerance level. Besides, the lecture also covers applications of the digital human models to estimate safety or amenity of products or living environment.

77016  
Theory and Applications of Urban Spatial Data  
Prof. Toshihiro Osaragi  
Autumn Semester, Odd year  
Credits: 2-0-0  
This course will focus on the theory and applications of spatiotemporal information for statistical-/mathematical modeling of the sort typically used in urban and metropolitan policy, planning, and environmental analysis. Participants will learn example applications from their area of interest and then develop a simple application in the form of a model that incorporates spatiotemporal data.

77019  
Analysis of Vibration and Elastic Wave  
Prof. Souichi Hirose
Spring Semester
Credits: 2-0-0
Fundamental theories and analytical methods for vibrations and waves in solids are explained, and various engineering applications in seismic engineering, ultrasonic nondestructive testing and so forth will be presented.

77020
Intellectual Infrastructure Systems
Assoc. Prof. Takamasa Mikami
Spring Semester, Odd year
Credits: 2-0-0
Social infrastructure is becoming smart with the progress of information science and technology. This lecture gives an overview of the state of the art in intellectual infrastructure systems. This course also provides an opportunity to study advanced technologies on lifeline networks and related anti-disaster facilities. Your presentations and discussions will form an important part of this class.

77026
Air Quality Engineering
Prof. Shuji Fujii and Assoc. Prof. Naoki Kagi
Spring Semester, Even year
Credits: 2-0-0
The objective in this course is to understand basics and cleaning techniques for air quality in indoor environment and atmospheric environment and etc. Through reviewing and discussing the previous research papers for air quality, the technologies for measuring, analyzing and cleaning of air were investigated.

77048
Advanced Course on Coastal Environments
Prof. Kazuo Nadaoka
Autumn Semester, Even year
Credits: 2-0-0
Coastal zone is characterized with high primary production and rich biodiversity in its ecosystem, but it is highly vulnerable to various natural disasters and environmental impacts. This course introduces theories on physical and environmental processes in coastal zone with advanced modeling and monitoring technologies. Emphasis is put on significance of integrated watershed and coastal zone system assessment and management.

75049
Topics in Mathematical Optimization
Assoc. Prof. Mituhiro Fukuda
Spring Semester
Credits: 2-0-0
The main focus of this course is on algorithms to solve convex optimization problems which have recently gained some attention in continuous optimization. The course starts with basic theoretical results and then well-known algorithms will be analyzed and discussed.
Fundamentals of Mathematical and Computing Sciences: Mathematics
Prof. Masaaki Umehara, Prof. Sadayoshi Kojima and Prof. Shinya Nishibata
Spring Semester
Credits: 2-0-0
This course introduces several basic concepts of mathematics (algebra, geometry, analysis etc.) and is intended to provide key knowledge necessary for advanced study in Mathematical and Computing Sciences.

Fundamentals of Mathematical and Computing Sciences: Applied Mathematical Sciences
Prof. Naoto Miyoshi, Assoc. Prof. Mituhiro Fukuda and Assoc. Prof. Taiji Suzuki
Spring Semester
Credits: 2-0-0
This course introduces several basic concepts of mathematical optimization, probability and statistics, and is intended to provide key knowledge necessary for advanced study in Mathematical and Computing Sciences.

Fundamentals of Mathematical and Computing Sciences: Computer Science
Prof. Osamu Watanabe, Assoc. Prof. Toshio Endo and Assoc. Prof. Ken Wakita
Autumn Semester
Credits: 2-0-0
This course introduces several basic concepts from fields of computer science such as algorithm, computational complexity, programming, computer system, and is intended to provide key knowledge necessary for advanced study in Mathematical and Computing Sciences.

Special Lecture on Mathematical and Information Sciences I, II, III, IV
Visiting (Assoc.) Professor
I: Spring Semester, Even year Credits: 2-0-0
II: Autumn Semester, Even year Credits: 2-0-0
III: Spring Semester, Odd year Credits: 2-0-0
IV: Autumn Semester, Odd year Credits: 2-0-0
In this course, lectures on various recent topics on mathematical and information sciences are given by visiting professors of Department of Mathematical and Computing Sciences.

Forum on Global Informatics I, II
Prof. Osamu Watanabe, Assoc. Prof. Tsuyoshi Murata and Assoc. Prof. Toru Yagi
I: Spring Semester Credits: 0-1-0
II: Autumn Semester Credits: 0-1-0
This course is for training scientific communication skills for scientific presentation, discussion, organizing tutorial sessions, etc.

Advanced Exercises and Experiments in Mathematical Science I, II, III, IV
Each Prof.
I: Spring Semester Credits: 0-1-1
II: Autumn Semester Credits: 0-1-1
III: Spring Semester Credits: 0-1-1
IV: Autumn Semester Credits: 0-1-1
These courses provide the opportunities of advanced level of exercises and/or experiments in the research field of each student.

75771-75774
Advanced Exercises and Experiments in Computing Science I, II, III, IV
Each Prof.
I: Spring Semester Credits: 0-1-1
II: Autumn Semester Credits: 0-1-1
III: Spring Semester Credits: 0-1-1
IV: Autumn Semester Credits: 0-1-1
These courses provide the opportunities of advanced level of exercises and/or experiments in the research field of each student.

75701-75704
Seminar I, II, III, IV on Mathematical and Computing Sciences
Supervisor
I: Spring Semester Credits: 0-1-0
II: Autumn Semester Credits: 0-1-0
III: Spring Semester Credits: 0-1-0
IV: Autumn Semester Credits: 0-1-0
In these courses, students practice the process of thinking and understanding and skill of presentation and discussion through reading papers and/or textbooks related to their research fields and discussing them each other.

75801-75806
Seminar V, VI, VII, VIII, IX, X on Mathematical and Computing Sciences
Supervisor
V: Spring Semester Credits: 0-2-0
VI: Autumn Semester Credits: 0-2-0
VII: Spring Semester Credits: 0-2-0
VIII: Autumn Semester Credits: 0-2-0
IX: Spring Semester Credits: 0-2-0
X: Autumn Semester Credits: 0-2-0
These courses provide the opportunities of high-level exercises and/or experiments in the research field of each student.

76039-76042
Internship on Information Science & Engineering 1A, 2A, 1B, 2B
A Chair of Department of Computer Science
1A: Spring Semester Credits: 0-0-1
2A: Spring Semester Credits: 0-0-2
1B: Autumn Semester Credits: 0-0-1
2B: Autumn Semester  Credits: 0-0-2
A student goes to an external industry or organization to undergo supervised practical training on the topic related to information science & engineering. There are 4 types of programs 1A, 1B, 2A and 2B according to the period and semester when the internship is undertaken. For example, 1A or 2A should be applied if the student undertakes in the spring semester. The unit of credits depends on the period of the internship, and if it is about 2 weeks, 1A or 1B for 1 credit is applied. In the case of 4 or more weeks, 2A or 2B for 2 credits is applied. When the student applies this subject, she or he must submit to a committee member via an academic adviser the documents including the company or organization that she or he will go and the contents, in advance. Unsuitable contents are rejected to get credits. The schedule including the contents depends on a supervised industry or organization.