※

Numbering code			
Course title <English>	工業数学A 1 Applied Mathematics A1	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,SHIBAYAMA MITSURU
Target year	2nd year students or above	Number of credits	2
Course offered year/period	2019/Second semester		
Day/period	Thu.2	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

Complex analysis, traditionally known as the theory of functions of a complex variable, is the branch of mathematical analysis that investigates functions of complex numbers. Students will study the foundation and apply it to compute some integral.

[Course Goals]

To understand properties of complex functions with a skill for evaluation of integrals appearing in applied mathematics and physics.

[Course Schedule and Contents]

1. Complex function
2. Holomorphic functions
3. Elementary functions
4. Integrals in the complex plane
5. Cauchy's integral theorem
6. Power series
7. Taylor series
8. Isolated singularities
9. Laurent series
10. Multivalued functions
11. Analytic continuation
12. Residue
13. Integrals including trigonometric functions
14. Application to improper integral
15. Point at infinity and Riemann sphere

[Class requirement]

Calculus, Linear algebra

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation depends mainly on marks of examination, but marks of exercises are taken into account when needed.

Continue to 工業数学A 1 (2)↓↓↓

Numbering code			
Course title <English>	工業数学A 2 Applied Mathematics A2	Affiliated department, Job title,Name	Graduate School of Informatics Professor,NAKAMURA YOSHIMASA Graduate School of Informatics Associate Professor,TSUJIMOTO SATOSHI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Mon.2	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

quotNumerical Analysisquot is prerequisite to this course. In this course matrix eigenvalue problem and singular value decomposition, iteration methods for nonlinear equations, interpolation methods by polynomials, and numerical integration methods are explained which are important especially in data science and information processing. *There is a possibility to replace Course Topics. Detail will be announced at the first class.

[Course Goals]

Understanding both the theory and practical methods for applications through general-purpose softwares and/or programs by each student is a goal of this course.

[Course Schedule and Contents]

matrix eigenvalue problem,6times,computation of matrix eigenvalues and eigenvectors by the Jacobi method, Gershgorin theorem, the power method and the inverse iteration, the QR method and the divide amp conquer method with the Householder transformations for preprocessing, Sturm theorem
matrix singular value decomposition,1time,computation of matrix singular value decomposition
iterative methods for nonlinear equations,3times,the principle of contractive mapping and the Newton method both of one and multi variables, and convergence acceleration algorithms
interpolation methods ,2times,the Lagrange interpolation formula and the Hermitian interpolation formula by polynomials, and the spline functions
numerical integration methods,2times,Newton-Cotes numerical integration formula,and the Gauss type numerical integration formula
confirmation for student assessment,1time,confirmation for each student assessment
,1time,

[Class requirement]

Linear Algebra A, Linear Algebra B, Numerical Analysis

[Method, Point of view, and Attainment levels of Evaluation]

mainly evaluated by examination score, but reports of exercises will be taken into account in a case.

Continue to 工業数学A 2 (2)↓↓↓

工業数学A 1 (2)

[Textbook]

Not used

[Reference books, etc.]

（Reference books）

Lars V. Ahlfors 『Complex Analysis』 （McGraw-Hill Education）ISBN:978-0070006577

（Related URLs）

(KULASIS)

[Regarding studies out of class (preparation and review)]

Students need to solve exercises.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

工業数学A 2 (2)

[Textbook]

quotIntroduction of Numerical Analysisquot (in Japanese) by T. Yamamoto, SAIENSU-SHA isbn{}{ 4781910386}

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	工業数学Ａ３ Appleid Mathematics A3	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAGASAKI KAZUYUKI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Wed.1	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

Fourier analysis originated in Fourier#039s work on thermal conduction and now becomes very important not only in mathematics but also in engineering, including applications in measurement technology. This course provides its theories and applications along with Laplace analysis closely related to it.

[Course Goals]

To understand the fundamental theories of Fourier and Laplace analysis and develop an ability to apply them to concrete problems.

[Course Schedule and Contents]

Fourier series,2-3times,The definition of Fourier series expansions are given and their fundamental properties such as computation of Fourier coefficients and convergence of Fourier series are discussed.
Properties and applications of Fourier series,3-4times,Several properties of Fourier series and their applications to differential and difference equations and signal processing are discussed.
One-dimensional Fourier transform,3-4times,The definition of one-dimensional Fourier transforms is given, and their fundamental properties such as the inversion formula and applications to partial differential equations are discussed.
Multi-dimensional Fourier transform,2-3times,The definition of multi-dimensional Fourier transforms is given, and their fundamental properties and applications to partial differential equations are discussed.
Laplace transforms,2-3times,Properties of Laplace transforms and their applications to differential equations are discussed.
Summary and learning achievement evaluation,1time,A summary and supplements of this course are given and the learning achievement of students is evaluated.

[Class requirement]

Calculus, Linear Algebra and Differential Eqautions

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation depends mainly on marks of examination, but marks of exercises and homework are taken into account when needed.

[Textbook]

S. Nakamura: Fourier analysis, Asakura shoten isbn{}{9784254115741}

[Reference books, etc.]

（Reference books）

H.Fukawa: Mathematics of control and vibration, KORONA-SHA ibid{}{TW86010572}

Continue to 工業数学Ａ３(2)↓↓↓

Numbering code			
Course title <English>	工学倫理 Engineering Ethics	Affiliated department, Job title,Name	Graduate School of Energy Science Professor,TAKUDA HIROHIKO Graduate School of Engineering Professor,ATOMI HARUYUKI Graduate School of Engineering Senior Lecturer,KANEKO KENTAROU
Target year	4th year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Thu.3	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

Modern ethics based on engineering aspect are becoming essential to present engineers and scientists. Instructors from various faculties give lectures about ethics in their research fields.

[Course Goals]

The goal of this class is to understand engineering ethics, and to develop the ability to judge by yourself when you encounter ethical issues.

[Course Schedule and Contents]

Significance to learn engineering ethics. (4/11) 1time. As an introduction to this course, the meaning of engineering ethics and the significance to learning it are explained. Examples are shown in building engineering area on daily disastrous accidents and fire event. The significances of engineering ethics to those examples are discussed. (K. Harada: Architecture)
Geotechnical engineering and engineering ethics. (4/18) 1 time. Geotechnical Engineering is indispensable in discussing the underground public use, slope stability, geo-sequestration of byproduct for the energy generating. Introducing some examples of natural disasters and construction accidents, geotechnical engineering and engineering ethics will be discussed. (K. Kishida: Global Engineering)
Engineering ethics as an applied ethics. (4/25) 1 time. In this lecture, I will show the basic Idea of Engineering Ethics by comparing with the other fields of Applied Ethics. And show its unique character in the age of information technology. (M. Mizutani: Graduate School of Letters)
Ethical theories for engineering ethics. (5/2) 1 time. This lecture focus on various ideas in ethics (utilitarianism, deontology, virtue ethics, professional ethics etc.) which will be useful for thinking about particular ethical problems in engineering ethics. (T. Iseda: Graduate School of Letters)
Art-view concept for engineering. (5/9) 1time. Concept of "quality of life" is required for human related engineering. Some practical examples in medical-care and welfare fields will be introduced, and problem of the QOL-evaluation will be discussed from both function-optimizing view point and art view point. (N. Tomita: Engineering Science)
Ethics of biotechnology and stem cell research. (5/16) 1time. With the rapid development of genome editing technology and stem cell engineering, editing of the human genome that goes beyond generations has become possible, at least technically. In this lecture, I will introduce these latest technologies and think about ethical problems accompanying technological development. (G. Eiraku: Industrial Chemistry)
Research and engineering ethics. (5/23) 1time. It is said that He that will do no ill, must do nothing that belongs thereto. The sense of ethics necessary to whom conducts research and engineering work in society is discussed in terms of the importance of equitability and fair evaluation to anyone involved in each area of research or engineering. (H. Mikada: Global Engineering)
Ethics in biomedical engineering. (5/30) 1time. Recent dramatic progress in biology-related techniques, such as reproductive medicine, genome editing, and clone-animal techniques, is causing revolutions in the fields of

Continue to 工学倫理(2)↓↓↓

工業数学Ａ３(2)

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

工学倫理(2)

medicines and food productions. Associated with it, problems of their safety and ethics are arising, which should be addressed by our societies. In this class, the recent progress in biology-related techniques, and problems we have and will have in near future are described. (M. Shirakawa: Industrial Chemistry)
Patents and ethics (Part 1). (6/6) 1time. This course will teach the students about 1) patent systems which protect inventions and research results and 2) ethical issues in patents. The first class, in preparation for the next subject of patent ethics, introduces Japan’s patent system with comparisons to the patent systems in the world’s major countries and international framework. (M. Nakagawa: Electrical and Electronics Engineering)
Patents and ethics (Part 2). (6/13) 1time. Students, equipped with the basic knowledge of patent systems by the previous lecture, will get familiar with actual case studies on ethical and legal issues in patents. (M. Nakagawa: Electrical and Electronics Engineering)
Ethics required for advanced science. (6/27) 1time. Engineers and researchers are at the forefront of preventing harm caused by advanced chemistry. Think about social roles and ethics required by engineers and researchers through relationships between chemical substances and environmental problems, efforts to avoid hazards of nanomaterials. (K. Miura: Industrial Chemistry)
Ethics in press release. (7/4) 1 time. Press Release is an essential process for introducing the research to our society through various medias. In this lecture, issues related to Press Release in University are addressed and discussed. (K. Umeno: Informatics and Mathematical Science)
Failure accidents and inspection/maintenance (7/11) 1time. On the occasions of failure accidents of vehicles and plants, the appropriateness of inspection/maintenance of their structures is often questioned. Some actual failure accidents are reviewed to discuss the importance of inspection/maintenance together with the relation to engineering ethics. (S. Biwa: Engineering Science)
Ethics in nuclear engineering. (7/18) 1time. Discussion on engineering ethics in the TEPCO accident from view point of Tsunami evaluation by the Japanese government. (I. Takagi: Engineering Science)
Ethical issues on sound design. (7/25) 1 time. Every working things consuming energy emits acoustic sound. Even a small sound energy affect human as noise and may create annoyance and health problems. Sound problems of various things are introduced in the lecture. Ethical issues, which shall be considered during design and operation environment, will be discussed. (Y. Takano: Architecture)

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Class participation and reports.

[Textbook]

Lecture materials will be distributed.

[Reference books, etc.]

（Reference books）

『Omnibus Engineering Ethics』（Kyoritsu Shuppan Co., Ltd.）ISBN:978-4320071964
『Practical Engineering Ethics - A Short Course, New Edition』（Kagaku-Dojin Publishing Company,INC）ISBN:9784759811551
『Engineering Ethics (Revised Edition)』（CORONA PUBLISHING CO.,LTD.）ISBN:978-4-339-07798-8
『World of Engineering Ethics (3rd Edition)』（Morikita Publishing Co., Ltd.）ISBN:978-4-627-97303-9

Continue to 工学倫理(3)↓↓↓

工学倫理(3)

[Regarding studies out of class (preparation and review)]

The assignment of the report will be given for each lesson.

（Others (office hour, etc.)）

The class order is subject to change.

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	ＧＬセミナーＩ（企業調査研究） Global Leadership Seminar I	Affiliated department, Job title,Name	Graduate School of Engineering Senior Lecturer,YOROZU KAZUAKI Graduate School of Engineering Senior Lecturer,MAEDA MASAHIRO
Target year	2nd year students or above	Number of credits	1
Course offered year/period	2019/Intensive, year-round		
Day/period	Intensive	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

The purpose of this course is to study about how worldwide leading company, institute, etc. make proposals and find solutions for expanding their own technologies to the international market. Throughout hands-on training on their laboratory, students investigate the methodology of team organization, proposal, market prediction and conception ability by group works. After the investigation, students are expected to improve their comprehension and explanation capability. As extended exersice subject of this course, the Global Leadership Seminar II is opened in the second semester.

[Course Goals]

The goal of this course is to improve student's comprehension and explanation capability for processes of proposal and expantion on the international market invesitgating worldwide leading companies by group work.

[Course Schedule and Contents]

Week 1, Guidance
Week 2-13, Hands-on training
Week 14, Pre-presentation
Week 15, Final presentation

[Class requirement]

How to register will be announced later. Students who want to join this course is requested to attend the first class.

[Method, Point of view, and Attainment levels of Evaluation]

Students are prohibited to skip hands-on training. Evaluation will be based on presentation.

[Textbook]

Not used

Continue to ＧＬセミナーＩ（企業調査研究）(2)↓↓↓

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Numbering code			
Course title <English>	工学序論 Introduction to Engineering	Affiliated department, Job title,Name	Graduate School of Engineering Senior Lecturer,MAEDA MASAHIRO Graduate School of Engineering Senior Lecturer,MATSUMOTO RIYOUSUKE Graduate School of Engineering Senior Lecturer,YOROZU KAZUAKI Graduate School of Engineering Senior Lecturer,KANEKO KENTAROU Graduate School of Engineering Senior Lecturer,ASHIDA RIYUUICHI
Target year	1st year students or above	Number of credits	1
Course offered year/period	2019/Intensive, First semester		
Day/period	Intensive	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1~2times,
,6times,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

ＧＬセミナーＩ（企業調査研究）(2)

[Reference books, etc.]

（Reference books）

（Related URLs）

http://www.glc.t.kyoto-u.ac.jp/ugrad

[Regarding studies out of class (preparation and review)]

Investigating companies in advance. Analyzing the result from hands-on training. Preparing presentation.

（Others (office hour, etc.)）

How to register will be announced later. Students who want to join this course is requested to attend the first class. Students are prohibited to skip hands-on training. Evaluation will be based on presentation.

*Please visit KULASIS to find out about office hours.

※

Numbering code					
Course title <English>	工学部国際インターンシップ１ Faculty of Engineering International Internship 1	Affiliated department, Job title,Name	Approved		
Target year	3rd year students or above	Number of credits	1	Course offered year/period	2019/Intensive, year-round
Day/period	Intensive	Class style	Seminar	Language	Japanese and English

[Outline and Purpose of the Course]

Acquisition of international skills with the training of foreign language through the internship programs hosted by the University, the Faculty of Engineering, or the undergraduate school the applicant belongs to.

[Course Goals]

The acquisition of international skills with the training of foreign language through the to internship programs hosted by the University is the major expectation to the students.

[Course Schedule and Contents]

Overseas Internship,1time,The contents to be acquired should be described in the brochure of each internship program.
Final Presentation,1time,A presentation by the student is required followed by discussion among participants.

[Class requirement]

Described in the application booklet for each internship program. The registrant is requested to have enough language skills for the participation.

[Method, Point of view, and Attainment levels of Evaluation]

Marit rating is done based on the presentation or reports after each internship program. Each **D**epartment responsible to identify if the credit earned by this subject to be included as mandatory ones or not. If the credit is not included in the undergraduate school in which the participant belongs to, the credit is granted by the Global Leadership Education Center as a optional credit. The number of credits, either 1 or 2, will be determined depending on the contents and the duration of the program that the participant has participated in.

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

It is required for students to check if the internship program to participate in could be evaluated as part of mandatory credits or not and could earn how many credits before the participation to the undergraduate school or educational program the student in enrolled. If the credit could not be treated as mandatory ones, get in touch with the Global Leadership Engineering Education Center.

*Please visit KULASIS to find out about office hours.

ＧＬセミナーＩＩ（課題解決演習）(2)

[Reference books, etc.]

（Reference books）

Will be indicated as necessary.

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

Course open period: October to January
How to register the course will be instructed.
*It depends on divisions which students belong to whether the earned credits are admitted as credits required for graduation. Please refer to the syllabus of your division.

*Please visit KULASIS to find out about office hours.

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Numbering code					
Course title <English>	ＧＬセミナーＩＩ（課題解決演習） Global Leadership Seminar II	Affiliated department, Job title,Name	Graduate School of Engineering Senior Lecturer,MAEDA MASAHIRO Graduate School of Engineering Senior Lecturer,KANEKO KENTAROU		
Target year	2nd year students or above	Number of credits	1	Course offered year/period	2019/Intensive, Second semester
Day/period	Intensive	Class style	Seminar	Language	Japanese

[Outline and Purpose of the Course]

This course is a small-group workshop program where students are supposed to extract or set up challenges by themselves aiming at creating new social values. In concrete, abilities of planning and problem-solving are trained through group works in residential training and skills of presentation and communication are enhanced through oral presentations regarding contents of the proposal at each step of the process from a preliminary draft to its completion.

[Course Goals]

Ability of planning, from extraction or setting up challenges to proposal of solutions aiming at creating new social values, is trained through group works.

[Course Schedule and Contents]

Orientation,1time,A brief overview and a schedule of the course are explained and working groups are organized.
Lectures,2times,Lectures by experts are given.
Group works,3times,Setting up challenges, extraction of problems, collecting information, and group works are done.
Residential training,7times,Through intensive group works based on discussion, a proposal for solving problems is planned, a draft report is made, and a few presentations are made.
Preliminary review meeting,1time,A preliminary review meeting is held and discussions are made.
Report meeting,1time,Final presentations are made and reports are submitted.

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

It is required to join the residential training. A report meeting is held and comprehensive evaluation concerning abilities in group discussion to extract or set up challenges and to propose solutions for achieving a goal is made through presentation of the proposal as well as a submitted report.

[Textbook]

Will be indicated as necessary.

Continue to ＧＬセミナーＩＩ（課題解決演習）(2)↓↓↓

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Numbering code					
Course title <English>	工学部国際インターンシップ２ Faculty of Engineering International Internship 2	Affiliated department, Job title,Name	Approved		
Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Intensive, year-round
Day/period	Intensive	Class style	Seminar	Language	Japanese and English

[Outline and Purpose of the Course]

Acqusition of international skills with wth the training of foreign language through the participation to the international internship programs held by the Faculty of Engineering or its subsidiary bodies.

[Course Goals]

The acquisition of international and foreign language skills through the participation to international programs is expected. Detailed objectives of the participation should be identified by each program.

[Course Schedule and Contents]

Overseas Internship,1time,The contents to be acquired should be described in the brochure of each internship program.
Final Presentation,1time,A presentation by the student is required followed by discussion among participants.

[Class requirement]

Described in the application booklet for each internship program. The registrant is requested to have enough language skills for the participation.

[Method, Point of view, and Attainment levels of Evaluation]

Marit rating is done based on the presentation or reports after each internship program. Each **D**epartment responsible to identify if the credit earned by this subject to be included as mandatory ones or not. If the credit is not included in the undergraduate school in which the participant belongs to, the credit is granted by the Global Leadership Education Center as a optional credit. The number of credits, either 1 or 2, will be determined depending on the contents and the duration of the program that the participant has participated in.

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

It is required for students to check if the internship program to participate in could be evaluated as part of mandatory credits or not and could earn how many credits before the participation to the undergraduate school or educational program the student in enrolled. If the credit could not be treated as mandatory ones, get in touch with the Global Leadership Engineering Education Center.

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	量子物理学１（材原宇）〈情報〉 Quantum Physics 1	Affiliated department, Job title,Name	Graduate School of Engineering Associate Professor,MIYADERA TAKAYUKI

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Fri.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

Quantum theory is the most succesful theory in the modern physics. It explains a lot of peculiar phenomena which can never been understood in the classical theory. An important purpose of this course is to understand the fundamental mathematical structure of the quantum theory.

[Course Goals]

An important purpose of this course is to understand the fundamental mathematical structure of the quantume theory. Based on this structure, one is hoped to become capable to calculate some basic properties of a quantum mechanical particle on one-dimensional space.

[Course Schedule and Contents]

1. Introduction. Wave mechanics and matrix mechanics.
2. Mathematical structure of quantum theory (1) State and observable.
3. Mathematical structure of quantum theory (2) Hilbert space and state vectors.
4. Mathematical structure of quantum theory (3) operators and observables
5. Mathematical structure of quantum theory (4) Schroedinger equation and time evolution
6. One particle on one-dimensional space (1) classical theory and its quantization
7. One particle on one-dimensional space (2) CCR and Robertson's uncertainty relation
8. Potential problem (1) General theory
9. Potential problem (2) General theory and its mathematical addendum
10. Square well potential
11. Box potental
12. Scattering theory
13. Harmonic oscillator (1)
14. Harmonic oscillator (2)
15. Learning achievement evaluation

[Class requirement]

Classical mechanics, Linear algebra

[Method, Point of view, and Attainment levels of Evaluation]

examination (100)

Continue to 量子物理学１（材原宇）〈情報〉(2)↓↓↓

Numbering code			
Course title <English>	量子物理学２（材原宇）〈情報〉 Quantum Physics 2	Affiliated department, Job title,Name	Graduate School of Engineering Associate Professor,MIYADERA TAKAYUKI

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Tue.1	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

Quantum theory is an astonishing theory. It describes perfectly a lot of phenomena inspite of its peculiar mathematical formulation.
An important purpose of this course is to understand the formulation and to become capable to manipulate it.

[Course Goals]

To understand the fundamental structure of quantum theory.
To be able to calculate some properties of quantum mechanical particle in three dimensional space.

[Course Schedule and Contents]

1. Fundamental framework
2. Angular momentum (1)
3. Angular momentum (2) generator of space rotation
4. Eigenvalue of Angular momentum operator. SU(2) and SO(3)
5. Spin
6. Central potential
7. Hydrogen atom
8. perturbation theory (1)
9. perturbation theory (2)
10. Heisenberg equation
11. Interaction picture
12. Bell's inequality
13. Mixed state
14. Many particle and Qunatum field
15. Learning achievement evaluation

[Class requirement]

Quantum Physics 1

[Method, Point of view, and Attainment levels of Evaluation]

exam

Continue to 量子物理学２（材原宇）〈情報〉(2)↓↓↓

量子物理学１（材原宇）〈情報〉(2)

[Textbook]

Not used

[Reference books, etc.]

（Reference books）

Modern Quantum Mechanics (J.J.Sakurai) isbn{}{9780805382914} isbn{}{9781292024103}
Lectures on Quantum Theory (C.J. Isham) isbn{}{1860940013}

[Regarding studies out of class (preparation and review)]

Clarify what you have learnt and what you do not understand. Solve a problem set which will be distributed.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

量子物理学２（材原宇）〈情報〉(2)

[Textbook]

Not used

[Reference books, etc.]

（Reference books）

Modern Quantum Mechanics (J.J.Sakurai) isbn{}{9780805382914} isbn{}{9781292024103}
Lectures on Quantum Theory (C.J. Isham) isbn{}{1860940013}

[Regarding studies out of class (preparation and review)]

Solve a distributed problem set.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

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Numbering code			
Course title <English>	エレクトロニクス入門（機宇）〈情報〉 Introduction to Electronics	Affiliated department, Job title,Name	Graduate School of Informatics Professor,MORIKURA MASAHIRO
Target year	2nd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Tue.5	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,2times,
,5times,
,2times,
,5times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

電子回路(2)

[Method, Point of view, and Attainment levels of Evaluation]

Examination and reports. Details about evaluation of the reports are opened on the homepage of this lecture located on PandA.

[Textbook]

Masao Kitano 『Fundamentals of Electronic Circuits』（Reimei Publishing, Kyoto）（ibid:BB04087527）

[Reference books, etc.]

（Reference books）

In addition to Japanese books, Tietze and Schenk: Electronic Circuits (Splinger) isbn{}{354050608X} isbn{}{9783540004295};
Hayes and Horowitz: Student Manual for the Art of Electronics (Cambridge) isbn{}{0521377099}

（Related URLs）

(Link to the homepage of this course is here; (https://panda.ecs.kyoto-u.ac.jp/portal/site/2019-110-6010-000) or (https://panda.ecs.kyoto-u.ac.jp/portal/). Sorry for Japanese version only.)

[Regarding studies out of class (preparation and review)]

In case you need.

（Others (office hour, etc.)）

The topics will be selected owing to limit of lecture time. The students should prepare quotBar Coverquot from the website of the Faculty of Electric and Electronic Engineering (http://www.s-ee.t.kyoto-u.ac.jp/ja/student/index.html)) by themselves, and use it as a title page of each report and the exercise in the lecture. The homepage of this course is located on PandA (https://panda.ecs.kyoto-u.ac.jp/portal/). Contact the instructor after the lecture, when the students have any questions.

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	電子回路 Electronic Circuits	Affiliated department, Job title,Name	Graduate School of Engineering Associate Professor,SUGIYAMA KAZUHIKO
Target year	2nd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Fri.2	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

Following the lecture of fundamentals of active device circuits in the course quotElectric and Electronic Circuitsquot, modeling of active devises, fundamentals of transistor circuits, various amplifier circuits, negative feedback in circuits, operational amplifiers, and oscillators are lectured. Nonlinear circuits, power supplies, and noise would be included in the course, when the lecture time remains.

[Course Goals]

The goal of this course is to acquire the fundamentals of electronic circuits. Starting with understanding of a fundamental concept of electronic circuits i.e., modeling of active devices, the lecture based on the fundamental concept proceeds step by step to understand electric circuits. In this style, the lecturer wants to give the students an ability to understand the principles of more complicated circuits by application of deep understanding the fundamentals. The main targets to be understood are the circuits with bipolar transistors and operational amplifiers, as well as the fundamental concepts.

[Course Schedule and Contents]

Modeling of active devices,3times,The essential concepts in the electronic circuit are lectured in order to treat active devices in the electric circuit theory. The concepts are the controlled source and the linearization. The decoupling between the bias and the signal, another important concept, is lectured.
Fundamentals of transistor circuits,3times,The characteristics of the basic bipolar-transistor circuits of three different common references are lectured based on the operation principle of the bipolar transistor. The biasing circuits are lectured with somewhat practical circuits.
Various amplifier circuits,3times,Several power amplifier circuits are lectured as we focus on their power efficiencies. DC amplifier circuits are lectured as we bear in mind that they are applied in operational amplifiers.
Operational amplifiers,2times,The concept and advantages of the negative feedback circuit are lectured, and an important concept in the operational amplifier, the virtual short, is explained. The linear operational circuits such as integrator and differential circuits, and nonlinear operational circuits such as logarithmic and exponential amplifiers are introduced.
Oscilators,2times,The principle of the oscillator circuit is lectured as a concept of the positive feedback. Various oscillator circuits are introduced with their characteristics.
Others,1time,If we have a more lecture time, nonlinear circuits of multiplier and modulation/demodulation circuits, power supplies for electronic circuits, and the noise in electronic circuits will be lectured.
Examination,1time,We make an examination in order to investigate the achievement in the lecture. We will offer an additional chance for discussion to the students who do not achieve satisfactorily.

[Class requirement]

quotElectric and Electronic Circuit (60030)quot and quotFundamentals of Circuit Theory (60630)quot. (The lecturer recommends moderate understanding of fundamentals of electric circuit as the minimum prerequisites in order to achieve this course.)

Continue to 電子回路(2)↓↓↓

※

Numbering code			
Course title <English>	通信基礎論 Modulation Theory in Electrical Communication	Affiliated department, Job title,Name	Graduate School of Informatics Professor,MORIKURA MASAHIRO Graduate School of Informatics Associate Professor,MURATA HIDEKAZU
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Wed.1	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

This course discusses all types of modulation methods, that is, the theories of amplitude, frequency, phase, pulse modulations, as well as the principles of modulation/demodulation. Further focus is made on signal processing basics, sampling theory, etc., including of related applications.

[Course Goals]

Students will gain an understanding of the fundamentals of communication theory, used in mobile telephones, wireless local area networks (LAN), optical fiber communications, etc. Specifically, students will master signal expression and signal processing (modulation/demodulation) within time axis and frequency axis of communication signals, chiefly in the physical layers of communication signals.

[Course Schedule and Contents]

"Signal processing (4-5 classes)
Clarification is made of the concept of “ frequency, ” and students learn of tools for handling frequency, namely, Fourier series and Fourier transforms and their practical applications. Discussion is next made especially of the basics of random signals and theories regarding the standardization and quantization of random signals.

Analog modulation and demodulation methods (5-6 classes)
Discussion is made of the principles of amplitude modulation and angle modulation and their generation and modulation methods, with comparison of their respective characteristics, including occupied bandwidth and signal-to-noise ratio, etc.

Digital modulation and demodulation methods (4-5 classes)
After description of various methods of pulse modulation, there is discussion of principles and methods of digital modulation types, including modulation phase shift keying (PSK), etc., plus the basics of signal space. Confirmation is made of the extent of student understanding, with supplementary discussion to further improve levels of understanding.

Confirmation of extent of student learning (1 class)
Confirmation is made of the extent that students have learned the contents of this course. Additional explanation is provided for those students whose understanding remains incomplete or imperfect.

Continue to 通信基礎論(2)↓↓↓

通信基礎論(2)

[Class requirement]

Students are required to have taken the course Industrial Mathematics (Fourier Analysis) and Electronic Circuits.

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation is made of extent of student's understanding of course contents via written examination.

[Textbook]

守倉他 『通信方式』（オーム社）ISBN:9784274214738

[Reference books, etc.]

（Reference books）

寺田他: 情報通信工学 (オーム社) isbn{}{4274129322}

[Regarding studies out of class (preparation and review)]

Students are required to have taken the course Industrial Mathematics (Fourier Analysis) and Electronic Circuits.

（Others (office hour, etc.) ）

After classes, from 10:30-12:00

*Please visit KULASIS to find out about office hours.

システム解析入門（数理）(2)

（Related URLs）

(http://www.bode.amp.i.kyoto-u.ac.jp/member/yoshito{}_ohta/system/index.html)

[Regarding studies out of class (preparation and review)]

Read the handouts in advance. Solve problems in the houdouts and exercise problems.

（Others (office hour, etc.) ）

Contact the instructor using email. Address: yoshito{}_ohta@i.kyoto-u.ac.jp

*Please visit KULASIS to find out about office hours.

※

Numbering code					
Course title <English>	システム解析入門（数理） Introduction to Systems Analysis	Affiliated department, Job title,Name	Graduate School of Informatics Professor,OOTA YOSHITO		
Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Wed.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

We will start by showing some examples of dyanamical systems in engineering. Then we mention modelling and analysis techniques. We explain Electrical circuits and mechanical systems that use the linearizaton technique in detail. Throughout the course, we aim to understand the importance of dynamical system modeling and the implication of system control based on mathematical models.

[Course Goals]

We will learn examples of dynamical systems and the rudiments of dynamical systems and approximated linearized systems. This course will be the basics of Linear Control Theory (90720) and Modern Control Theory (90580).

[Course Schedule and Contents]

Introduction to system analysis,2times,Overview of the course.
Linear dynamical systems,3times,First and second order systems such as electric circuits consisting of a capacitor and an inductor and mechanical systems consisting of a spring and a dumper.
State equation and linear approximation,1 times,Linearized systems at an operating point. Linear dynamical systems and their responses.
Laplace transform and transfer function,2times,Laplace transform and linear differential equations. Transfer functions of first and second order systems.
Examples of system modeling,2times,Examples of system modeling including mechanical systems, biological systems, and social infrastructures.
Discrete-time systems,1time,Discrete-time systems described by difference equations.
System identification,1time,System modeling using input-output data.
Exercises,3 times,Excercises.

[Class requirement]

Linear Algebra (A and B) and Calculus (A and B) are recommended.

[Method, Point of view, and Attainment levels of Evaluation]

The grade is determined by the final examination.

[Textbook]

Handouts are given.

[Reference books, etc.]

（Reference books）

Shimemura, What is automatic control?, Korona (in Japanese) isbn{}{9784339031409}

Continue to システム解析入門（数理）(2)↓↓↓

※

Numbering code					
Course title <English>	プログラミング言語（計算機） Programming Languages	Affiliated department, Job title,Name	Graduate School of Informatics Professor,IGARASHI ATSUSHI		
Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Mon.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,2times,
,4times,
,2times,
,2times,
,3times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.) ）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	計算機科学実験及演習１（H26以前入学者） Computer Science Laboratory and Exercise 1	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,MATSUBARA SHIGEO Academic Center for Computing and Media Studies Associate Professor,IIYAMA MASAAKI Graduate School of Informatics Assistant Professor,SHIMIZU TOSHIYUKI Part-time Lecturer,YAMAMOTO TAKEHIRO

Target year	2nd year students or above	Number of credits	1	Course offered year/period	2019/First semester
Day/period	Wed.3,4	Class style	Seminar	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

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[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

計算機科学実験及演習２（計算機）(2)

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	計算機科学実験及演習２（計算機） Computer Science Laboratory and Exercise 2	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,MATSUBARA SHIGEO Graduate School of Informatics Associate Professor,NAKAZAWA ATSUSHI Graduate School of Informatics Associate Professor,YAMADA MAKOTO Graduate School of Informatics Assistant Professor,TAKASE HIDEKI Academic Center for Computing and Media Studies Assistant Professor,Kotani Daisuke Part-time Lecturer,TAKAGI KAZUYOSHI Part-time Lecturer,TAMAKI SUGURU

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Tue.3,4	Class style	Seminar	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,7times,
,7times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

Continue to 計算機科学実験及演習２（計算機）(2)↓↓↓

※

Numbering code			
Course title <English>	数値解析 Numerical Analysis	Affiliated department, Job title,Name	Graduate School of Informatics Professor,NISHIMURA NAOSHI

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Wed.3	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,6times,
,3times,
,4times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	確率と統計 Probability and Statistics	Affiliated department, Job title,Name	Graduate School of Informatics Professor,Shimodaira, Hidetoshi

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Wed.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

This course involves the basics of probability and statistics. The probability theory is illustrated through random number generation. Theory and applications of statistical inference, such as Bayesian inference and maximum likelihood method, are then discussed.

[Course Goals]

To understand the basics of probability and statistics from the viewpoints of mathematics, algorithm, and applications.

[Course Schedule and Contents]

Monte Carlo methods,6times,Random number generation from probability distribution: inverse transform sampling, rejection sampling, Markov chain Monte Carlo (Metropolis-Hastings sampler, Gibbs sampler). Simulation of the model of ferromagnetism. The basics of probability (probability distribution, density function, the law of large numbers, the central limit theorem).
Bayesian inference,4times,Statistical inference with Bayes method. Image restoration via Bayesian inference with Markov chain Monte Carlo. Classification via Bayesian discriminant analysis with an application to spam mail filter. The error rate of Bayes classifier.
The methods of least squares and maximum likelihood,5times,Theory of statistical inference including the following topics. Multiple regression analysis with least squares and weighted least squares. Logistic regression analysis via maximum likelihood method. The asymptotic distribution of the maximum likelihood estimator (MLE). Hypothesis testing and model selection. Additional topics including multivariate analysis (principal component analysis, canonical correlation analysis).

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Grading is based on papers and final exam.

[Textbook]

Handouts may be distributed in class.

[Reference books, etc.]

（Reference books）

C. M. Bishop: Pattern Recognition and Machine Learning, Springer. isbn{}{9780387310732}
T. Hastie, R. Tibshirani, and J. Friedman: The Elements of Statistical Learning, Springer. isbn{}{0387952845} isbn{}{9780387848570} isbn{}{9780387848587}

Continue to 確率と統計(2)↓↓↓

Numbering code			
Course title <English>	グラフ理論（計算機） Graph Theory	Affiliated department, Job title,Name	Academic Center for Computing and Media Studies Associate Professor,MIYAZAKI SHIYUUICHI

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Thu.4	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

We learn basic theories of graphs and their applications, and fundamental algorithms for solving graph problems.

[Course Goals]

The goal of this course is to learn basic theories of graphs and their applications, and fundamental algorithms for solving graph problems.

[Course Schedule and Contents]

1. Foundations of Graphs and (4 timeslots)
I explain definition of graphs and basic properties of graphs. I also briefly review the basics of algorithms and their complexity.

2. Minimum spanning trees (1 timeslot)
Kruskal's algorithm, Prim's algorithm, Steiner tree problem.

3. Shortest path problems (1 timeslot)
Dijkstra's algorithm.

4. Eurer circuits and Hamiltonian cycles (2 timeslots)
Eurer circuits, Hamiltonian cycles, Dirac's theorem. Ore's theorem.

5. Graph coloring (2 timeslots)
Vertex coloring and edge coloring. Brooks's theorem, Vizing's theorem, Konig's theorem. Coloring maps.

6. Maximum flow problems (2 timeslots)
Ford-Fulkerson's algorithm.

7. Matching (2 timeslots)
Matchings, in particular, bipartite matchings. Hall's theorem, Hungarian method.

8. Exam (1 timeslot)

[Class requirement]

Basics of algorithms, data structures, and set theory.

[Method, Point of view, and Attainment levels of Evaluation]

Mainly evaluated by the final exam. In some cases, exercises or the number of attendance to the class may be

Continue to グラフ理論（計算機）(2)↓↓↓

確率と統計(2)

[Regarding studies out of class (preparation and review)]

In addition to attending class, work at home including real data analysis is required.

（Others (office hour, etc.)）

Details of office hours will be notified at class.

*Please visit KULASIS to find out about office hours.

グラフ理論（計算機）(2)

considered.

[Textbook]

宮崎修一『グラフ理論入門 ～基本とアルゴリズム～』（森北出版株式会社）ISBN:978-4-627-85281-5（Written in Japanese）

[Reference books, etc.]

（Reference books）

I may show some recommended books in class.

[Regarding studies out of class (preparation and review)]

Reading the textbook is effective for study. Due to time constraints, I do not give complete description of the proofs in class. I strongly recommend do it by yourself after the class.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	グラフ理論（数理） Graph Theory	Affiliated department, Job title,Name	Graduate School of Informatics Professor,NAGAMOCHI HIROSHI

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Thu.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

After basic notations and properties on graphs and networks are given, algorithms to some representative problems such as the shortest path problem, the minimum spanning tree problem and the maximum flow problem are described. Applications of these results and extensions of them in discrete mathematics are also presented.

[Course Goals]

Not only to learn the notions on graph structure as knowledge but to understand proofs to mathematical properties on discrete structures and logical mechanisms in computational methods

[Course Schedule and Contents]

graphs and networks ,1time,Basic terminology on graphs and networks are defined, and some representative problems such as the Eulerian trail problem, the Hamiltonian cycle problem and the graph isomorphism problem are introduced.
connectivity,1time,Graph connectivity such as k-connectivity of undirected graphs and strong connectivity of digraphs are defined and some properties for them are derived.
plane graphs and dual graphs,2times,Some combinatorial aspects of graphs such as Kratowski#039s theorem, which characterizes the planar graphs, duality of plane graphs, the four-color theorem are described.
representation for graphs,1time,As representation for data to input graphs, matrix and adjacency lists are introduced.
graph search,2times,The depth first search and the width first search are introduced, and as their applications, an algorithm for computing cut-vertices and biconnected components is designed.
shortest path ,2times,Properties on shortest paths and Dijkstra#039s method, as a representative shortest path algorithm, are described.
trees and cut-sets,1time,Important properties on spanning trees and cut-sets, especially the roles of fundamental cycles and fundamental cut-sets are described.
minimum spanning tree ,1-2times,Kruskal#039s method and Prim#039s method, as representative minimum spanning tree algorithms, are described, and data structure for them and their computational complexities are discussed.
maximum-flow ,2times,The maximum-flow and minimum-cut theorem in networks and an algorithm for finding a maximum flow are described.

[Class requirement]

None

Continue to グラフ理論（数理）(2)↓↓↓

※

Numbering code			
Course title <English>	応用代数学 Applied Algebra	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,TSUJIMOTO SATOSHI

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Mon.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

An introduction with application to basic algebra in informatics.

[Course Goals]

To understand basic ideas and some applications of algebras (mainly group theory).

[Course Schedule and Contents]

Introduction to group theory,2-3times,Definition and examples of group: symmetric group, permutation group, cyclic group, general linear group and so on.
Structure of groups,4-5times,Subgroup, coset, normal subgroup, quotient group, the isomorphism theorems.
Symmetric group and enumeration problem,3-4times,Action of the symmetric group on a finite set. Enumeration problem.
Group representation,3-4times,Groups in terms of linear transformations of vector space.
Summary and assessment,1time,Summary and supplement of this course. Measure the progress of students in acquiring knowledge and skills.

[Class requirement]

Linear algebra

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation depends mainly on marks of examination, but marks of exercises are taken into account when needed.

[Textbook]

[Reference books, etc.]

（Reference books）

T. Hiramatsu: Joho no suri oyo daisugaku (Shokabo) isbn{}{4785315040}

（Related URLs）

(http://www-is.amp.i.kyoto-u.ac.jp/lab/tujimoto/appalg/)

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

グラフ理論（数理）(2)

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation is made based on marks on answers in exercises (30%) and score of end-term examination (70%)

[Textbook]

[Reference books, etc.]

（Reference books）

C ni yoru Algorithms to Data Structure, Ibaraki, Shokou-do isbn{}{4785631171} isbn{}{9784274216046}

（Related URLs）

(Necessary materials are uploaded at http://www-or.amp.i.kyoto-u.ac.jp/members/nag/)

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

Some exercises are conducted in each class. The answers to questions in exercises and end-term examination and the achievement attained by students to each question will be uploaded.

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	計算機科学実験及演習４（計算機） Computer Science Laboratory and Exercise 4	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,MATSUBARA SHIGEO Graduate School of Informatics Associate Professor,MA QIANG Academic Center for Computing and Media Studies Associate Professor,IIYAMA MASAAKI Graduate School of Informatics Associate Professor,YOSHII KAZUYOSHI Graduate School of Informatics Assistant Professor,SHIMIZU TOSHIYUKI Academic Center for Computing and Media Studies Assistant Professor,HIRAISHI TASUKU Part-time Lecturer,YAMAMOTO TAKEHIRO Part-time Lecturer,UMATANI SEIJI

Target year	3rd year students or above	Number of credits	3	Course offered year/period	2019/Second semester
Day/period	Thu.3,4,Fri.1,2,3,4	Class style	Seminar	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,15times,
,15times,
,15times,
,15times,
,15times,
,15times,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Continue to 計算機科学実験及演習４（計算機）(2)↓↓↓

計算機科学実験及演習４（計算機）(2)

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	現代制御論（数理） Modern Control Theory	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,KASHIMA KENJI
Target year	4th year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Tue.2	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

This course provides the fundamentals in modern control theory - centered around the so-called state space methods - as a continuation of classical control theory taught in Linear Control Theory. Emphasis is placed on the treatment of such concepts as controllability and observability, pole allocation, the realization problem, observers, and linear quadratic optimal regulators.

[Course Goals]

The objective is to study controllability and observability that are the basis of modern control theory, and also understand design methods such as optimal regulators. It is hoped that the course provides a basis for a more advanced topic such as robust control theory.

[Course Schedule and Contents]

Introduction to modern control,1time,We give real examples for which the modern control theory are applied. We also give a state-space formulation for modeling dynamical systems.
Mathematics for modern control,1time,We discuss some fundamental properties of mathematics, in particular, vectors and matrices.
Controllability and observability,2times,We introduce the fundamental notions of controllability and observability for linear dynamical systems, and also discuss their basic properties and their criteria.
Canonical decomposition,2times,We give the canonical decomposition for linear systems.
Realization problem,2times,We introduce the realization problem that constructs state space representations from transfer functions for single-input and single-output systems.
Stability,2times,We discuss the stability of dynamical systems described by state-space equations. We also give mathematical tools for checking if a system is stable or not.
State feedback and dynamic compensators,3times,We introduce the construction of dynamic compensators via state feedback, pole allocation and observers. The relationships with controllability and observablity are also discussed.
Opimal regulators,2times,We give the basic construction of optimal regulators, in particular, the introduction of the matrix Riccati equation, its solvability, relationship to stability and observability, and root loci.

[Class requirement]

It is desirable that the student has studied classical control theory (linear control theory). Fundamental knowledge on linear algebra is assumed, e.g., matrices, determinants, rank of a matrix, dimension of a vector space, isomorphism.

Continue to 現代制御論（数理）(2)↓↓↓

※

Numbering code			
Course title <English>	アルゴリズム論 Theory of Algorithms	Affiliated department, Job title,Name	Graduate School of Informatics Professor,MINATO SHINICHI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/Second semester		
Day/period	Thu.2	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

We introduce a computation model suitable for discussing both time and space complexities of algorithms and problems, then study basic ideas and issues of computational complecity theory.

[Course Goals]

[Course Schedule and Contents]

review of language and automata theory,2times,
Turing machines,4times,Basic properites of Turing machites including their computation power and several equivalent machines.
Decidability and Undecidability,3times,The notion of decidability of problems and examples of undecidable problems.
Introduction of complexity theory,6times,Decidable but intractable problems and NP-completeness.
Discussion to check the achievements of students

[Class requirement]

91040

[Method, Point of view, and Attainment levels of Evaluation]

Two reports and a final exam.

[Textbook]

Iwama, Introduction to theory of algorithms, Shoko-do, 2001 isbn{}{4785631252} isbn{}{9784254122039}.

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

現代制御論（数理）(2)

[Method, Point of view, and Attainment levels of Evaluation]

The grading is based on the evaluation of reports and final examination.

[Textbook]

None specified.

[Reference books, etc.]

（Reference books）

Linear Algebra, K. Jaenich, translation by M. Nagata, Gendai-suugakusha, isbn{}{4768703194}
Mathematics for Systems and Control, Y. Yamamoto, Asakura, isbn{}{4254209762}

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	情報システム理論（数理） Theory of Information Systems	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,MASUYAMA HIROYUKI
Target year	4th year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Thu.2	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

This course covers modeling and performance evaluation methods for optimal design of information/service systems, focusing on queueing theory and Markov analysis.

[Course Goals]

This course aims to deepen the understanding of the fundamental results of both queuing theory and Markov analysis for the modeling and performance evaluation methods of information/service systems.

[Course Schedule and Contents]

Outline of this course,1time,The contents of this course are outlined, together with introducing the significance and history of performance evaluation of information/service systems by queuing theory and Markov analysis.
Review of fundamental notions,2〜3times,The fundamental notions, such as random variables, probability distributions, Markov chains etc., are explained
Performance evaluation of semi-Markovian queues,5〜6times,The following performance measures are delivered: the stationary queue length distribution and waiting time distribution of semi-Markovian queues, such as M/G/1 and GI/M/1 queues, in addition to the loss probability of their finite-capacity analogues.
Formulas for performance evaluation,5〜6times,The following formulas for performance evaluation are lectured: Erlang#039s loss formula, Little#039s law, Kingman#039s inequality, and approximate formulas for multi-server queues.

[Class requirement]

Stochastic discrete event systems, and basics of queueing theory.

[Method, Point of view, and Attainment levels of Evaluation]

Based on the score of the term examination

[Textbook]

Handouts are provided.

[Reference books, etc.]

（Reference books）

P. Bremaud, Markov Chains: Gibbs Fields, Monte Carlo Simulation, and Queues, Springer, 1999. isbn{}{9780387985091}
L. Kleinrock, Queueing Systems Vol.1, John Wiley and Sons, 1975. isbn{}{9780471491101}
L. Kleinrock, Queueing Systems, Vol.2, John Wiley and Sons, 1976. isbn{}{9780471491118}
D. P. Heyman and M. J. Sobel, Stochastic Models in Operations Research, Vol. 1, Dover Publications, 2003.

Continue to 情報システム理論（数理）(2)↓↓↓

※

Numbering code			
Course title <English>	線形計画 Linear Programming	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAMASHITA NOBUO
Target year	1st year students or above	Number of credits	2
Course offered year/period	2019/Second semester		
Day/period	Tue.1	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

Lectures on modeling and algorithms of mathematical optimization, with main focus on linear programming, which is the most fundamental subject in system optimization.

[Course Goals]

To learn the basic ideas of formulating optimization models, and to understand theoretical properties and solution methods of linear programming.

[Course Schedule and Contents]

Introduction to Mathematical Optimizaiton,1time,Introduction to Mathematical Optimization. Reviews of some mathematics for linear programming, in particular, linear algebras.
Mathematical Programming Models,4times,Representative mathematical programming models such as linear programming models, network programming models, noninear programming models, and combinatorial programming models, with simple illustrative examples.
Linear Programming and Basic Solutions,2times,Formulation of linear programs in the standard form, and basic concepts of basic solutions, basic feasible solutions, and optimal basic solutions.
Simplex Method,3times,Basic ideas and concrete procedures of the simplex method that is a classical method for linear programming. Topics include two-stage linear programming, variables with upper bounds, and network simplex methods.
Duality and Sensitivity Analysis,3times,Duality as an important theory in linear programming, and sensitivity analysis as a useful technique in decision making.
Interior Point Methods,1time,Interior point methods as polynomial-time algorithms in linear programming.
Review and Summary,1time,Review and Summary. Confirmation of achievement level.

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Based on the score of the term examination.

[Textbook]

Fukushima, M.: Introduction to Mathematical Programming: New Edition (in Japanese), Asakura Shoten isbn{}{9784254280043}.

[Reference books, etc.]

（Reference books）

Continue to 線形計画(2)↓↓↓

情報システム理論（数理）(2)

isbn{}{0070286310}.

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

線形計画(2)

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	論理システム（計算機） Logical Systems	Affiliated department, Job title,Name	Graduate School of Informatics Professor,TAKAGI NAOFUMI

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Wed.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

In this course, we learn about symbolic logic and Boolean algebra, the basis of computer science, and about logic circuits, the basis of digital machine configurations. We first study symbolic logic, especially propositional logic. Next, we take up Boolean algebra, its various characteristics (properties); meanwhile, students will gain logic function simplification methods. We further study the design and analysis of combinational logic circuits, as well as sequential circuits and their models, sequential machines.

[Course Goals]

1. Students will understand and be able to explain propositional logic.
2. Students will understand and be able to explain the fundamental concepts and various characteristics of Boolean algebra and logic functions.
3. Students will understand and be able to use logic function simplification methods.
4. Students will understand and be able to explain the fundamental concepts and design methods of combinational logic circuits and sequential circuits.

[Course Schedule and Contents]

Mathematical preparation (1 class)
A review of knowledge necessary for this course, including sets, relationships, etc.

Symbolic logic (1 class)
Students learn about propositional logic, together with an overview of symbolic logic.

Boolean algebra and logic functions (2 classes)
Students learn about Boolean algebra and logic expressions, as well as about logic functions and their expressions, etc.

Simplification of logic functions (2 classes)
Students learn about the simplification of logic functions.

Various characteristics of logic functions (2 classes)
Students learn about the various properties of logic functions and about logic functions that have special characteristics.

Design and analysis of combinational circuits (2 classes)
Students learn about design methods and analysis methods for combinational circuits.

Sequential machines and sequential circuits (4 classes)
Students learn about design methods for sequential circuits, and especially regarding the minimization of, and

Continue to 論理システム（計算機）(2)↓↓↓

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Numbering code			
Course title <English>	論理システム（数理） Logical Systems	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAMASHITA NOBUO

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Wed.3	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,3times,
,6times,
,6times,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

state allocation for, sequential machines.

Term-end examination (1 class)

Feedback (1 class)
Review, including of the problems on the final examination, etc.

[Class requirement]

Nothing of special note.

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation is performed regarding each element of this course's end goals, namely, the final examination (approximately 95%) and exercises (approximately 5%). If an understanding is shown of 80% or higher on the final exam, then the student will pass the course.

[Textbook]

Naofumi Takagi 『Logic circuits』 （Ohm-sha）ISBN:9784274215995

[Reference books, etc.]

（Reference books）

（Related URLs）

http://www.lab3.kuis.kyoto-u.ac.jp/~ntakagi/ls.html

[Regarding studies out of class (preparation and review)]

Students are to read assigned textbook portions to prepare for each class.
Students are to solve the problem exercises assigned during each class and to submit each week's problems at the next class.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	解析力学（数理） Analytical Mechanics	Affiliated department, Job title,Name	Graduate School of Informatics Professor,AOYAGI TOSHIO

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Wed.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,7times,
,8times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	線形制御理論 Linear Control Theory	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,KASHIMA KENJI

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Wed.3	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

In this course, we will learn the basics of feedback control theory which has wide range of applications such as drones, automatic driving, systems biology. We will give lectures on analysis of feedback systems, stability criterion, servo mechanism design, and so on, based on Laplace transform.

[Course Goals]

The goal of this course is to understand the basics on analysis of feedback systems and to acquire frequency-domain methods for control systems design.

[Course Schedule and Contents]

Introduction,1time,
Laplace transform,2times,
System modeling and transfer function,2times,
Transient response and stability,3times,
Frequency response,2times,
Stability analysis of feedback systems,2times,
Characteristics of feedback control systems,2times,
Summary,1time,

[Class requirement]

It is recommended, but not required, that students take Introduction to Systems Analysis (90070) and Applied Mathematics A3 (20700) before taking this course.

[Method, Point of view, and Attainment levels of Evaluation]

The final grade in this course is based on your scores in reports and the final examination.

[Textbook]

None.

[Reference books, etc.]

（Reference books）

T. Sugie and M. Fujita: Introduction to Feedback Control (in Japanese). Corona Publishing, 1999 isbn{}{4339033030}

T. Katayama: Fundamentals of Feedback Control: New edition (in Japanese). Asakura Publisher, 2002 isbn{}{4254201117}

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

数理工学セミナー（数理）(2)

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

In early July, all the themes of seminars are announced. Students are asked to give application forms. It is assumed that students are looking at the announce board of the department office carefully.

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	数理工学セミナー（数理） Seminar on Applied Mathematics and Physics	Affiliated department, Job title,Name	Graduate School of Informatics Professor,TAGUCHI Satoshi Graduate School of Informatics Assistant Professor,OOKI KENTAROU Graduate School of Informatics Assistant Professor,HARADA KENJI Graduate School of Informatics Assistant Professor,TSUTSU HIROKI Graduate School of Informatics Assistant Professor,Aleksandar Shurbevski Graduate School of Informatics Associate Professor,FUKUDA HIDEMI Graduate School of Informatics Assistant Professor,KAMIOKA SHIYUUHEI

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Fri.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

Having seminars on various themes related to applied mathematics and physics.

[Course Goals]

[Course Schedule and Contents]

Seminars,times,Eight themes are provided.

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Attendances are requested. Presentation and discussions are evaluated.

[Textbook]

Continue to 数理工学セミナー（数理）(2)↓↓↓

※

Numbering code			
Course title <English>	最適化（数理） Optimization	Affiliated department, Job title,Name	Graduate School of Informatics Professor,NAGAMOCHI HIROSHI Graduate School of Informatics Professor,YAMASHITA NOBUO

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Wed.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

Mathematical programming or optimization is a methodology for modeling a real-world problem as a mathematical problem with an objective function and constraints, and solving it by some suitable procedure (algorithm). This course consists of lectures on basic theory and methods in nonlinear optimization and combinatorial optimization.

[Course Goals]

To understand basic theory and algorithms in continuous optimization and combinatorial optimization.

[Course Schedule and Contents]

Fundamentals of nonlinear optimization,2times,Basic notions in continuous optimization such as global and local minima, convex sets and functions, gradients and Hessian matrices of multivariate functions.
Method of unconstrained optimization,2times,Basic unconstrained optimization methods such as steepest descent method, Newton#039s method, quasi-Newton methods, conjugate gradient method.
Optimality conditions and duality,2times,Optimality conditions for constrained optimization problems, called Karush-Kuhn-Tucker conditions, as well as the second-order optimality conditions and Lagrangian duality theory.
Methods of constrained optimization,1time,Basic methods of constrained optimization such as penalty methods and sequential quadratic programing methods.
Combinatorial optimization,1time,Typical combinatorial optimization problems such as traveling salesman problem and knapsack problem, and their computational complexity.
Branch-and-bound method and dynamic programming,2times,Basic exact solution strategies for combinatorial optimization such as branch-and-bound method and dynamic programming.
Approximation algorithms,3times,Approximation algorithms for hard combinatorial optimization problems, and their theoretical performance guarantees.
Summary and review,1time,Summary and review. Confirmation of achievement level.

[Class requirement]

Linear Programming (90690) recommended.

[Method, Point of view, and Attainment levels of Evaluation]

Based on the score of the term examination.

Continue to 最適化（数理）(2)↓↓↓

最適化（数理）(2)

[Textbook]

[Reference books, etc.]

（Reference books）

M. Fukushima, Introduction to Mathematical Programming: New Edition (in Japanese), Asakura Shoten isbn{}{9784254280043};
M. Yagiura and T. Ibaraki, Combinatorial Optimization - Metaheuristic Algorithms (in Japanese), Asakura Shoten isbn{}{4254275129}.

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

力学系の数学(2)

to Chaos isbn{}{9780123820105}
J. Guckenheimer and P. Holmes, Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields, Springer isbn{}{0387908196}
J.D. Meiss, Differential Dynamical Systems, SIAM isbn{}{9780898716351}
S. Wiggins, Introduction to Applied Nonlinear Dynamical Systems and Chaos, Springer isbn{}{0387001778}

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	力学系の数学 Dynamical Systems	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAGASAKI KAZUYUKI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Thu.3	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

Dynamical systems represent general mathematical models such as differential equations for time-dependent phenomena and a mathematical field having originated in the work of the greatest mathematician in 19th century, Poincare. Dynamical systems theory provides tools to treat nonlinear phenomena such as bifurcations and chaos, and its application range is very wide since there are numerous time-dependent phenomena in natural and social sciences. This course provides fundamentals of dynamical systems theory with a special focus on differential equations.

[Course Goals]

(1) To understand dynamics of differential equations and maps near neighborhoods of equilibria and fixed points
(2) To understand mechanisms for nonlinear phenomena such as bifurcations and chaos
(3) To master fundamental techniques for dynamical systems

[Course Schedule and Contents]

Introduction to Dynamical Systems,5-6times,Fundamentals of differential equations are reviewed and elementary concepts such as Poincare maps, stability, dynamics of linear systems and invariant manifolds are explained.
Local Bifurcations,4-5times,Bifurcations of equilibria and fixed points, center manifold reductions and normal forms are discussed.
Chaos,4-5times,Horseshoe maps, homoclinic theorem and Melnikov#039s method are discussed.

[Class requirement]

Calculus, Linear Algebra and Differential Equations

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation depends mainly on marks of examination, but marks of exercises and homework are taken into account when needed.

[Textbook]

Handouts

[Reference books, etc.]

（Reference books）

K.T. Alligood, T. Sauer and J.A. Yorke, Chaos: An Introduction to Dynamical Systems, Springer isbn{}{9780387946771}
M.W. Hirsch, S. Smale and R.L. Devaney,Differential Equations, Dynamical Systems, and an Introduction

Continue to 力学系の数学(2)↓↓↓

※

Numbering code			
Course title <English>	信号とシステム Signals and Systems	Affiliated department, Job title,Name	Graduate School of Informatics Professor,OOTA YOSHITO Graduate School of Informatics Associate Professor,KASHIMA KENJI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Wed.4	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,2times,
,3times,
,2times,
,2times,
,2times,
,3times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	連続体力学（数理） Continuum Mechanics	Affiliated department, Job title,Name	Graduate School of Informatics Professor,TAGUCHI Satoshi

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Tue.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

The lecture on fundamental theory of fluid dynamics and elasticity is given as an introduction to the theory of mechanical behavior of continuous media.

[Course Goals]

Understanding the basic concepts in fluid dynamics and elasticity.

[Course Schedule and Contents]

concept of continuous media,1time,
stress,2times,
momentum equation,1time,
basic equations of fluids,2-3times,
dynamics of viscous fluids,3-4times,
dynamics of inviscid fluids,1-2times,
compressible fluids and sound waves,1time,
basic equations in elasticity,2-3times,
,,

[Class requirement]

analysis, linear algebra, fundamentals of dynamics, fundamentals of vector analysis

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation is based on the score of examination.

[Textbook]

No

[Reference books, etc.]

（Reference books）
Introduced in the lecture

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

計算機科学実験及演習３（計算機）(2)

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	計算機科学実験及演習３（計算機） Computer Science Laboratory and Exercise 3	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,MATSUBARA SHIGEO Graduate School of Informatics Associate Professor,SUENAGA KOUHEI Graduate School of Informatics Assistant Professor,TAKASE HIDEKI Graduate School of Informatics Associate Professor,YAMADA MAKOTO Graduate School of Informatics Assistant Professor,OOMOTO YOSHIMASA Part-time Lecturer,TAKAGI KAZUYOSHI Part-time Lecturer,UMATANI SEIJI

Target year	3rd year students or above	Number of credits	4	Course offered year/period	2019/First semester
Day/period	Thu.3,4,5,Fri.1,2,3,4,5	Class style	Seminar	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,15times,
,15times,
,15times,
,15times,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

Continue to 計算機科学実験及演習３（計算機）(2)↓↓↓

※

Numbering code			
Course title <English>	計算と論理 Logic and Computation	Affiliated department, Job title,Name	Graduate School of Informatics Professor,IGARASHI ATSUSHI

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Tue.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,6times,
,7times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	数理工学実験（数理:H25以前入学者） Applied Mathematics and Physics Laboratory	Affiliated department, Job title,Name	Graduate School of Informatics Assistant Professor,Aleksandar Shurbevski Graduate School of Informatics Associate Professor,FUKUDA HIDEMI Part-time Lecturer,MATSUMOTO YUTAKA
Target year	2nd year students or above	Number of credits	2
Course offered year/period	2019/Second semester		
Day/period	Mon.3,4,Tue.3,4	Class style	Experiment
Language	Japanese		

[Outline and Purpose of the Course]

Applied mathematics and physics as an academic discipline gives a theoretical interpretation and explanation to the behavior and physical phenomena of various systems around us, and provides a means of problem solving. For the purpose of acquiring the fundamental skills and methods of applied mathematics and physics, we will tackle several experiment themes prepared from fields such as operations research and communication network.

[Course Goals]

Acquire an understanding of fundamental algorithms in the fields of operations research and communication networks, as well as acquire basic programming techniques for implementing such algorithms, perform experiments, and analyze experiment data to draw conclusions and insights.

[Course Schedule and Contents]

Guidance, 1 times,Explanation of experiment guideline.
Continuous Optimization,9times,Given an objective function and some constraints that take a vector as an argument, we call the problem of finding a value for the argument vector that minimizes (or maximizes) the value of the objective function under the given constrains an ldquoOptimization Problemrdquo. In this experiment, students will implement a procedure that generates a sequence of points that converge to an optimal solution (called an iterative method) of a given optimization problem. Further, the students should observe and discuss the appropriateness of a solution delivered by their implementation, as well as the time needed to reach to this solution.
Discrete Optimization,9times,Combinatorial, or Discrete, optimization problems are optimization problems where the feasible solution space is discrete, and can be defined by some combinatorial structures such as orders or partitions. These types of problems often occur in many areas, but it is difficult to solve them efficiently unless one grasps the structure of the problem. In this experiment, students will get familiar with the difficulty of combinatorial optimization problems through some representative problems, such as the Subset Sum or Shortest Path problems. Further, will study and implement the method of Dynamic Programming as one of the solution methods for combinatorial optimization problems.
Communication Network Design,9times,As an application example of queuing theory, consider designing a communication network. Through two simple case studies, students will explore the differences between the design methods of a voice network and a data network. Further, students will learn how to use queuing theory to evaluate the performance of a network as a design indicator. As an assignment, students will also tackle the design of an optimal network under given constraints.
Confirmation of Learning Achievements,2times,Provide feedback to students on basic topics such as report-writing or the contents of the course.

Continue to 数理工学実験（数理:H25以前入学者）(2)↓↓↓

※

Numbering code			
Course title <English>	基礎数理演習（数理） Exercise on Applied Mathematics and Physics	Affiliated department, Job title,Name	Graduate School of Informatics Senior Lecturer,MIYAZAKI SHIYUUJI Graduate School of Informatics Assistant Professor,KAMIOKA SHIYUUHEI Graduate School of Informatics Assistant Professor,TSUTSU HIROKI Graduate School of Informatics Assistant Professor,YAMAGUCHI YOSHIYUKI
Target year	2nd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Tue.3,4	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Continue to 基礎数理演習（数理）(2)↓↓↓

数理工学実験（数理:H25以前入学者）(2)

[Class requirement]

Acquired credits for all Basic Subjects offered by the Applied Mathematics and Physics Course.

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation will be based on class attendance and a report for each of the class themes. The minimum passing criterion is attendance to all class sessions and submitted reports for each theme, however this does not guarantee a passing mark and obtained credit. Late arrivals, absence and report re-submission will influence negatively on the final evaluation score.

[Textbook]

An experiment manual prepared by the instructors will be distributed in class.

[Reference books, etc.]

（Reference books）
Supplemental materials will be introduced if deemed necessary.

[Regarding studies out of class (preparation and review)]

Pre-class preparation by reading the provided experiment manual, class notes, and other reference materials is highly recommended.

（Others (office hour, etc.)）

The number of credits that students can obtain through this course has changed for students who have entered as of 2008.
It is mandatory to attend the guidance at the first class in October.
Details of the guidance time and place will be announced in September on the notice board in front of the administration office in General Research Building 8.
At the guidance, explanation about the BYOD (Bring Your Own Device) system will be given, so please bring your PC at the guidance.

*Please visit KULASIS to find out about office hours.

基礎数理演習（数理）(2)

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	プログラミング演習（数理） Exercise on Programming	Affiliated department, Job title,Name	Part-time Lecturer,MATSUMOTO YUTAKA Graduate School of Informatics Associate Professor,MASUYAMA HIROYUKI
Target year	2nd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Mon.3,4	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

Exercise on C programming. This class is mainly designed for beginners of programming. Students will practice the fundamental syntax of C language, such as data types, operators, conditional statements, loops, arrays, strings, pointers, functions, structures, file I/O, etc. Further, they will study the computer simulation method as one of application exercises. Besides the exercises in the class, the ldquoProgram Contest of the Applied Mathematics and Physics Course (may not be held depending on circumstances)rdquo (arbitrary participation) will be introduced and explained to have a chance to challenge more advanced programming.

[Course Goals]

Acquire the knowledge and skills of programming to be able to make a program (or source code) as one wants when seeking a solution in any field of the applied mathematics and physics by computer programming.

[Course Schedule and Contents]

Guidance,1time,Explanation of exercise guideline and how to progress with programming.
Fundamentals of C,9times,Practice of C syntax from data types to file I/O through the textbook.
Simulation Method,2times,How to make simulation programs by using random number generators, Monte Carlo method, Runge-Kutta method, etc.
Program Contest,2times,Explanation of this yearrsquos contest theme and its introductory exercise.
Confirmation of Learning Achievements,1time,Confirm the achieving level of programming ability.

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation will be based on submitted programs (source codes) for 70% and a report for 30%. Class attendance will be emphasized, and late arrival, absence and early leave will influence negatively on the final evaluation score.

[Textbook]

「やさしく学べるC言語入門［第2版］」（皆本晃弥著，サイエンス社，2015） isbn{}{ 9784781913599}

Continue to プログラミング演習（数理）(2)↓↓↓

Numbering code			
Course title <English>	数値計算演習（数理） Exercise on Numerical Analysis	Affiliated department, Job title,Name	Graduate School of Informatics Assistant Professor,HARADA KENJI Graduate School of Informatics Assistant Professor,Ueda Masahiko Graduate School of Informatics Assistant Professor,IWASAKI ATSUSHI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Wed.3,4	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

The numerical approach with computers is useful when we solve several problems in informatics and applied mathematics. In this exercise, we will learn numerical methods through implementing computer codes, executing the programs, and interpreting results.

[Course Goals]

We will learn fundamental techniques for numerical analysis with computers. Specifically, we aim at obtaining the following four techniques.
(1) Understanding algorithm for numerical analysis
(2) Coding techniques
(3) Methodology of data analysis
(4) Writing ability.

[Course Schedule and Contents]

Week 1, Guidance and "How to write an effective report"
(a) We will explain contents of exercises on numerical simulations and introduce staffs and teaching assistants. We will further explain how to use computers in the computer room.
(b) We will study how to write an effective report.
Week 2-5 Numerical integration method and Monte Carlo method
(a) Trapezoidal rule, Simpson's rule
(b) Markov Chain Monte Carlo method
Week 6-10 Diffusion equation
We will study an explicit Euler method and Crank-Nicolson method for a one-dimensional diffusion equation and a reaction-diffusion equation.
Week 11-14 Statistical analysis
We will study fundamental methods which we need in data analysis.
(a) Least square method
(b) Statistical inference
(c) Statistical hypothesis testing
Week 15 Supplement to exercise

Continue to 数値計算演習（数理）(2)↓↓↓

プログラミング演習（数理）(2)

[Reference books, etc.]

（Reference books）

None

（Related URLs）

(URL: Program Contest of the Applied Mathematics and Physics Course

http://infosys.sys.i.kyoto-u.ac.jp/~contest/)

[Regarding studies out of class (preparation and review)]

Students will be asked to prepare specified pages of the textbook every time.

（Others (office hour, etc.)）

The attendance of guidance is requisite for taking this class. Each student is required to have obtained an ECS-ID (account for the education computer system) and the textbook by the start of the class.

*Please visit KULASIS to find out about office hours.

数値計算演習（数理）(2)

[Class requirement]

Under the UNIX operating system, students have to edit a file, code and test C programs, make reports and graphs, and print them. BYOD.

[Method, Point of view, and Attainment levels of Evaluation]

The students MUST submit all the reports for all subjects. The grading will be done based on the total scores of reports.

[Textbook]

Instructed during class

[Reference books, etc.]

（Reference books）

Introduced during class

[Regarding studies out of class (preparation and review)]

Students need to prepare by exercise documents.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	システム工学実験（数理:H25以前入学者） System Analysis Laboratory	Affiliated department, Job title,Name	Graduate School of Informatics Assistant Professor,LIU YAN Graduate School of Informatics Assistant Professor,OOKI KENTAROU Graduate School of Informatics Assistant Professor,NIINO KAZUKI

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Thu.3,4,Fri.3,4	Class style	Experiment	Language	Japanese

[Outline and Purpose of the Course]

Systems engineering consists of three factors: (1) modeling, (2) analysis, and (3) control. Our course aims at making students have a solid grasp of systems engineering through the application of their knowledge to three different real systems. Three real systems are Active Silencer, Flexible-Link Manipulator, and Inverted Pendulum. Students will master the control methods through the computer simulation and the pilot experiments. To experience the control of all three different systems in turn, students will be divided into three groups during the Guidance class.

[Course Goals]

To understand the following theoretical knowledge through the control of the real systems:
-- The first principle of physical modeling
-- Parameter identification from experiments
-- Analyses of responses and stabilities
-- System stabilization and optimal control
To obtain the practical solution to the problem through the observation of the behavior of the real system, the consideration of the gap between theory and practice, and understanding the feature of the systems.
To precisely express own understanding of the experiments through presentations and reports.

[Course Schedule and Contents]

Guidance,1time,Introduction of topics and Group division
Active Silencer,9times,1. Introduction to principle of active sliencer\\ 2. Basic lecture on DSP and programming\\ 3. Experiment\\ 4. Analyses on response in time and frequency\\ *The specialized software Scilab is used.
Flexible-Link Manipulator,9times,1. A recursive estimation of frequency transfer function and parameter identification\\ 2. Tracking step signals\\ 3. Two-degree-of-freedom controller\\ 4. Tracking desired signals\\ *The specialized softwares Scilab and MATLAB/SIMULINK are used.
Inverted Pendulum,9times,1. Mechanical model of inverted pendulum and identification of its parameters\\ 2. Controller by state space representation\\ 3. Inference of state variables by observer\\ 4. Pole-place method / optimal control method\\ 5. Swinging up of inverted pendulum\\ *The specialized softwares Scilab and MATLAB/SIMULINK are used.

Continue to システム工学実験（数理:H25以前入学者）(2)↓↓↓

※

Numbering code			
Course title <English>	物理統計学（数理） Statistical Physics	Affiliated department, Job title,Name	Graduate School of Informatics Professor,UMENO KEN

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Thu.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

Probability theory, statistical mechanics, and theory of stochastic processes are explained as methods to investigate systems with many degrees of freedom. Technics for describing dynamics, and fluctuation in equilibrium or stationary systems and some topics for nonequiliburium systems are explained.

[Course Goals]

To gain firmly the fundamental skills for understanding various phenomena with the use of probability theory and stochastic process.

[Course Schedule and Contents]

Fundamentals of probability and entropy,3times,Continuous and discrete stochastic variables are introduced and entropy, KL entropy and mutual information are explained.
Fundamentals of statistical mechanics,3times,Fundamentals of thermodynamics are reviewed and statistical mechanics is formularized with the maximum entropy principle. Applications to ideal gases and spin systems are explained.
Stochastic processes and random walks,3times,Stochastic processes, especially Markov processes are explained. As examples, Gauss process, Poisson process, Wiener process and random walks are explained. Langevin equaitons and Fokker-Planck equations,3times,Brownian motion is introduced as an example of Langevin equations. Derivation of Fokker-Planck equations from Langevin equations are described and several applications of both equations are explained.
Some topics for nonequiliburium systems,2times,We explain some topics chosen from entropy production in relaxation processes from nonequiliburium states to equilibrium states, the linear responce theory, the fluctuation theory, thermal excitation, diffusion and so on.

[Class requirement]

Fundamentals of calculus and linear algebra

[Method, Point of view, and Attainment levels of Evaluation]

Based on quizzes and the semester final exam.

[Textbook]

None

[Reference books, etc.]

（Reference books）
To be announced in the lecture

[Regarding studies out of class (preparation and review)]

Reviews through solving the assigned quizzes are expected.

（Others (office hour, etc.)）

According to progress of the lecture, some topics may be omitted or added.

*Please visit KULASIS to find out about office hours.

システム工学実験（数理:H25以前入学者）(2)

[Class requirement]

Students are supposed to have the knowledge of Introduction to Systems Analysis (90070) and take the course of Linear Control Theory (90720).

[Method, Point of view, and Attainment levels of Evaluation]

Class participation and reports are mainly evaluated. Attitude, Creativeness, and Individual work and group work are also important during the evaluation process.

[Textbook]

Each instructor will distribute his own text when necessary.

[Reference books, etc.]

（Reference books）
Doyle, Francis and Tannenbaum: Feedback Control Theory, Prentice Hall (1992) isbn{}{0023300116}
Ljung: System Identification, 2nd edition, Prentice Hall (1998) isbn{}{0136566952}

[Regarding studies out of class (preparation and review)]

Students have to prepare for presentations and reports for each subject.

（Others (office hour, etc.)）

It is recommended to take the course Linear Control Theory (90720) for third-year students and take the courses Modern Control Theory (90580) and Signals and Systems (90810) for fourth-year students. Under the BYOD policy of Kyoto University, students have to bring their own device in order to participate in classes.

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	確率離散事象論 Stochastic Discrete Event Systems	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,MASUYAMA HIROYUKI

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Tue.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

In the analysis of stochastic discrete event systems, the theoretical results on Markov chains are useful mathematical tools. This course covers the fundamental results of Markov chains and their applications to ranking/rating methods and to the analysis methods of basic queuing models.

[Course Goals]

This course aims to deepen the understanding of the fundamental results of Markov chains and their applications.

[Course Schedule and Contents]

Outline of this course and review of fundamental notions,1?2times,The contents of this course are outlined. Furthermore, basic notions, such as random variables, probability distributions and generating function methods, are explained.
Discrete-time Markov chains,3?4times,The discrete-time Markov chain is introduced. Topics include the basic notions of the Markov chain, such as irreducibility, period, and recurrence, as well as the condition for the existence of its stationary and limiting distributions.
Markov methods for ranking/rating,2～3times,Markov methods for ranking/rating are lectured, focusing on the group of web pages.
Continuous-time Markov chains,3～4times,The Poisson process and continuous-time Markov chain are introduced. Furthermore, the properties of a birth-and-death process (a special case of the continuous-time Markov chain) are explained, together with the derivation of its stationary distribution.
Exponential-type queueing models,2～3times,Exponential-type queueing models (which are reduced to birth-and-death processes) are lectured, focusing on the derivation of their performance measures, such as the stationary queue length distribution and the waiting time distribution.

[Class requirement]

Background knowledge on probability and statistics is helpful to learn this course but it is not prerequisite.

[Method, Point of view, and Attainment levels of Evaluation]

Based on the scores of the term examination.

[Textbook]

Handouts are provided.

[Reference books, etc.]

（Reference books）
P. Bremaud, Markov Chains: Gibbs Fields, Monte Carlo Simulation, and Queues, Springer, 1999. isbn{}{

Continue to 確率離散事象論(2)↓↓↓

確率離散事象論(2)

9780387985091}
L. Kleinrock, Queueing Systems Vol.1, John Wiley and Sons, 1975. isbn{}{9780471491101}

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

データベース（計算機）(2)

isbn{}{0201537710}

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code					
Course title <English>	データベース（計算機） Databases	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YOSHIKAWA MASATOSHI Graduate School of Informatics Associate Professor,MA QIANG		
Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Tue.4	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,2times,
,4times,
,2times,
,2times,
,3times,
,3times,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

Raghu Ramakrishnan and Johannes Gehrke-- Database Management Systems, 3rd edition, McGraw-Hill, 2002. isbn{}{9780072465631}
J.D.Ullman: Principles of Database and Knowledge-base Systems Vol.1,Computer Science Press, 1988 isbn{}{0716781581}.
Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom: Database Systems: The Complete Book, Pearson; 2nd International, 2008. isbn{}{9780131354289} isbn{}{9780131873254}
C.J. Date: An Introduction to Database Systems, Addison Wesley; 8th edition, 2003. isbn{}{0321197844}
Serge Abiteboul, Richard Hull, Victor Vianu: quotFoundations of Databasesquot, Addison Wesley, 1994.

Continue to データベース（計算機）(2)↓↓↓

※

Numbering code					
Course title <English>	ソフトウェア工学（計算機） Software Engineering	Affiliated department, Job title,Name	Institute for Information Management and Communication Assistant Professor,ATSUMI NORITOSHI Part-time Lecturer,HOSHINO HIROSHI		
Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Mon.4	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

Introduction,1time,
Software Requirements Engineering,2times,
Software Design Techniques,2times,
Software Process,1time,
Software Quality Management,1time,
Business Model Innovation,1time,
Project Management,1time,
Software Modules,1time,
Softwre Tests,1time,
Formal Methods,1time,
Software Metrics,1time,
Software Maintenance and Evolution,1time,
Summary and Assessment,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

Continue to ソフトウェア工学（計算機）(2)↓↓↓

ソフトウェア工学（計算機）(2)

[Reference books, etc.]

（Reference books）

Ian Sommerville: quotSoftware Engineering 10th Editionquot, Pearson, 2016. isbn{}{9780133943030}

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	言語・オートマトン Languages and Automata	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAMAMOTO AKIHIRO
Target year	2nd year students or above	Number of credits	2
Course offered year/period	2019/Second semester		
Day/period	Mon.3	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

We start with regular expressions and finite automata, then go to context-free grammars and pushdown automata. We learn why studying automata theory is important in computer science especially design and analysis of algorithms.

[Course Goals]

[Course Schedule and Contents]

,1time,
Finite automata,5times,Description of finite automata, minimization and regular expressions.
Context-free grammars,4times,Push-down automata, context-free grammars and their equivalency.
Turing machines and related issues,3times,Turing machine, its definition and basic properties.
Hierarchy of languages,2times,Summary of language classes. Discussions to check the achievements of students

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Will be specified in the lectures.

[Textbook]

Iwama, Automata, languages and theory of computation, Corona-sha, 2003 isbn{}{433901821X}.

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	オペレーティングシステム（計算機） Operating Systems	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAMAMOTO AKIHIRO Graduate School of Informatics Associate Professor,KAWAHARA JUN Graduate School of Informatics Assistant Professor,TAKASE HIDEKI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Tue.2	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,9times,
,4times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	情報と職業 Information and Business	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YOSHIKAWA MASATOSHI Graduate School of Informatics Associate Professor,YAMADA MAKOTO
Target year	4th year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Fri.3,4	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,7times,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code					
Course title <English>	コンピュータネットワーク Computer Networks	Affiliated department, Job title,Name	Academic Center for Computing and Media Studies Professor,OKABE YASUO		
Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Tue.3	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

Learn about basic technologies on computer networks, which are the indispensable basis of the ubiquitous network society. The idea of the Internet, basic concepts of the Internet architecture and the protocols are lectured. Visions for the future are also presented.

[Course Goals]

[Course Schedule and Contents]

Introduction,2times,- Service and protocols\\ - The reference models
The Application Layer,3times,- The application layer and principles - The transport service\\ - Application-level protocols\\ * The Domain Name System\\ * Electronic mail\\ * The Hyper Text Transfer Protocol\\ - Writing simple networked applications\\
The Transport Layer,3times,- Principles of a reliable transport protocol\\ - The User Datagram Protocol (UDP)\\ - The Transmission Control Protocol (TCP)
The Network Layer,3times,- Principles\\ * Datagram and virtual circuit\\ * routing\\ - Internet Protocol (IP)\\ - Routing in IP networks
The Datalink Layer and the Local Area Networks,2times,- Principles\\ - Media Access Control\\ - Datalink layer technologies
Network Security,1time,- Information security and network security\\ - Cyber laws

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Grading is based on the semester-end exam, and partially on reports and the attendance.

[Textbook]

Olivier Bonaventure著： Computer Networking : Principles, Protocols and Practice, 1st edition
http://cnp3book.info.ucl.ac.be/1st/html/

Continue to コンピュータネットワーク(2)↓↓↓

コンピュータネットワーク(2)

[Reference books, etc.]

（Reference books）

Norio Shiratori (ed.): Information Network (Kyoritsu) isbn{}{9784320123038}
Katsuo Ikeda (ed.): Computer networks (Ohmsha) isbn{}{4274132226}

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code					
Course title <English>	情報システム（計算機） Information Systems	Affiliated department, Job title,Name	Institute for Liberal Arts and Sciences Professor,TAJIMA KEISHI		
Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Wed.3	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

Course lectures cover fundamental theory and related techniques for constructing information systems. Discussions will especially focus on architecture of Web information systems, theories for information retrieval systems, techniques for graph data analysis, techniques for processing structured documents and semi-structured data used in Web information systems and theories underpin them.

[Course Goals]

The goals of this course are for students to have gained an understanding of the basics and the theories of technologies concerning the construction of Web information systems, information retrieval systems, graph data analysis, and processing of structured documents and semi-structured data used in Web information systems.

[Course Schedule and Contents]

1. History of information systems: From hypertext to Web services (2 classes)
An overview is provided of the history of developments in information systems for supporting the intellectual work of humans. Specifically, lectures will discuss hypertext (Memex, Dexter model, HyperCard), GUI and hypermedia (Smalltalk development environment, SMIL), structured documents (SGML, HTML, XML), stylesheets, as well as architecture of Web information systems (SOAP, REST, Ajax).

2. Information retrieval: Evaluation measures (2 classes)
Overview explanation is made of the fundamental concepts of information retrieval, and the various measures used in performance evaluation of information retrieval systems (precision, recall, F-measure, mean reciprocal rank (MRR), mean average precision (MAP), normalized discounted cumulative gain (nDCG), average mutual information, correlation coefficient, rank correlation coefficient, kappa coefficient). The models that lies behind these measures will also be explained in overview.

3. Information retrieval: Retrieval models (3 classes)
Overview explanation is made of the three representative basic information retrieval models, and of their various successor models (Boolean model, fuzzy set model, extended Boolean model, vector space model, latent semantic indexing (LSI), latent Dirichlet allocation (LDA), word2vec, probability model, binary independence model, and query likelihood model).

4. Information retrieval: Other topics (1 class)
Several other concepts related to information retrieval will be overviewed. The topics include: techniques for query modification and recommendation, information recommendation techniques such as collaborative filtering, and information retrieval for structured data.

5. Web analysis (2 classes)
These lectures describe analysis techniques for graph structures of Web data. Taken up especially as

Continue to 情報システム（計算機）(2)↓↓↓

情報システム（計算機）(2)

representative analysis methods are PageRank, Topic-Specific PageRank, TrustRank, HITS, SimRank, etc.

6. Network analysis (2 classes)
Fundamental concepts of network analysis are explained. Specifically explained are the concepts of scale-free properties, small-world properties, cluster properties, and analysis methods including the infection model and community extraction methods.

7. Structured documents and semi-structured data processing (2 classes)
XML is taken up as an example case of data formatting that are used for representing structured documents and semi-structured data. Discussion is made of general-purpose processing techniques for XML data (DOM and SAX) and techniques for querying and converting them (XPath, XQuery, and XSLT). Differences between the paradigms of each method are discussed. Also, local tree grammar, regular tree grammar, and single-type tree grammar are taken up as examples of tree grammar, used to define the schema of tree-structured data. Differences between the expressive power of each language are explained.

8. Feedback (1 class)
Evaluation is made of the extent of learning achieved in the course.

[Class requirement]

It is not mandatory but desired that students have basic knowledge taught in the following courses: Introduction to Algorithms and Data Structures, Language and Automata, Graph Theory, Databases, and Fundamentals of Statistical Modeling.

[Method, Point of view, and Attainment levels of Evaluation]

Evaluations will be made based on the scores of the final examination, which examine if the students understand the basics and the theories of technologies concerning the construction of Web information systems, information retrieval systems, graph data analysis, and processing of structured documents and semi-structured data used in Web information systems.

[Textbook]

Lecture notes will be used as teaching materials.

[Reference books, etc.]

（Reference books）

Introduced during class

[Regarding studies out of class (preparation and review)]

Students are to use lecture notes to prepare for and review classes. Exercise problems and homework will be assigned in classes, and students are to use these also to prepare for and review classes.

Continue to 情報システム（計算機）(3)↓↓↓

情報システム（計算機）(3)

（Others (office hour, etc.)）

Office hours are available with prior confirmation. Please use the following e-mail addresses to schedule an appointment.

tajima@i.kyoto-u.ac.jp

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	数理工学概論 Introduction to Applied Mathematics and Physics	Affiliated department, Job title,Name	Graduate School of Informatics Professor,UMENO KEN Graduate School of Informatics Professor,YAMASHITA NOBUO Graduate School of Informatics Professor,Shimodaira, Hidetoshi
Target year	1st year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Tue.2	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

Basic ideas in applied mathematics and physics are introduced via topics on communications and reasoning, operation researches, and quantum information science.

[Course Goals]

Understanding basic ideas in applied mathematics and physics.

[Course Schedule and Contents]

,4times,
,4times,
,4times,
reserved,3times,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Evaluated by writing homework.

[Textbook]

None

[Reference books, etc.]

（Reference books）
None

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

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Numbering code			
Course title <English>	計算機科学概論 Introduction to Computer Science	Affiliated department, Job title,Name	Graduate School of Informatics Professor,IGARASHI ATSUSHI Graduate School of Informatics Professor,KAWAHARA TATSUYA Graduate School of Informatics Professor,TAKAGI NAOFUMI Graduate School of Informatics Professor,NISHIDA TOYOAKI
Target year	1st year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Wed.5	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

Introduction to Computer Science.

[Course Goals]

[Course Schedule and Contents]

Introduction,1time,
Fundamentals of computer science,3-4times,
Computer systems,6-7times,
Informatics and AI,3-4times,
Examination amp review,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	アルゴリズムとデータ構造入門 Introduction to Algorithms and Data Structures	Affiliated department, Job title,Name	Graduate School of Informatics Professor,KASHIMA HISASHI
Target year	1st year students or above	Number of credits	2
Course offered year/period	2019/Second semester		
Day/period	Mon.1	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

Algorithms and data structures are two fundamental components of computer programs. This course gives their basic concepts, design principles, techniques, and other important concepts in computer science.

[Course Goals]

The goals of the course is to understand: - mathematical models of computers and concepts of computational complexity, - basic algorithms and data structures, - design principles of algorithms, such as divide-and-conquer method and dynamic programming, - classes of hard problems and solutions to them, and - basic ideas of graph algorithms, approximation algorithms, and online algorithms.

[Course Schedule and Contents]

Introduction,1time,Overview
algorithms,2.5times,sorting, search, ...
data structures,2.5times,list, stack, queue, binary search, heap, hash, ...
algorithm design,2times,divide-and conquer, dynamic programming, ...
graph algorithms,2times,- Trees and graphs - depth-/breadth-first search - shortest path algorithms - maximum-flow algorithms
computational complexity,3times,P, NP, NP-complete, NP-hard, ...
advanced topics,1time,approximation and online algorithms
final exam,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Mid-term and final examinations

[Textbook]

will be specified in the lectures

[Reference books, etc.]

（Reference books）
will be specified in the lectures

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	人工知能 Artificial Intelligence	Affiliated department, Job title,Name	Graduate School of Informatics Professor,KANDA TAKAYUKI Graduate School of Informatics Associate Professor,MATSUBARA SHIGEO
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Wed.3	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

This lecture introduces basic technologies of artificial intelligence. Topics will be selected from search, machine learning, and real-world agent.

[Course Goals]

Learning the concept of artificial intelligence and the basic models and algorithms of search, machine learning, and real-world agent.

[Course Schedule and Contents]

Introduction,1time,Introducing the history of artificial intelligence researches.
Search,3-4times,Introducing breadth-first search, depth-first search, heuristic search, AND/OR-graph search, adversarial search, constraint satisfaction, etc. Applications of search techniques such as computer chess, Sudoku, are also introduced.
Machine Learning,7-8times,Introducing decision tree learning, perceptron, SVM, genetic algorithm, reinforcement learning, deep learning, etc. Applications of machine learning techniques such as data mining are also introduced.
Real-world agent,3-4times,Introducing AI techniques for quotuncertainquot situation, including basic perception and robotics, and probabilistic reasoning over time. Applications of AI for robotics are also introduced.
Achievement level check,1time,Checking the achievement level

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

By reports and a final examination.

[Textbook]

Materials will be distributed.

[Reference books, etc.]

（Reference books）

S. Russell and P. Norvig, Artificial Intelligence A Modern Approach (3rd.ed.), Prentice Hall, 2010 isbn{}{9780136042594}.

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	数理解析 Analysis in Mathematical Sciences	Affiliated department, Job title,Name	Graduate School of Informatics Professor,NISHIMURA NAOSHI Graduate School of Informatics Associate Professor,YOSHIKAWA HITOSHI
Target year	4th year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Thu.4	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,5times,
,3times,
,2times,
,1time,
,1time,
,1time,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	ヒューマンインタフェース Human Interface	Affiliated department, Job title,Name	Academic Center for Computing and Media Studies Professor,Ogata Hiroaki Part-time Lecturer,YAMASHITA NAOMI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/Second semester		
Day/period	Wed.4	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

This lecture introduces basic concepts and methods of interaction design. Topics will be selected from user model, usability analysis, experiment and evaluation, and design process.

[Course Goals]

Learning the concepts and methods of interaction design, including user model, usability analysis, experiment and evaluation, and design process.

[Course Schedule and Contents]

Introduction,1time,Introducing the history and important concepts of interaction design.
Usability analysis,2-3times,Introducing usability analysis and evaluation methods including questionnaire, interview, heuristic evaluation and cognitive walkthrough. Applications of usability analysis to Web evaluation are also introduced.
Experiments and evaluation,3-4times,Introducing various evaluation methods including ethnography and statistical analysis. Applications of those methods to real problems are discussed.
Design process,1-2times,Introducing the process of interaction design. The comparison between interaction design and software design is explained.
Interfaces,2-3times,Introducing various interfaces that enable several kinds of interactions including social and emotional ones. Then future interfaces are discussed.
Data gathering and analysis,2-3times,Introducing data gathering and analysis methods in the design and evaluation process of interfaces with several examples.
Achievement level check,1time,Checking the achievement level.

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

By reports and a final examination.

[Textbook]

Preece, Sharp, Rogers. Interaction Design. Wiley, 3rd edition, 2011. isbn{}{9780470665763}

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

Digital online learning materials will be provided. So please read it before and after lesson.

（Others (office hour, etc.)）

Please bring your notebook PC in each lesson.

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	生命情報学 Introduction to Computational Systems Bioinformatics	Affiliated department, Job title,Name	Institute for Chemical Research Professor,AKUTSU TATSUYA Graduate School of Informatics Professor,KUMADA TAKATSUNE
Target year	4th year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Tue.4	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

This course overviews mathematical models and computational methods in bioinformatics. In particular, this course explains how such methods as graph theory, machine learning, optimization, and nonlinear differential equations are applied to analyses of biological sequences and biological systems including neural and brain systems. This course is given in Japanese.

[Course Goals]

See Japanese page for details.

[Course Schedule and Contents]

Neural information processing in brain,1time,
Visual information processing,2times,
Visual attention,2times,
Cognitive function,2times,
Overview of bioinformatics,1time,
Sequence analysis,1time,
Inference of phylogenetic trees,2times,
Hidden Markov models,1time,
Analysis of protein structures,1time,
Scale-free networks,1time,
Feedback ,1time,

[Class requirement]

Basic knowledge related to biology and brain science will be provided in the course.

[Method, Point of view, and Attainment levels of Evaluation]

See Japanese page for details.

[Textbook]

Not used

[Reference books, etc.]

（Reference books）

Textbooks or recommended books will be informed in the course as required. The latter part of the course, a recomennded book is as follows (in Japanese); **阿久津達也　著：バイオインフォマティクスの数理とアルゴリズム，共立出版** (2007) isbn{}{9784320121782}.

[Regarding studies out of class (preparation and review)]

See Japanese page for details.

（Others (office hour, etc.)）

The oder and contents of the course topics can be changed.

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	ビジネス数理（数理） Business Mathematics	Affiliated department, Job title,Name	Part-time Lecturer,KAI YOSHITAKA

Target year	4th year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Mon.3	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

It is important to learn the mechanism of the business and the process of the value creation in understanding the contemporary society. I introduce various theories of the business strategy including the finance, accounting, risk management, RampD and marketing. Moreover, how the technique and the idea of mathematical engineering are used in the phase of various decision makings of the business.

[Course Goals]

The target of the class is to obtain enough knowledge about an outline, a vital point of the business strategy and the effectiveness of mathematical methods.

[Course Schedule and Contents]

Evaluation of corporate value and business strategy,4times,
Finance and accounting, **2** times,
Business strategy,6times,Bayes theorem (strategic change by acquisition of information by marketing);
Optimization technique (decision of business portfolio and sales price); Decision tree and real option (research management); Game Theory (environmental solution)
Business risk management,2times,
Summary and review,1time,Summary and review; Confirmation of achievement level.

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Written examination (70%), and attendance and the class participation (30%)

[Textbook]

Prints are distributed every lecture.

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

Since prints are distributed 1,2 weeks before the lecture,read them beforehand.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

パターン認識と機械学習(2)

[Textbook]

Lecture slides are provided via PandA CMS.

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

Excersize included in lecture slides

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	パターン認識と機械学習 Pattern Recognition	Affiliated department, Job title,Name	Graduate School of Informatics Professor,KAWAHARA TATSUYA

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Wed.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

This course provides foundations of modeling and systems, which extract useful information for classification and prediction from real-world data. It covers a variety of machine learning techniques oriented for pattern recognition.

[Course Goals]

to master basic approaches and major techniques of machine learning.
to be able to design a system for pattern classification and recognition.

[Course Schedule and Contents]

1. Introduction to pattern recognition
2. Discriminant function and machine capacity
3. Discriminant function based on Gaussian distribution
4. Clustering and Gaussian mixture model
5. DP matching and HMM (classification of sequential patterns)
6. Bayes classification
7. Naive Bayes classifier and logistic regression model
8. Perceptron learning of discriminant function
9. Neural network
10. Support vector machines (SVM)
11. Statistical feature extraction
12. Maximum likelihood estimation and regularization
13. Deep learning(1)
14. Deep learning(2); Pattern recognition systems
15. Examination and Feedback

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

The grading is based on the examination following the course, and some exercises provided in the course.

Continue to パターン認識と機械学習(2)↓↓↓

※

Numbering code			
Course title <English>	非線形動力学（数理） Nonliner Dynamics	Affiliated department, Job title,Name	Graduate School of Informatics Professor,AOYAGI TOSHIO

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Fri.3	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,3times,
,3times,
,2times,
,2times,
,2times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	プログラミング入門 Introduction to Programming	Affiliated department, Job title,Name	Graduate School of Informatics Professor,IGARASHI ATSUSHI

Target year	1st year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Thu.1	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,2times,
,2-3times,
,2-3times,
,2-3times,
,2-3times,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

数理工学実験（数理:H26以降入学者）(2)

[Class requirement]

Acquired credits for all Basic Subjects offered by the Applied Mathematics and Physics Course.

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation will be based on class attendance and a report for each of the class themes. The minimum passing criterion is attendance to all class sessions and submitted reports for each theme, however this does not guarantee a passing mark and obtained credit. Late arrivals, absence and report re-submission will influence negatively on the final evaluation score.

[Textbook]

An experiment manual prepared by the instructors will be distributed in class.

[Reference books, etc.]

（Reference books）

Supplemental materials will be introduced if deemed necessary.

[Regarding studies out of class (preparation and review)]

Pre-class preparation by reading the provided experiment manual, class notes, and other reference materials is highly recommended.

（Others (office hour, etc.)）

It is mandatory to attend the guidance at the first class in October.
Details of the guidance time and place will be announced in September on the notice board in front of the administration office in General Research Building 8.
At the guidance, explanation about the BYOD (Bring Your Own Device) system will be given, so please bring your PC at the guidance.

*Please visit KULASIS to find out about office hours.

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Numbering code			
Course title <English>	数理工学実験（数理:H26以降入学者） Applied Mathematics and Physics Laboratory	Affiliated department, Job title,Name	Graduate School of Informatics Assistant Professor,Aleksandar Shurbevski Graduate School of Informatics Associate Professor,FUKUDA HIDEMI Part-time Lecturer,MATSUMOTO YUTAKA

Target year	2nd year students or above	Number of credits	4	Course offered year/period	2019/Second semester
Day/period	Mon.3,4,Tue.3,4	Class style	Experiment	Language	Japanese

[Outline and Purpose of the Course]

Applied mathematics and physics as an academic discipline gives a theoretical interpretation and explanation to the behavior and physical phenomena of various systems around us, and provides a means of problem solving. For the purpose of acquiring the fundamental skills and methods of applied mathematics and physics, we will tackle several experiment themes prepared from fields such as operations research and communication network.

[Course Goals]

Acquire an understanding of fundamental algorithms in the fields of operations research and communication networks, as well as acquire basic programming techniques for implementing such algorithms, perform experiments, and analyze experiment data to draw conclusions and insights.

[Course Schedule and Contents]

Guidance,1time,Explanation of experiment guideline. \\ Explanation about the BYOD (Bring Your Own Device) system will be given, so please bring your PC at the guidance.
Continuous Optimization,9times,Given an objective function and some constraints that take a vector as an argument, we call the problem of finding a value for the argument vector that minimizes (or maximizes) the value of the objective function under the given constrains an ldquoOptimization Problemrdquo. In this experiment, students will implement a procedure that generates a sequence of points that converge to an optimal solution (called an iterative method) of a given optimization problem. Further, the students should observe and discuss the appropriateness of a solution delivered by their implementation, as well as the time needed to reach to this solution.
Discrete Optimization,9times,Combinatorial, or Discrete, optimization problems are optimization problems where the feasible solution space is discrete, and can be defined by some combinatorial structures such as orders or partitions. These types of problems often occur in many areas, but it is difficult to solve them efficiently unless one grasps the structure of the problem. In this experiment, students will get familiar with the difficulty of combinatorial optimization problems through some representative problems, such as the Subset Sum or Shortest Path problems. Further, will study and implement the method of Dynamic Programming as one of the solution methods for combinatorial optimization problems.
Communication Network Design,9times,As an application example of queuing theory, consider designing a communication network. Through two simple case studies, students will explore the differences between the design methods of a voice network and a data network. Further, students will learn how to use queuing theory to evaluate the performance of a network as a design indicator. As an assignment, students will also tackle the design of an optimal network under given constraints.
Confirmation of Learning Achievements,2times,Provide feedback to students on basic topics such as report-writing or the contents of the course.

Continue to 数理工学実験（数理:H26以降入学者）(2)↓↓↓

Numbering code			
Course title <English>	計算機の構成 Computer organization	Affiliated department, Job title,Name	Graduate School of Informatics Professor,TAKAGI NAOFUMI

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Wed.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

This course presents an overview study of the basic organization of computers and their operation principles, instructions of computers, computer arithmetic, how to design simple computers, and overview of memory hierarchy and I/O of computers.

[Course Goals]

1. Students will understand and be able to explain basic organization of a computer and its operation principles.
2. Students will understand and be to explain instructions of computers.
3. Students will understand and be able to explain computer arithmetic.
4. Students will understand and be able to explain design methods of simple processors.
5. Students will understand and be able to explain overview of memory hierarchy and I/O of computers.

[Course Schedule and Contents]

Basic computer organization and its operation principles (2 classes)
Students will learn about basic computer organization and its operation principles, as well as performance evaluations.

Instructions of computers (5 classes)
Students learn about instructions of computers.

Computer arithmetic (3 classes)
Students learn about computer arithmetic and floating-point arithmetic.

Design of simple processors (3 classes)
Students learn design methods of simple processors.

Overview of memory hierarchy and I/O of computers. (1 classes)
Students learn about an overview of memory hierarchy and I/O of computers.

Term-end examination (1 class)

Feedback (1 class)
Review, including of the problems on the final examination, etc.

Continue to 計算機の構成(2)↓↓↓

計算機の構成(2)

[Class requirement]

Having knowledge on logic circuits is preferable.

[Method, Point of view, and Attainment levels of Evaluation]

Evaluation is performed regarding each element of this course's end goals, namely, the term-end examination (approximately 95%) and exercises (approximately 5%). If an understanding is shown of 80% or higher on the term-end exam, then the student will pass the course.

[Textbook]

David A. Patterson and John L. Hennessy, Translated in Japanese by M. Narita 『Computer Organization and Design - The Hardware/Software Interface - 5th ed. No. 1』 （Nikkei BP）ISBN:9784822298425

[Reference books, etc.]

（Reference books）

（Related URLs）

(http://www.lab3.kuis.kyoto-u.ac.jp/~ntakagi/co.html)

[Regarding studies out of class (preparation and review)]

Students are to read assigned textbook portions to prepare for each class.
Students are to solve the problem exercises assigned during each class and to submit each week's problems at the next class.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	情報符号理論 Information and Coding Theory	Affiliated department, Job title,Name	Graduate School of Informatics Professor,NISHIDA TOYOAKI

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Mon.1	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

This course introduces information theory, an foundation for reliable information transmission and storage. We elaborate on source and channel models, source and channel coding, quantitative measure of information and entropy, and coding theory.

[Course Goals]

Students will be able to understand and apply basic concepts and principles of information theory.

[Course Schedule and Contents]

Introduction,1time,I briefly overview the history, goal, techniques and applications of information theory.
Source Coding and its Limitation,5times,I introduce source coding, Markov sources, the source coding theorem, and entropy of information source.
Channel Coding and its Limitation,4times,I elaborate on mutual information and entropy, channel capacity, maximum likelihood decoding, random coding, and the channel coding theorem.
Coding Theory,4times,Following a general introduction to coding theory, I describe parity codes, Hamming codes, cyclic codes, and BCH codes.
Feedback,1time,I will answer questions arising from the lecture and advise on further learning.

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Credit will be awarded based on a final written examination and one or more mini-tests.

[Textbook]

Hideki Imai: Information Theory, Shokodo (in Japanese) isbn{}{9784274216015}

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	プログラミング言語処理系 Implementation of Programming Languages	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,SUENAGA KOUHEI

Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Mon.2	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

This class will be given in Japanese. For the detail of the class, see the Japanese version.

[Course Goals]

[Course Schedule and Contents]

Introduction,1time,
Programming language used in the class,1time,
Interpreters,5times,
Midterm exam,1time,
Backend of compilers,3times,
Lexers and parsers,3times,
Advanced topics,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	電気電子回路入門 Introduction to Electric and Electronic Circuit Theory	Affiliated department, Job title,Name	Graduate School of Energy Science Professor,SHIMODA HIROSHI Graduate School of Informatics Associate Professor,KAWAHARA DAISUKE

Target year	2nd year students or above	Number of credits	2	Course offered year/period	2019/First semester
Day/period	Wed.1	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

It has long been introducing computers to various situations of our daily lives and these computers can work based on electric signals. If you look around society, electricity is used in various contexts such as lighting, air conditioning, motive power and control, and its fundamental principle is electric or electronic circuit. The purpose of this subject is explanation of basic knowledge of electric and electronic circuit, to understand the fundamental principles and to get the ability to analyze simple circuits.

[Course Goals]

To understand;
・basic way of thinking and principles of electric circuit,
・analysis method of simple electric circuits consisting of power supplies and passive components,
・principles of active components such as diodes and transistors,
・principles of amplifier circuits and oscillation circuits employing active components, and
・basic principle of digital electronic circuits.

[Course Schedule and Contents]

1. Direct current circuit (1.5 times)
・Ohm's law
・Kirchhoff's law
・Voltage source and current source
・Thevenin's theorem and Norton's theorem
2. Alternating current circuit (3.5 times)
・Sinusoidal alternating current
・Inductance and capacitance
・Vector display of sinusoidal alternating current
・Resonance circuit
・Bridge circuit
3. Basics of semiconductor devices (2 times)
・Diode
・Bipolar transistor
・Field effect transistor
4. Analog electronic circuit (4 times)
・Basic concept of electronic circuit
・Equivalent circuit
・Oscillation circuit
・Operational amplifier circuit
5. Digital electronic circuit　(3 times)
・Semiconductor switch element

Continue to 電気電子回路入門(2)↓↓↓

電気電子回路入門(2)

・Semiconductor logic circuit
・Digital interface circuit
6. Feedback (1 time)
・Q&A

[Class requirement]

・To know high school level knowledge of electric circuit, and
・To understand simple differential and integral calculus.

[Method, Point of view, and Attainment levels of Evaluation]

The achievement will be evaluated through submission of exercises given in the class (20%), submission of report assignments (20%) and the result of final examination(60%).

[Textbook]

Susumu Sugiyama, Katsuhiko Tanaka, Satoshi Konichi 『Electric and Electronic Circuit - Analog and Digital Circuit - (In Japanese)』 （CORONA PUBLISHING CO.,LTD.）ISBN:9784339045130

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

Preparation, review and assignment will be given by each lecturer in the class.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

計算機科学のための数学演習(2)

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

※

Numbering code			
Course title <English>	計算機科学のための数学演習 Mathematics in Practice for Computer Science	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,SUENAGA KOUHEI Graduate School of Informatics Assistant Professor,KOBAYASHI YASUAKI
Target year	2nd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Thu.4	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Continue to 計算機科学のための数学演習(2)↓↓↓

Numbering code			
Course title <English>	システム工学実験（数理:H26以降入学者） System Analysis Laboratory	Affiliated department, Job title,Name	Graduate School of Informatics Assistant Professor,LIU YAN Graduate School of Informatics Assistant Professor,OOKI KENTAROU Graduate School of Informatics Assistant Professor,NIINO KAZUKI
Target year	3rd year students or above	Number of credits	4
Course offered year/period	2019/Second semester		
Day/period	Thu.3,4,Fri.3,4	Class style	Experiment
Language	Japanese		

[Outline and Purpose of the Course]

Systems engineering consists of three factors: (1) modeling, (2) analysis, and (3) control. Our course aims at making students have a solid grasp of systems engineering through the application of their knowledge to three different real systems. Three real systems are Active Silencer, Flexible-Link Manipulator, and Inverted Pendulum. Students will master the control methods through the computer simulation and the pilot experiments. To experience the control of all three different systems in turn, students will be divided into three groups during the Guidance class.

[Course Goals]

To understand the following theoretical knowledge through the control of the real systems:
-- The first principle of physical modeling
-- Parameter identification from experiments
-- Analyses of responses and stabilities
-- System stabilization and optimal control
To obtain the practical solution to the problem through the observation of the behavior of the real system, the consideration of the gap between theory and practice, and understanding the feature of the systems.
To precisely express own understanding of the experiments through presentations and reports.

[Course Schedule and Contents]

Guidance,1time,Introduction of topics and Group division
Active Silencer,9times,1. Introduction to principle of active sliencer\\ 2. Basic lecture on DSP and programming\\ 3. Experiment\\ 4. Analyses on response in time and frequency\\ *The specialized software Scilab is used.
Flexible-Link Manipulator,9times,1. A recursive estimation of frequency transfer function and parameter identification\\ 2. Tracking step signals\\ 3. Two-degree-of-freedom controller\\ 4. Tracking desired signals\\ *The specialized softwares Scilab and MATLAB/SIMULINK are used.
Inverted Pendulum,9times,1. Mechanical model of inverted pendulum and identification of its parameters\\ 2. Controller by state space representation\\ 3. Inference of state variables by observer\\ 4. Pole-place method / optimal control method\\ 5. Swinging up of inverted pendulum\\ *The specialized softwares Scilab and MATLAB/SIMULINK are used.

Continue to システム工学実験（数理:H26以降入学者）(2)↓↓↓

システム工学実験（数理:H26以降入学者）(2)

[Class requirement]

Students are supposed to have the knowledge of Introduction to Systems Analysis (90070) and take the course of Linear Control Theory (90720).

[Method, Point of view, and Attainment levels of Evaluation]

Class participation and reports are mainly evaluated. Attitude, Creativeness, and Individual work and group work are also important during the evaluation process.

[Textbook]

Each instructor will distribute his own text when necessary.

[Reference books, etc.]

（Reference books）

Doyle, Francis and Tannenbaum: Feedback Control Theory, Prentice Hall (1992) isbn{}{0023300116}
Ljung: System Identification, 2nd edition, Prentice Hall (1998) isbn{}{0136566952}

[Regarding studies out of class (preparation and review)]

Students have to prepare for presentations and reports for each subject.

（Others (office hour, etc.)）

It is recommended to take the course Linear Control Theory (90720) for third-year students and take the courses Modern Control Theory (90580) and Signals and Systems (90810) for fourth-year students. Under the BYOD policy of Kyoto University, students have to bring their own device in order to participate in classes.

*Please visit KULASIS to find out about office hours.

計算機アーキテクチャ(2)

[Textbook]

Computer Organization and Design - The Hardware/Software Interface - 5th ed.No. 2,
by David A. Patterson and John L. Hennessy, Translated in Japanese by M. Narita, Nikkei BP
isbn{}{9784822298432}

[Reference books, etc.]

（Reference books）

Introduced during class

（Related URLs）

https://panda.ecs.kyoto-u.ac.jp/portal/ (The page of quotComputer Architecturequot and its subordinates linked from the PandA portal shown above.)

[Regarding studies out of class (preparation and review)]

Through the work on the weakly exercise, review what you learned in each class.

（Others (office hour, etc.)）

Office Hour: 16:30-17:30, every Thursday
Office: Room 411, 4F, Research Bldg. #5

*Please visit KULASIS to find out about office hours.

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Numbering code			
Course title <English>	計算機アーキテクチャ Computer Architecture	Affiliated department, Job title,Name	Academic Center for Computing and Media Studies Professor,NAKASHIMA HIROSHI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Thu.2	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

We learn pipelined instruction execution, memory hierarchy and parallel processing mechanism in modern computers.

[Course Goals]

Understanding the following topics so that you explain them to other people.
1. Instruction Pipeline
2. Memory Hierarchy
3. Parallel Processors

[Course Schedule and Contents]

Instruction Pipeline (1),1time,Overview of pipelining
Instruction Pipeline (2),1time,Pipelined data-path and its control mechanism
Instruction Pipeline (3),1time,Data hazards
Instruction Pipeline (4),1time,Control (branch) hazards and execptions
Instruction Pipeline (5),1time,Instruction-level parallelism
Memory Hierarchy (1),1time,Meomory technology\\ Cache (1)
Memory Hierarchy (2),1time,Cache (2)
Memory Hierarchy (3),1time,Cache (3)
Memory Hierarchy (4),1time,Virtual memory (1)
Memory Hierarchy (5),1time,Virtual memory (2)
Memory Hierarchy (6),1time,Other concepts of memory hierarchy
Parallel Processors (1),1time,Overview, SIMD extension, Vector processors
Parallel Processors (2),1time,Multithreading, Cache coherence
Parallel Processors (3),1time,Shared Memory Multiprocessors
End-of-term Exam,1time,
Feedback,1time,Explanatoin of exam problems

[Class requirement]

Though not a mandatory prerequisite, you are expected to having received the credit of "Computer Organization" for 2nd-year students.

[Method, Point of view, and Attainment levels of Evaluation]

Your achievements in end-of-term exam and per-class exercises are evaluated with respect to the "Course Goals".

Continue to 計算機アーキテクチャ(2)↓↓↓

Numbering code			
Course title <English>	統計的モデリング基礎 Foundations of Statistical Modeling	Affiliated department, Job title,Name	Graduate School of Informatics Professor,KASHIMA HISASHI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Wed.4	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

This course gives foundations of statistical data modeling methods to capture the uncertainty in target systems and to estimate the probability of future events for prediction and control.

[Course Goals]

The goal of this course is to learn how to choose and apply appropriate processing and modeling approaches to analyze various types of data.

[Course Schedule and Contents]

Basic ideas,1time,Basic ideas of statistical data analysis
,1time,
Regression models,1time,Linear regression model and estimation methods
Model estimation,2times,Model estimation frameworks including maximum likelihood estimation
Model selection,2times,Model selection frameworks including information criterion
Models for categorical data,2times,Predictive models for categorical data including logistic regression
Correlation and causation,2times,Difference between correlation and causation. Methods for estimating causality.
Bayesian estimation,2times,Statistical inference methods based on Bayesian statistics
Models for various data types,2times,Models for various data types including time series and texts

[Class requirement]

Basic knowledge of probability and statistics

[Method, Point of view, and Attainment levels of Evaluation]

Mid-term and final examinations

[Textbook]

None

[Reference books, etc.]

（Reference books）

They will be given in the lectures

（Related URLs）

(The course website will be given in the lectures)

[Regarding studies out of class (preparation and review)]

Exercises on real data analysis.

（Others (office hour, etc.)）

Office hours are available upon request. An appointment is needed by sending an email to kashima@i.kyoto-u.ac.jp

*Please visit KULASIS to find out about office hours.

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Numbering code			
Course title <English>	計算機科学実験及演習１（H27以降入学者） Computer Science Laboratory and Exercise 1	Affiliated department, Job title,Name	Graduate School of Informatics Associate Professor,MATSUBARA SHIGEO Academic Center for Computing and Media Studies Associate Professor,IIYAMA MASAAKI Graduate School of Informatics Assistant Professor,SHIMIZU TOSHIYUKI Part-time Lecturer,YAMAMOTO TAKEHIRO
Target year	2nd year students or above	Number of credits	2
Course offered year/period	2019/First semester		
Day/period	Wed.3,4	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

[Course Goals]

[Course Schedule and Contents]

,1time,
,1time,
,1time,
,5times,
,5times,
,1time,
,1time,

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

メディア情報処理(2)

[Regarding studies out of class (preparation and review)]

Exercises included in lecture slides.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code			
Course title <English>	メディア情報処理 Mutimedia Processing	Affiliated department, Job title,Name	Graduate School of Informatics Professor,KAWAHARA TATSUYA Academic Center for Computing and Media Studies Associate Professor,IIYAMA MASAAKI
Target year	3rd year students or above	Number of credits	2
Course offered year/period	2019/Second semester		
Day/period	Wed.1	Class style	Lecture
Language	Japanese		

[Outline and Purpose of the Course]

This course provides an overview of technologies to handle, analyze, recognize and generate a variety of information media or pattern data such as image, speech and text.

[Course Goals]

to master basic methods to deal with image, speech and text, and also processing of their analysis, recognition and synthesis.

[Course Schedule and Contents]

1. Introduction; speech and music
2. Speech analysis
3. Speech recognition and synthesis
4. Spoken dialogue systems
5. Natural language processing (1)
6. Natural language processing (2)
7. Fundamental of Digital Images
8. Image Processing (1): Image Filtering
9. Image Processing (2): Image Feature Extraction
10. Image Recognition (1): Convolutional Neural Network
11. Image Recognition (2): Applications of Image Recognition
12. Computer Graphics
13. Computer Vision (1): Camera model
14. Computer Vision (2): Shape-from-X
15. Examination and Feedback

[Class requirement]

None

[Method, Point of view, and Attainment levels of Evaluation]

Based on the examination following the course

[Textbook]

Lecture slides are provided via PandA CMS.

[Reference books, etc.]

（Reference books）

Continue to メディア情報処理(2)↓↓↓

※

Numbering code			
Course title <English>	情報セキュリティ演習 Practice in Information Security	Affiliated department, Job title,Name	Academic Center for Computing and Media Studies Professor,OKABE YASUO Academic Center for Computing and Media Studies Associate Professor,MIYAZAKI SHIYUUICHI Academic Center for Computing and Media Studies Assistant Professor,Kotani Daisuke
Target year	3rd year students or above	Number of credits	1
Course offered year/period	2019/Intensive, First semester		
Day/period	Intensive	Class style	Seminar
Language	日本語		

[Outline and Purpose of the Course]

IDS (Intrusion Detection System), which detects attempts of unauthorized access, creates an enormous number of alarms, and it is difficult to analyze them manually. In this class, students learn the mechanism and role of IDS, and classify normal communication and attacks from IDS alarms by machine learning.

[Course Goals]

Students understand the role of IDS in network security.
Students understand the mechanism of signature-based IDS, and can explain advantages and disadvatages of the IDS. Students understand the mechanism of intrusion detection by machine learning, and can explain advantages and disadvantages of machine learning approach.

[Course Schedule and Contents]

Guidance,2times,Guidance on how this class is operated, and how to use computing facility for this class.\\
Basic knowledge on the role of IDS in network security and how machine learning can help the intrusion detection.
Intrusion Detection by Signature-Based IDS,5times,Learn the mechanism of intrusion detection by signature-based IDS by studying open source signature-based IDS and attacks, such as correspondence between alarms issued from IDS and communications, and adding signatures to detect attacks.
Intrusion Detection by Machine Learning,7times,Learn the method of classifying normal and malicious traffic by machine learning algorithms and public dataset for benchmarking intrusion detection performance.
Presentation,1time,Based on the exercise, students presents their methods of intrusion detection using machine learning, and discuss it with other students and instructors.

[Class requirement]

Students should be able to have basic knowledge of Linux operations (editing files, etc). Students should be able to write simple programs by Python.

[Method, Point of view, and Attainment levels of Evaluation]

The achievement of the tasks and the content of the presentations within the class.

Continue to 情報セキュリティ演習(2)↓↓↓

情報セキュリティ演習(2)

[Textbook]

[Reference books, etc.]

（Reference books）

[Regarding studies out of class (preparation and review)]

Students should be able to have basic knowledge of Linux operations and Python.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

情報符号理論続論（数理）(2)

etc., related to the course, and further advice will be provided regarding content study.

[Class requirement]

Prerequisites are knowledge of basic probability theory, and knowledge regarding the course“Information and Coding Theory.”Knowledge of statistics and Markov chains is also desirable.

[Method, Point of view, and Attainment levels of Evaluation]

Grading is performed both on the basis of reports submitted when necessary during the term and the final exam.

[Textbook]

T. M. Cover and J. A. Thomas『Elements of Information Theory, 2nd ed.』（Wiley-Interscience）ISBN: 9780471241959（The e-book version can be accessed from within the university. A Japanese translation is also available from Kyoritsu Shuppan Publishing Co.）

[Reference books, etc.]

（Reference books）

Other materials will be introduced in class as necessary.

[Regarding studies out of class (preparation and review)]

Since a prerequisite of this class is the course“Information and Coding Theory,”an appropriate review of that course’s contents is recommended prior to attendance. Assigned pages in the course textbook should be read before each lecture. A good way to review each class is to do the problems at the end of assigned chapters.

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code					
Course title <English>	情報符号理論続論（数理） Mathematical theory of information and communications	Affiliated department, Job title,Name	Graduate School of Informatics Professor,TANAKA TOSHIYUKI		
Target year	3rd year students or above	Number of credits	2	Course offered year/period	2019/Second semester
Day/period	Tue.3	Class style	Lecture	Language	Japanese

[Outline and Purpose of the Course]

Lectures discuss information theory, a basic theory related to storing and transmission of information. While referring to contents of the course“Information and Coding Theory,”lectures take up topics such as entropy of continuous-valued random variables, Gaussian communication channels, rate-distortion theory, universal coding, etc. More advanced topics are also introduced, including network information theory and more.

[Course Goals]

Our goal is to gain an understanding that enables appropriate responses to questions and issues regarding examples introduced during lectures, topics set for written reports, etc.

[Course Schedule and Contents]

Introduction (1 class)
Confirmation of basic concepts, including information entropy, mutual information, source coding, channel coding, etc.

Information theory of continuous-valued random variables (4 classes)
When considering wireless communications and measurements, a theory is needed for random variables which take continuous values. The argument will proceed by introducing differential entropy for continuous random variables, and by taking up concrete examples from Gaussian communication channels, with discussion of the information transmission capabilities of such channels.

Rate-distortion theory (3 classes)
Toleration of a certain extent of information degradation enables more efficient data compression than when no degradation is permitted. Lectures focus on rate-distortion theory, the theory underpinning information compression with degradation toleration.

Information theory and statistics (4 times)
Type theory is introduced so as to discuss universal information compression, large-deviations theory, hypothesis testing, and other applications.

Network information theory (2 classes)
Thanks to the development and spread of information and communications technologies, one-to-one information exchanges have been superseded by many-to-many information exchanges. There is a growing need, then, for discussions regarding these changes. Lectures will focus on fundamental network information theory, necessary for proceeding with such discussions.

Confirmation of extent of student learning (1 class)
To confirm the extent that students have learned the contents of course lectures, students will solve questions,

Continue to 情報符号理論続論（数理）(2)↓↓↓

Numbering code	U-ENG29 49991 GJ10　U-ENG29 49991 GJ11　U-ENG29 49991 GJ12				
Course title <English>	特別研究１（計算機） Graduation Thesis 1	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YOSHIKAWA MASATOSHI		
Target year	4th year students or above	Number of credits	2	Course offered year/period	2019/Intensive, First semester
Day/period	Intensive	Class style	Seminar	Language	Japanese

[Outline and Purpose of the Course]

教員の指導のもと、情報学（計算機科学）に関連する研究課題を設定し、研究動向を把握したうえで、その課題解決力の向上を目指す。

[Course Goals]

研究課題の設定、関連研究の調査、研究計画の立案等を通じて、研究活動に必要な力を向上させる。

[Course Schedule and Contents]

研究課題の設定、関連研究の調査、研究計画の立案等について、教員が指導する。各学生の研究課題の特性、研究活動の進捗状況に応じて計画するが、授業計画の目安は以下のようになる。

第１～４回　　研究課題の設定
第５～９回　　関連研究の調査
第１０～１１回　研究計画の立案
第１２～１５回　先行研究の調査等

[Class requirement]

計算機科学コースの特別研究着手に必要な条件を満たしていること。

[Method, Point of view, and Attainment levels of Evaluation]

一連の研究活動の実施状況に基づいて行う。

[Textbook]

各学生の研究課題に応じて教員が指示する。

[Reference books, etc.]

（Reference books）

各学生の研究課題に応じて教員が指示する。

[Regarding studies out of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code	U-ENG29 49991 GJ10　U-ENG29 49991 GJ11　U-ENG29 49991 GJ12		
Course title <English>	特別研究１（計算機） Graduation Thesis 1	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YOSHIKAWA MASATOSHI
Target year	4th year students or above	Number of credits	2
Course offered year/period	2019/Intensive, Second semester		
Day/period	Intensive	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

教員の指導のもと、情報学（計算機科学）に関連する研究課題を設定し、研究動向を把握したうえで、その課題解決力の向上を目指す。

[Course Goals]

研究課題の設定、関連研究の調査、研究計画の立案等を通じて、研究活動に必要な力を向上させる。

[Course Schedule and Contents]

研究課題の設定、関連研究の調査、研究計画の立案等について、教員が指導する。各学生の研究課題の特性、研究活動の進捗状況に応じて計画するが、授業計画の目安は以下のようになる。

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第５～９回　　関連研究の調査
第１０～１１回　研究計画の立案
第１２～１５回　先行研究の調査等

[Class requirement]

計算機科学コースの特別研究着手に必要な条件を満たしていること。

[Method, Point of view, and Attainment levels of Evaluation]

一連の研究活動の実施状況に基づいて行う。

[Textbook]

各学生の研究課題に応じて教員が指示する。

[Reference books, etc.]

（Reference books）
各学生の研究課題に応じて教員が指示する。

[Regarding studies out of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code	U-ENG29 49991 GJ10　U-ENG29 49991 GJ11　U-ENG29 49991 GJ12		
Course title <English>	特別研究１（数理） Graduation Thesis 1	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAMASHITA NOBUO
Target year	4th year students or above	Number of credits	2
Course offered year/period	2019/Intensive, Second semester		
Day/period	Intensive	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

教員の指導のもと、情報学（数理工学）に関連する研究課題を設定し、研究動向を把握したうえで、その課題解決力の向上を目指す。

[Course Goals]

研究課題の設定、関連研究の調査、研究計画の立案等を通じて、研究活動に必要な力を向上させる。

[Course Schedule and Contents]

研究課題の設定、関連研究の調査、研究計画の立案等について、教員が指導する。各学生の研究課題の特性、研究活動の進捗状況に応じて計画するが、授業計画の目安は以下のようになる。

第１～４回　　研究課題の設定
第５～９回　　関連研究の調査
第１０～１１回　研究計画の立案
第１２～１５回　先行研究の調査等

[Class requirement]

数理工学コースの特別研究着手に必要な条件を満たしていること。

[Method, Point of view, and Attainment levels of Evaluation]

一連の研究活動の実施状況に基づいて行う。

[Textbook]

各学生の研究課題に応じて教員が指示する。

[Reference books, etc.]

（Reference books）
各学生の研究課題に応じて教員が指示する。

[Regarding studies out of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code	U-ENG29 49991 GJ10　U-ENG29 49991 GJ11　U-ENG29 49991 GJ12		
Course title <English>	特別研究１（数理） Graduation Thesis 1	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAMASHITA NOBUO
Target year	4th year students or above	Number of credits	2
Course offered year/period	2019/Intensive, First semester		
Day/period	Intensive	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

教員の指導のもと、情報学（数理工学）に関連する研究課題を設定し、研究動向を把握したうえで、その課題解決力の向上を目指す。

[Course Goals]

研究課題の設定、関連研究の調査、研究計画の立案等を通じて、研究活動に必要な力を向上させる。

[Course Schedule and Contents]

研究課題の設定、関連研究の調査、研究計画の立案等について、教員が指導する。各学生の研究課題の特性、研究活動の進捗状況に応じて計画するが、授業計画の目安は以下のようになる。

第１～４回　　研究課題の設定
第５～９回　　関連研究の調査
第１０～１１回　研究計画の立案
第１２～１５回　先行研究の調査等

[Class requirement]

数理工学コースの特別研究着手に必要な条件を満たしていること。

[Method, Point of view, and Attainment levels of Evaluation]

一連の研究活動の実施状況に基づいて行う。

[Textbook]

各学生の研究課題に応じて教員が指示する。

[Reference books, etc.]

（Reference books）
各学生の研究課題に応じて教員が指示する。

[Regarding studies out of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code	U-ENG29 49992 GJ10　U-ENG29 49992 GJ11　U-ENG29 49992 GJ12		
Course title <English>	特別研究２（計算機） Graduation Thesis 2	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YOSHIKAWA MASATOSHI
Target year	4th year students or above	Number of credits	3
Course offered year/period	2019/Intensive, First semester		
Day/period	Intensive	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

教員の指導のもと、特別研究１で設定した課題について研究を行い、課題解決力を向上させるとともに、研究成果を特別研究報告書としてまとめ、特別研究試問会で発表する。

[Course Goals]

研究の実施、特別研究報告書の作成、特別研究試問会での発表等を通じて、研究活動に必要な力を向上させる。

[Course Schedule and Contents]

研究の実施、報告書の作成、試問会での発表準備等について、教員が指導する。各学生の研究課題の特性、研究活動の進捗状況に応じて計画するが、授業計画の目安は以下のようになる。

第１～１２回　　研究の実施
第１３～１４回　報告書の作成
第１５回　　試問会での発表準備

[Class requirement]

「特別研究１」を修得済みであること。

[Method, Point of view, and Attainment levels of Evaluation]

一連の研究活動の実施状況、特別研究報告書の内容、特別研究試問会の発表内容に基づいて行う。

[Textbook]

各学生の研究課題に応じて教員が指示する。

[Reference books, etc.]

（Reference books）
各学生の研究課題に応じて教員が指示する。

[Regarding studies out of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code	U-ENG29 49992 GJ10　U-ENG29 49992 GJ11　U-ENG29 49992 GJ12		
Course title <English>	特別研究２（計算機） Graduation Thesis 2	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YOSHIKAWA MASATOSHI
Target year	4th year students or above	Number of credits	3
Course offered year/period	2019/Intensive, Second semester		
Day/period	Intensive	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

教員の指導のもと、特別研究１で設定した課題について研究を行い、課題解決力を向上させるとともに、研究成果を特別研究報告書としてまとめ、特別研究試問会で発表する。

[Course Goals]

研究の実施、特別研究報告書の作成、特別研究試問会での発表等を通じて、研究活動に必要な力を向上させる。

[Course Schedule and Contents]

研究の実施、報告書の作成、試問会での発表準備等について、教員が指導する。各学生の研究課題の特性、研究活動の進捗状況に応じて計画するが、授業計画の目安は以下のようになる。

第１～１２回　研究の実施
第１３～１４回　報告書の作成
第１５回　試問会での発表準備

[Class requirement]

「特別研究１」を修得済みであること。

[Method, Point of view, and Attainment levels of Evaluation]

一連の研究活動の実施状況、特別研究報告書の内容、特別研究試問会の発表内容に基づいて行う。

[Textbook]

各学生の研究課題に応じて教員が指示する。

[Reference books, etc.]

（Reference books）
各学生の研究課題に応じて教員が指示する。

[Regarding studies out of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code	U-ENG29 49992 GJ10　U-ENG29 49992 GJ11　U-ENG29 49992 GJ12		
Course title <English>	特別研究２（数理） Graduation Thesis 2	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAMASHITA NOBUO
Target year	4th year students or above	Number of credits	3
Course offered year/period	2019/Intensive, Second semester		
Day/period	Intensive	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

教員の指導のもと、特別研究１で設定した課題について研究を行い、課題解決力を向上させるとともに、研究成果を特別研究報告書としてまとめ、特別研究試問会で発表する。

[Course Goals]

研究の実施、特別研究報告書の作成、特別研究試問会での発表等を通じて、研究活動に必要な力を向上させる。

[Course Schedule and Contents]

研究の実施、報告書の作成、試問会での発表準備等について、教員が指導する。各学生の研究課題の特性、研究活動の進捗状況に応じて計画するが、授業計画の目安は以下のようになる。

第１～１２回　研究の実施
第１３～１４回　報告書の作成
第１５回　試問会での発表準備

[Class requirement]

「特別研究１」を修得済みであること。

[Method, Point of view, and Attainment levels of Evaluation]

一連の研究活動の実施状況、特別研究報告書の内容、特別研究試問会の発表内容に基づいて行う。

[Textbook]

各学生の研究課題に応じて教員が指示する。

[Reference books, etc.]

（Reference books）
各学生の研究課題に応じて教員が指示する。

[Regarding studies out of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.

Numbering code	U-ENG29 49992 GJ10　U-ENG29 49992 GJ11　U-ENG29 49992 GJ12		
Course title <English>	特別研究２（数理） Graduation Thesis 2	Affiliated department, Job title,Name	Graduate School of Informatics Professor,YAMASHITA NOBUO
Target year	4th year students or above	Number of credits	3
Course offered year/period	2019/Intensive, First semester		
Day/period	Intensive	Class style	Seminar
Language	Japanese		

[Outline and Purpose of the Course]

教員の指導のもと、特別研究１で設定した課題について研究を行い、課題解決力を向上させるとともに、研究成果を特別研究報告書としてまとめ、特別研究試問会で発表する。

[Course Goals]

研究の実施、特別研究報告書の作成、特別研究試問会での発表等を通じて、研究活動に必要な力を向上させる。

[Course Schedule and Contents]

研究の実施、報告書の作成、試問会での発表準備等について、教員が指導する。各学生の研究課題の特性、研究活動の進捗状況に応じて計画するが、授業計画の目安は以下のようになる。

第１～１２回　研究の実施
第１３～１４回　報告書の作成
第１５回　試問会での発表準備

[Class requirement]

「特別研究１」を修得済みであること。

[Method, Point of view, and Attainment levels of Evaluation]

一連の研究活動の実施状況、特別研究報告書の内容、特別研究試問会の発表内容に基づいて行う。

[Textbook]

各学生の研究課題に応じて教員が指示する。

[Reference books, etc.]

（Reference books）
各学生の研究課題に応じて教員が指示する。

[Regarding studies out of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Others (office hour, etc.)）

*Please visit KULASIS to find out about office hours.