未更新

Course number	U-ENG29 22050 LJ10　U-ENG29 22050 LJ55		
Course title (and course title in English)	工業数学Ａ１ Applied Mathematics A1	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,SHIBAYAMA MITSURU

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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

[Course requirements]

Calculus, Linear algebra

[Evaluation methods and policy]

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

[Textbooks]

Not used

Continue to 工業数学Ａ１(2)↓↓↓

工業数学Ａ１(2)

[References, etc.]

（Reference books）

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

（Related URLs）

(KULASIS)

[Study outside of class (preparation and review)]

Students need to solve exercises.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 32060 LJ10　U-ENG29 32060 LJ55　U-ENG29 32060 LJ54		
Course title (and course title in English)	工業数学Ａ２ Applied Mathematics A2	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,SHIBAYAMA MITSURU Graduate School of Informatics Associate Professor,YOSHIKAWA HITOSHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Mon.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

曲線や曲面に対する微分幾何や位相幾何の基礎を習得する。
また、多様体の定義や、ベクトル解析で学んだ積分定理の
拡張であるストークスの定理を理解する。
工学に現れる偏微分方程式を紹介する。
また偏微分方程式の解析的な解法や数値的な解法について説明する。

[Course objectives]

曲線や曲面の幾何的な性質を理解し、多様体の概念を理解すること、
および簡単な偏微分方程式を数値的に解く能力を身に着けることを目標とする。

[Course schedule and contents]

曲線の曲率と捩率、まつわり数(2回)
曲面の例とその曲率(2回)
曲面のオイラー標数とガウス・ボンネの定理(1回)
多様体の定義(1回)
ストークスの定理(1回)
学習到達度の確認(1回)

工学に現れる偏微分方程式の紹介(1回)
偏微分方程式の境界値問題(1回)
1次元問題の解析的解法(1回)
偏微分方程式の数値的解法(3回)
学習到達度の確認(1回)

[Course requirements]

微分積分学A、 B、線型代数学A、 B、 微分積分学続論I、 II

[Evaluation methods and policy]

必要に応じて行うレポートの提出状況（平常点）も加味しつつ、基本的には中間試験と期末試験による。

Continue to 工業数学Ａ２(2)↓↓↓

工業数学Ａ２(2)

[Textbooks]

Not used

[References, etc.]

（Reference books）

小林 昭七『曲線と曲面の微分幾何』（裳華房，1995年）ISBN:978-4785310912
松本幸夫『トポロジーへの誘い』（遊星社，2008年）ISBN:978-4434116261
松本幸夫『多様体の基礎』（東京大学出版会，1988年）ISBN:978-4130621038
J. W. ミルナー『微分トポロジー講義(蟹江訳)』（丸善出版，2012年）ISBN:978-4621062722
以上は前半の内容に関する参考書である。
後半の内容については講義中に紹介する。

（Related URLs）

(――)

[Study outside of class (preparation and review)]

演習問題を出題するので、自力で解くように。

（Other information (office hours, etc.)）

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*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 32070 LJ55　U-ENG29 32070 LJ10		
Course title (and course title in English)	工業数学Ａ３ Appleid Mathematics A3	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,YAGASAKI KAZUYUKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Fourier analysis originated in Fourier's 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 the Laplace transforms closely related to it.

[Course objectives]

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

[Course schedule and contents]

Fourier series expansions, 3-4 times:
The definition of Fourier series expansions for periodic functions are given and their fundamental results such as computation of Fourier coefficients and convergence of Fourier series are discussed.
Properties and applications of Fourier series, 3-4 times:
Several properties of Fourier series and their applications to differential and difference equations and signal processing are discussed.
One-dimensional Fourier transform, 4-5 times:
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.
Laplace transforms, 2-3times:
Fundamental properties of Laplace transforms and their applications are discussed.
Summary and learning achievement evaluation, 1 time:
A summary and supplements of this course are given and the learning achievement of students is evaluated.

[Course requirements]

Calculus, Linear Algebra and Differential Equations

[Evaluation methods and policy]

Evaluation depends mainly on marks of mid-term examinations (20%) and final one (80%).

Continue to 工業数学Ａ３(2)↓↓↓

工業数学Ａ３(2)

[Textbooks]

S. Nakamura 『Fourier Analysis』 （Asakura shoten, 2003）ISBN:9784254115741

[References, etc.]

（Reference books）

H.Fukawa 『Mathematics of control and vibration』 （Korona-sha）

[Study outside of class (preparation and review)]

Prepare and review the lectures and solving the problems given on KULASIS or PANDA to understand the contents of the textbook and lectures.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG20 42105 LJ77		
Course title (and course title in English)	工学倫理 Engineering Ethics	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUBARA ATSUSHI Graduate School of Engineering Professor,SOTOWA KENICHIRO Graduate School of Engineering Senior Lecturer,KANEKO KENTAROU

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Thu.3	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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]

(4/8) The central topic is what is ethics for engineers and what is significance of studying ethics for engineers.
(4/15) “General research ethics"
Lectures on the concept of writing academic papers with ethics.
(4/22) ”Ethical Theories for Engineering Ethics ”
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. This Lecture will be conducted online by using zoom.
(5/6) “Engineering Ethics as a Professional Ethics: ”
This lecture discusses basic ideas of engineering ethics in comparison with other fields of applied ethics. In particular, it discusses the characteristics of engineering ethics as professional ethics and what engineers as professionals are required to do.
(5/13) “Ethics for Engineers ”
Engineers have to go through some ethical issues about research, development, design, manufacturing, and maintenance. In particular, the ethical decisions of engineers need to be considered for society and environment.
(5/20) Press Release is an essential process for introducing the research to our society through various medias. In this lecture, issues related to Press Release will be addressed and discussed with several examples including SNS release. Lecture will be conducted by Zoom.
(5/27) "Ethics in Water Supply."
It is a basic right in a society that a person can receive and use safe water in sufficient quantity. In addition, a person of water supply utility is recognized to be an essential worker. Taking drinking water supply as a topic, ethics required for a water supplier and an engineer is discussed. It is given by Zoom.
(6/3) “Forensic Analysis ”
Forensic repots are sometimes requested by the court in order to clarify the charge of incidents. The nylon rope incident, the Wakayama curry poisoning incident, and the pig iron incident are explained as examples. How to write the forensic report is explained in order to avoid the ethical problems. (Zoom&Youtube)
(6/10) “Patents and Ethics (Part 1) ”
This course will teach the students about 1) patent systems which protect inventions and research results and

Continue to 工学倫理(2)↓↓↓

工学倫理(2)

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.
(6/17) “ Patents and Ethics (Part 2) ”
Students, equipped with the basic knowledge of patent systems by the previous lecture, will get familier with actual case studies on ethical and legal issues in patents.
(6/24) "Urban Planning and Ethics"
The lecture focuses on the norms regulating the actions of the engineers involved in planning and designing urban areas, as well as on the normative consciousness required to facilitate such planning and design, demonstrating some examples on urban transport planning. This will be given via Zoom.
(7/1) “ General research ethics of synthetic chemistry ”
Lectures on the concept of writing academic papers and patents of synthetic chemisty with ethics.
(7/8) Architecture has developed by imitating beautiful buildings, but in recent years there has been an increase in the number of cases where copyright disputes have arisen. In addition, the appearance of architecture often causes landscape controversy because of its influence on the surrounding environment. Issues concerning the ethics and sociality of architecture are discussed while introducing overseas lawsuits and design processes.
(7/15) The materials engineer may stand on the side using materials as well as a side supplying materials. Some examples are introduced and, by this lecture, are argued about an ethic found from each situation by materials engineer. Note that this lecture is going to be carried out in ZOOM, but may be changed to the on-demand on account of the speaker.
(7/29) "Engineer ethics in mechanical design"
Engineer ethics is not a passive and passive thinking that issues the action of simply following existing norms, but a more active and creative thinking to decide and design one's own actions. It requires the logical thinking and ethical thinking necessary for engineers. This is explained with past cases in mechanical design.

[Course requirements]

None

[Evaluation methods and policy]

Class participation and reports.

[Textbooks]

Lecture materials will be distributed.

[References, 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)

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

The class order is subject to change.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG20 12108 LJ77		
Course title (and course title in English)	工学序論 Introduction to Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Senior Lecturer,TAKATSU HIROSHI Graduate School of Engineering Senior Lecturer,KANEKO KENTAROU Graduate School of Engineering Senior Lecturer,YOROZU KAZUAKI Graduate School of Engineering Professor,MATSUNO FUMITOSHI Research Institute for Sustainable Humanosphere Professor,YAMAMOTO MAMORU Graduate School of Engineering Professor,NUMATA KEIJI Graduate School of Informatics Professor,MINATO SHINICHI Graduate School of Engineering Professor,UNO NOBUHIRO Graduate School of Engineering Professor,KANETA TAKASHI

Target year	1st year students or above	Number of credits	1	Year/semesters	2022/Intensive, First semester
Days and periods	Intensive	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Engineering is to inquire after truth, to develop useful technologies, and to establish ways how to give back development results of technology to the society.
First, we offer special lectures regarding the basic knowledge that students in faculty of engineering are expected to have.
Then, we offer a series of intensive lectures about how engineering can suggest solutions of current and future problems of our society, the value of technology, and the responsibilities that researchers and engineers are expected to fulfill.

[Course objectives]

Students learn basic matters such as attitudes and responsibilities they are expected to take as a member of social community. They find value in studying engineering and become to consider what they do in future by understanding technology can suggest solutions of problems our society is facing, especially problems about safety and security.

[Course schedule and contents]

Special lectures,1time, About basic knowledge and attitude as students who start to learn engineering, and the role of engineering in society.
Intensive lectures,6times, A series of lectures offered by special lecturers playing on global stages of science and technology. Lectures are for understanding the role that technology is playing in modern society, for reconfirming importance to study engineering and to work as a researcher and engineer in society, and are to be opportunities to consider own future path. Essays are assigned in every lecture to summarize the lecture content and opinions of other students.
Schedule of the lectures are announced later.

Continue to 工学序論(2)↓↓↓

工学序論(2)

[Course requirements]

None

[Evaluation methods and policy]

Evaluation will be based on participation and essays assigned in every intensive lecture.

[Textbooks]

Specify if necessary.

[References, etc.]

（Reference books）

Specify if necessary.

[Study outside of class (preparation and review)]

Specify if necessary.

（Other information (office hours, etc.)）

Information about lecturers and contents of lectures are announced on electric bulletin boards.
Please confirm to your department office that the credit of this course is admitted to graduation requirements.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG20 32402 SE77		
Course title (and course title in English)	工学部国際インターンシップ１ Faculty of Engineering International Internship 1	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,HONDA MITSURU

Target year	3rd year students or above	Number of credits	1	Year/semesters	2022/Intensive, year-round
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese and English

[Overview 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 objectives]

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.

[Course requirements]

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

[Evaluation methods and policy]

Marit rating is done based on the presentation or reports after each internship program. Each Department 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.

[Textbooks]

Continue to 工学部国際インターンシップ１(2)↓↓↓

工学部国際インターンシップ１(2)

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, 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.

[Courses delivered by instructors with practical work experience]

(1) Category
A course that includes off-campus training classes.

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG20 22403 SJ77		
Course title (and course title in English)	グローバル・リーダーシップセミナーI(企業調査研究) Global Leadership Seminar I (Study for methodology in a company)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Senior Lecturer,hirai yoshikazu Graduate School of Engineering Senior Lecturer,KOMIYAMA YOSUKE Graduate School of Engineering Professor,HONDA MITSURU

Target year	2nd year students or above	Number of credits	1	Year/semesters	2022/Intensive, year-round
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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 objectives]

The goal of this course is to improve student's comprehension and explanation capability for processes of proposal and expansion on the international market invesitigating 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

[Course requirements]

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

[Evaluation methods and policy]

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

[Textbooks]

Not used

Continue to グローバル・リーダーシップセミナーI(企業調査研究) (2)↓↓↓

グローバル・リーダーシップセミナーI(企業調査研究)(2)

[References, etc.]

（Reference books）

（Related URLs）

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

[Study outside of class (preparation and review)]

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

（Other information (office hours, 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.

[Courses delivered by instructors with practical work experience]

(1) Category
An omnibus course delivered by invited lecturers and guest speakers from different companies, etc.

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG20 32502 SE77		
Course title (and course title in English)	工学部国際インターンシップ２ Faculty of Engineering International Internship 2	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,HONDA MITSURU

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Intensive, year-round
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese and English

[Overview 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 objectives]

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.

[Course requirements]

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

[Evaluation methods and policy]

Marit rating is done based on the presentation or reports after each internship program. Each Department 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.

[Textbooks]

Continue to 工学部国際インターンシップ２(2)↓↓↓

工学部国際インターンシップ２(2)

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, 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.

[Courses delivered by instructors with practical work experience]

(1) Category
A course that includes off-campus training classes.

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

Course number	U-ENG20 22503 SJ77		
Course title (and course title in English)	グローバル・リーダーシップセミナーII(イノベーションとその事業化) Global Leadership Seminar II (Innovation and its commercialization)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,HONDA MITSURU Graduate School of Engineering Senior Lecturer,KANEKO KENTAROU Graduate School of Engineering Senior Lecturer,TAKATSU HIROSHI

Target year	2nd year students or above	Number of credits	1	Year/semesters	2022/Intensive, Second semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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 objectives]

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]

※Depending on the situation of COVID-19 pandemic, all lectures will be given online and residential training will be canceled.

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.

[Course requirements]

None

[Evaluation methods and policy]

※Depending on the situation of COVID-19 pandemic, all lectures will be given online and residential training will be canceled.

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

Continue to グローバル・リーダーシップセミナーII(イノベーションとその事業化)(2)↓↓↓

a goal is made through presentation of the proposal as well as a submitted report.

[Textbooks]

Will be indicated as necessary.

[References, etc.]

（Reference books）

Will be indicated as necessary.

[Study outside of class (preparation and review)]

Will be indicated as necessary.

（Other information (office hours, etc.)）

Course open period: October to January

*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.

[Courses delivered by instructors with practical work experience]

(1) Category

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG25 35018 LJ71　U-ENG25 35018 LJ77　U-ENG25 35018 LJ75		
Course title (and course title in English)	量子物理学１（材原宇）〈情報〉 Quantum Physics 1	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MIYADERA TAKAYUKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Fri.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Quantum theory is one of the most successful theories in the modern physics. It explains well a lot of peculiar phenomena which can not be understood within the classical theory. The main purpose of this course is to understand the fundamental mathematical structure of the quantum theory.
We may use online materials. Check PandA in advance.

[Course objectives]

An important purpose of this course is to understand the fundamental mathematical structure of the quantum theory. In addition 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. Summary

[Course requirements]

Classical mechanics, Linear algebra

[Evaluation methods and policy]

【Evaluation method】
Evaluation will be based on reports.
【Evaluation policy】

Continue to 量子物理学１（材原宇）〈情報〉(2)↓↓↓

量子物理学１（材原宇）〈情報〉(2)

The result of reports should be 60 and above out of 100.
60 and above: Passed
59 and below: Failed

[Textbooks]

Not used

[References, etc.]

（Reference books）

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

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

Send an email.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG25 45019 LJ71　U-ENG25 45019 LJ77　U-ENG25 45019 LJ75		
Course title (and course title in English)	量子物理学２（材原宇）〈情報〉 Quantum Physics 2	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MIYADERA TAKAYUKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Tue.1	Class style	Lecture	Language of instruction	Japanese

[Overview 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.
We may use online materials. Check PandA in advance.

[Course objectives]

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 Quantum field
15. Applications to quantum information

[Course requirements]

Quantum Physics 1

[Evaluation methods and policy]

【Evaluation method】
Evaluation will be based on reports.
【Evaluation policy】
The result of reports should be 60 and above out of 100.
60 and above: Passed

Continue to 量子物理学２（材原宇）〈情報〉(2)↓↓↓

量子物理学２（材原宇）〈情報〉(2)

59 and below: Failed

[Textbooks]

Not used

[References, etc.]

（Reference books）

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

[Study outside of class (preparation and review)]

Solve a distributed problem set.

（Other information (office hours, etc.)）

Send an email.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

Course number	U-ENG25 25300 LJ77　U-ENG25 25300 LJ71		
Course title (and course title in English)	エレクトロニクス入門（機宇）〈情報〉 Introduction to Electronics	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,AWANO HIROMITSU Graduate School of Informatics Professor,HASHIMOTO MASANORI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Tue.5	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

In this course, students will learn about the basic characteristics of electronic circuits, digital circuits that are indispensable in today's information society, and computer architecture as hardware for running programs.

[Course objectives]

In this course, students will learn the minimum level of electronic circuits required for research in the Department of Physics and the Department of Computer Science, and as researchers and engineers.

[Course schedule and contents]

The order and number of lectures for each topic are not fixed, and are subject to change by the lecturer depending on the lecture policy of the instructor and the background and understanding of the students.

* Fundamentals of Electronic Circuits (3 clases) Learn DC, AC, and transient analysis.
* Amplification Circuits (1 class) Learn about amplification circuits using operational amplifiers.
* Fundamentals of digital logic circuits (1 class) Learn fundamentals of logic circuits including Boolean algebra, Karnaugh diagrams, etc.
* Sequential circuits (1 class) Learn how to construct circuits with internal states.
* Circuit Delay (1 class) Learn about what determines the operating speed of a circuit.
* Digital representation of numbers (1 class) Learn how to represent numbers including floating point format, which is often used in scientific and technological calculations.
* Arithmetic logic circuits (1 class) Learn about the structure of arithmetic circuits for digitally represented numbers.
* Overview of computer architecture (1 class) Learn about the configuration of computers, the hardware that executes programs.
* Machine language (1 class) Learn about the relationship between high-level languages such as C and instructions that can be interpreted by hardware.
* Composition of computer architecture (2 classes) Learn about the composition and operation of computers, using a processor that can execute simple instructions as an example.
* Integrated circuit manufacturing process (1 class)
* Feedback (1 class)

Translated with www.DeepL.com/Translator (free version)

Continue to エレクトロニクス入門（機宇）〈情報〉(2)↓↓↓

エレクトロニクス入門（機宇）〈情報〉(2)

[Course requirements]

Students who do not specialize in electrical and electronic engineering can take this course if they have some prior knowledge of high school physics.

[Evaluation methods and policy]

Multiple report assignments will be given during the course to evaluate the achievement of the objectives.

[Textbooks]

Not used

[References, etc.]

（Reference books）

Introduced during class

[Study outside of class (preparation and review)]

Students are required to review mathematical expressions using complex numbers in advance.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG26 26010 LJ72		
Course title (and course title in English)	電子回路 Electronic Circuits	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,SUGIYAMA KAZUHIKO

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Fri.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Following the lecture of fundamentals of active device circuits in the course "Electric and Electronic Circuits", 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 objectives]

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 (3 times):
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 (3 times)
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 (3 times)
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 (2 times):
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.

Oscillators (2 times):
The principle of the oscillator circuit is lectured as a concept of the positive feedback. Various oscillator

Continue to 電子回路(2)↓↓↓

circuits are introduced with their characteristics.

Others (1 time):
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.

Feedback (1 time):
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.

[Course requirements]

"Electric and Electronic Circuit (60030)" and "Fundamentals of Circuit Theory (60630)". (The lecturer recommends moderate understanding of fundamentals of electric circuit as the minimum prerequisites to achieve this course.)

[Evaluation methods and policy]

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

[Textbooks]

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

[References, 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/2022-110-6010-000) or (https://panda.ecs.kyoto-u.ac.jp/portal/). Sorry for Japanese version only.)

[Study outside of class (preparation and review)]

In case you need.

（Other information (office hours, 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.

Continue to 電子回路(3)↓↓↓

電子回路(3)

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.

The office hour is shown in KULASIS.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG26 36032 LJ72		
Course title (and course title in English)	通信基礎論 Modulation Theory in Electrical Communication	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,HARADA HIROSHI Graduate School of Informatics Associate Professor,MURATA HIDEKAZU

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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)

[Course requirements]

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

[Evaluation methods and policy]

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

[Textbooks]

守倉他『通信方式』（オーム社）ISBN:9784274214738

[References, etc.]

（Reference books）

寺田他: **情報通信工学** (**オーム社**) isbn{}{4274129322}

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

After classes, from 10:30-12:00

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29007 LJ10　U-ENG29 29007 LJ72		
Course title (and course title in English)	システム解析入門（数理） Introduction to Systems Analysis	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,MORIMOTO JUN

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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.

[Course requirements]

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

[Evaluation methods and policy]

The grade is determined by the final examination.

Continue to システム解析入門（数理）(2)↓↓↓

システム解析入門（数理）(2)

[Textbooks]

Handouts are given.

[References, etc.]

（Reference books）

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

（Related URLs）

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

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

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

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29017 LJ11		
Course title (and course title in English)	プログラミング言語（計算機） Programming Languages	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,IGARASHI ATSUSHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Mon.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29022 SJ11		
Course title (and course title in English)	計算機科学実験及演習２（計算機） Computer Science Laboratory and Exercise 2	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,SUENAGA KOUHEI Graduate School of Informatics Associate Professor,KAWAHARA JUN Academic Center for Computing and Media Studies Associate Professor,KONDO KAZUAKI Graduate School of Informatics Associate Professor,NAKAZAWA ATSUSHI Graduate School of Informatics Assistant Professor,INOUE KOJI Graduate School of Informatics Assistant Professor,IWAMASA YUNI Graduate School of Informatics Assistant Professor,TAKEUCHI KOH Graduate School of Informatics Assistant Professor,YASUDO RYOTA

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Tue.3,4	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

Continue to 計算機科学実験及演習２（計算機）(2)↓↓↓

計算機科学実験及演習２（計算機）(2)

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG29 39025 LJ10　U-ENG29 39025 LJ55		
Course title (and course title in English)	数値解析 Numerical Analysis	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,YOSHIKAWA HITOSHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Wed.3	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39028 LJ55　U-ENG29 39028 LJ10		
Course title (and course title in English)	確率と統計 Probability and Statistics	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,Shimodaira, Hidetoshi

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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).

[Course requirements]

None

[Evaluation methods and policy]

Grading is based on papers and final exam.

[Textbooks]

Handouts may be distributed in class.

[References, etc.]

（Reference books）

C. M. Bishop: Pattern Recognition and Machine Learning, Springer. isbn{}{9780387310732}

Continue to 確率と統計(2)↓↓↓

確率と統計(2)

T. Hastie, R. Tibshirani, and J. Friedman: The Elements of Statistical Learning, Springer. isbn{}{ 0387952845} isbn{}{9780387848570} isbn{}{9780387848587}

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

Details of office hours will be notified at class.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29030 LJ10		
Course title (and course title in English)	グラフ理論（計算機） Graph Theory	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,KAWAHARA JUN

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Thu.4	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

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

[Course objectives]

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)

Continue to グラフ理論（計算機）(2)↓↓↓

グラフ理論（計算機）(2)

[Course requirements]

Basics of algorithms, data structures, and set theory.

[Evaluation methods and policy]

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

[Textbooks]

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）

[References, etc.]

（Reference books）

I may show some recommended books in class.

[Study outside 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.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29030 LJ10		
Course title (and course title in English)	グラフ理論（数理） Graph Theory	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,NAGAMOCHI HIROSHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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.

Continue to グラフ理論（数理）(2)↓↓↓

グラフ理論（数理）(2)

[Course requirements]

None

[Evaluation methods and policy]

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

[Textbooks]

[References, 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/)

[Study outside of class (preparation and review)]

（Other information (office hours, 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.

未更新

Course number	U-ENG29 39031 LJ10　U-ENG29 39031 LJ55		
Course title (and course title in English)	応用代数学 Applied Algebra	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,TSUJIMOTO SATOSHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Mon.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

An introduction with application to basic algebra in informatics.

[Course objectives]

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.

[Course requirements]

Linear algebra

[Evaluation methods and policy]

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

[Textbooks]

[References, 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/)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39039 SJ11　U-ENG29 39039 SJ13　U-ENG29 39039 SJ12		
Course title (and course title in English)	計算機科学実験及演習４（計算機） Computer Science Laboratory and Exercise 4	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,SUENAGA KOUHEI Graduate School of Informatics Associate Professor,YOSHII KAZUYOSHI Graduate School of Informatics Associate Professor,MA QIANG Graduate School of Informatics Associate Professor,Drazen Brscic Graduate School of Informatics Assistant Professor,INOUE KOJI Academic Center for Computing and Media Studies Assistant Professor,SHIMONISHI KEI Graduate School of Informatics Assistant Professor,SEO Stela Hanbyeol

Target year	3rd year students or above	Number of credits	3	Year/semesters	2022/Second semester
Days and periods	Thu.3,4,Fri.1,2,3,4	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

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)

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG29 39055 LJ11　U-ENG29 39055 LJ10		
Course title (and course title in English)	アルゴリズム論 Theory of Algorithms	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,MINATO SHINICHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

Not used

[References, etc.]

（Reference books）

Introduced during class

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39058 LJ10　U-ENG29 39058 LJ72		
Course title (and course title in English)	現代制御論（数理） Modern Control Theory	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,KASHIMA KENJI

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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,2times,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.
Overall summary, 1time

Continue to 現代制御論（数理）(2)↓↓↓

現代制御論（数理）(2)

[Course requirements]

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.

[Evaluation methods and policy]

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

[Textbooks]

None specified.

[References, 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}

[Study outside of class (preparation and review)]

Fundamental knowledge of linear algebra such as matrix manipulation is assumed.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 49059 LJ10　U-ENG29 49059 LJ55		
Course title (and course title in English)	情報システム理論（数理） Theory of Information Systems	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,TANAKA TOSHIYUKI

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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.

[Course requirements]

Stochastic discrete event systems, and basics of queueing theory.

[Evaluation methods and policy]

Based on the score of the term examination

[Textbooks]

Handouts are provided.

[References, 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}

Continue to 情報システム理論（数理）(2)↓↓↓

情報システム理論（数理）(2)

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. isbn{}{0070286310}.

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 29070 LJ55　U-ENG29 29070 LJ11　U-ENG29 29070 LJ10		
Course title (and course title in English)	論理システム（計算機） Logical Systems	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,TAKAGI NAOFUMI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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.

Continue to 論理システム（計算機）(2)↓↓↓

論理システム（計算機）(2)

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

Term-end examination (1 class)

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

[Course requirements]

None

[Evaluation methods and policy]

Evaluation is performed regarding each element of this course's end goals, namely, the final examination (approximately 90%) and exercises (approximately 10%). If an understanding is shown of 80% or higher on the final exam, then the student will pass the course.

[Textbooks]

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

[References, etc.]

（Reference books）
Zvi Kohavi, Niraj K. Jha 『Switching and Finite Automata Theory, Third Ed.』 （Cambridge University Press, 2010）ISBN:0521857481, 9780521857482

（Related URLs）

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

[Study outside 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 before the next class.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 29070 LJ55　U-ENG29 29070 LJ11　U-ENG29 29070 LJ10		
Course title (and course title in English)	論理システム（数理） Logical Systems	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,FUKUDA HIDEMI Graduate School of Informatics Associate Professor,HARAGUCHI KAZUYA

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

The student will learn the basics of mathematical logic, in particular, associated to propositional calculus, predicate logic, Boolean algebra, digital circuits and related topics.

[Course objectives]

Learn the basics of mathematical logic, which is the principle of computational science.

[Course schedule and contents]

[Topics]
Mathematical logic, logical algebra, digital circuits

- Class 1 to 3 (prof. Fukuda):
  Mathematical logic, propositional calculus, predicate logic
- Class 4 to 10 (prof. Fukuda):
  Boolean algebra, threshold function and other examples
- Class 11 to 14 (prof. Haraguchi):
  Digital circuits, combinatorial circuits, sequential circuits
- Final examination
- Feedback

[Course requirements]

None

[Evaluation methods and policy]

One final test, but with possibility of having a smaller test in the middle of the semester.

[Textbooks]

Instructed during class

[References, etc.]

（Reference books）
高木直史 『論理回路』（オーム社）ISBN:978-4274215995
天野英晴, 武藤佳恭, 相磯秀夫 『だれにもわかる ディジタル回路』（オーム社）ISBN:978-4274217531

Continue to 論理システム（数理）(2)↓↓↓

論理システム（数理）(2)

[Study outside of class (preparation and review)]

No preparation in advance is required, but the review of previous classes is recommended.

（Other information (office hours, etc.)）

Prof. Fukuda: ellen at i.kyoto-u.ac.jp
Prof. Haraguchi: haraguchi at amp.i.kyoto-u.ac.jp

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29071 LJ57　U-ENG29 29071 LJ10		
Course title (and course title in English)	解析力学（数理） Analytical Mechanics	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,TAGUCHI Satoshi

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39072 LJ72　U-ENG29 39072 LJ10		
Course title (and course title in English)	線形制御理論 Linear Control Theory	Instructor's name, job title, and department of affiliation	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	Year/semesters	2022/Second semester
Days and periods	Wed.3	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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,

[Course requirements]

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

[Evaluation methods and policy]

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

[Textbooks]

None.

[References, 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}

Continue to 線形制御理論(2)↓↓↓

線形制御理論(2)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39074 LJ10　U-ENG29 39074 LJ55		
Course title (and course title in English)	数理工学セミナー（数理） Seminar on Applied Mathematics and Physics	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,HONDA JUNYA Graduate School of Informatics Assistant Professor,IWASAKI ATSUSHI Graduate School of Informatics Assistant Professor,Aleksandar Shurbevski Graduate School of Informatics Assistant Professor,TSUTSU HIROKI Graduate School of Informatics Assistant Professor,NAKAYAMA YUGO Graduate School of Informatics Assistant Professor,NIINO KAZUKI Graduate School of Informatics Assistant Professor,NEMOTO TAKAHIRO

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Fri.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

It is a seminar-type class, related to various topics related to Applied Mathematics and Physics.

[Course objectives]

Each student will learn an specific topic of his/her choice. During the class, the students will learn not only the topic itself, but how to present it appropriately.

[Course schedule and contents]

- 15 classes in total including feedback class.
- 6 topics, related to General Mathematics, General Physics, Operations Research and Control Theory, will be provided.
- Each student will choose one topic only.

[Course requirements]

It will depend on the topic chosen by the student. Please read the information that will be posted on Kulasis in July.

[Evaluation methods and policy]

- Each student should attend all classes. If, for some reason, he/she cannot attend some classes, he/she should tell the instructor in advance.
- The grades will be based on the attendance, communication during the class, presentation, and understanding of the topic.

Continue to 数理工学セミナー（数理）(2)↓↓↓

数理工学セミナー（数理）(2)

[Textbooks]

It depends on the topic of choice.

[References, etc.]

（Reference books）

It depends on the topic of choice.

[Study outside of class (preparation and review)]

Please ask the instructor of your topic.

（Other information (office hours, etc.)）

In early July, all the topics of this seminar class will be announced. Students should pay attention to KULASIS and/or to the announce board of the department office. After that, the students should follow the instructions of this announcement, which includes choosing the topic of interest.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39079 LJ10　U-ENG29 39079 LJ54		
Course title (and course title in English)	最適化（数理） Optimization	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,NAGAMOCHI HIROSHI Graduate School of Informatics Professor,YAMASHITA NOBUO Graduate School of Informatics Associate Professor,HARAGUCHI KAZUYA

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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.

[Course requirements]

Linear Programming (90690) recommended.

[Evaluation methods and policy]

Based on the score of the term examination.

[Textbooks]

Not used

Continue to 最適化（数理）(2)↓↓↓

最適化（数理）(2)

[References, 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}.

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 39080 LJ55　U-ENG29 39080 LJ10		
Course title (and course title in English)	力学系の数学 Dynamical Systems	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,YAGASAKI KAZUYUKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Tue.3	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

(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]

Examples of Dynamical Systems, 1 time:
Classical dynamical systems given by differential equations and maps are considered and nonlinear phenomena occurred in numerical simulations of these systems are reviewed.
Introduction to Dynamical Systems, 5-6 times:
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, 4-5 times:
Bifurcations of equilibria and fixed points, center manifold reductions and normal forms are discussed.
Chaos, 3-4 times:
Horseshoe maps, homoclinic theorem and Melnikov's method are discussed.
Summary and learning achievement evaluation, 1 time:
A summary and supplements of this course are given and the learning achievement of students is evaluated.

[Course requirements]

Calculus, Linear Algebra and Differential Equations

[Evaluation methods and policy]

Evaluation depends mainly on marks of mid-term examinations (20%) and final one (80%).

Continue to 力学系の数学(2)↓↓↓

力学系の数学(2)

[Textbooks]

Handouts

[References, etc.]

（Reference books）

K.T. Alligood, T. Sauer and J.A. Yorke 『Chaos: An Introduction to Dynamical Systems』 （Springer） ISBN:9783642592812

M.W. Hirsch, S. Smale and R.L. Devaney 『Differential Equations, Dynamical Systems, and an Introduction to Chaos 』 （Elsevier, 2013） ISBN:9780123820105

J. Guckenheimer and P. Holmes 『Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields』 （Springer, 1983） ISBN:0387908196

J.D. Meiss 『Differential Dynamical Systems』 （SIAM, 2017） ISBN:9780898716351

S. Wiggins 『Introduction to Applied Nonlinear Dynamical Systems and Chaos』 （Springer, 2003） ISBN: 0387001778

[Study outside of class (preparation and review)]

Prepare and review the lectures and solving the problems given on KULASIS or PANDA to understand the contents of the textbook and lectures.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39081 LJ72　U-ENG29 39081 LJ10		
Course title (and course title in English)	信号とシステム Signals and Systems	Instructor's name, job title, and department of affiliation	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	Year/semesters	2022/First semester
Days and periods	Wed.4	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39084 SJ11		
Course title (and course title in English)	計算機科学実験及演習３（計算機） Computer Science Laboratory and Exercise 3	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,SUENAGA KOUHEI Academic Center for Computing and Media Studies Assistant Professor,Kotani Daisuke Academic Center for Computing and Media Studies Assistant Professor,SHIMONISHI KEI Graduate School of Informatics Assistant Professor,YASUDO RYOTA Graduate School of Informatics Assistant Professor,WAGA MASAKI

Target year	3rd year students or above	Number of credits	4	Year/semesters	2022/First semester
Days and periods	Thu.3,4,5,Fri.1,2,3,4,5	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

Continue to 計算機科学実験及演習３（計算機）(2)↓↓↓

計算機科学実験及演習３（計算機）(2)

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG29 39086 LJ10　U-ENG29 39086 LJ11		
Course title (and course title in English)	計算と論理 Logic and Computation	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,IGARASHI ATSUSHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29089 EJ10　U-ENG29 29089 EJ55		
Course title (and course title in English)	数理工学実験（数理:H25以前入学者） Applied Mathematics and Physics Laboratory	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Assistant Professor,YAMAKAWA YUYA Graduate School of Informatics Assistant Professor,Aleksandar Shurbevski Graduate School of Informatics Assistant Professor,NAKAYAMA YUGO

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Mon.3,4,Tue.3,4	Class style	Experiment	Language of instruction	Japanese

[Overview and purpose of the course]

Applied Mathematics and Physics is a scientific discipline that gives a theoretical foundation to understand and explain the behavior of systems and physical phenomena around us, as well as give us means to solve various problems. This experiment class is a chance to see in action the basic principles of mathematical modeling behind engineering that have been learned in elementary mathematics and physics courses. In addition, students will work on developing their programming skills and learn how to produce scientific reports in the LaTeX system.

[Course objectives]

・Understand basic algorithms and develop skills to implement them in a programming language, as well as use experimental results to analyze, understand, and conjecture about certain phenomena.
・Become familiar on using the LaTeX writing system, and producing scientific reports.

[Course schedule and contents]

Day 1-2　: Class guidance and instructions on writing reports
・Guidance on the course of the classes, as well as using the BYOD class system
・General instructions on writing scientific reports
・Using gnuplot to produce plots of a set of data, including illustrations using the LaTeX system, etc.
Day 3-6 : Ordinary differential equations
Day 7-10 : Finite difference method of heat equations
Day 11-14: Numerical integration
Day 15-18: Finding function roots; Continuous optimization
Day 19-22: Least squares method
Day 23-26: Image generation by neural networks (VAE and GAN, etc)
Day 27-30: Combinatorial optimization

[Course requirements]

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

Continue to 数理工学実験（数理:H25以前入学者）(2)↓↓↓

数理工学実験（数理:H25以前入学者）(2)

[Evaluation methods and policy]

The evaluation will be based on a report for each of the class topics. It is necessary to submit reports for all topics in order to get credit for the class (note, it is not guaranteed that credit will be earned if all reports are submitted).
In addition, tardiness, absence from class, and re-submitting a report will incur reduction in the grade.

[Textbooks]

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

[References, etc.]

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

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

This class is in BYOD (Bring Your Own Device) style, and it is mandatory to bring your own computer for the class.

In addition, it is necessary to prepare the necessary environment and software for conducting the class:
・Prepare to use gnuplot to produce plots from data
・Prepare to use the LaTeX system to produce reports
(Please install a LaTeX compiler, dvipdfmx, dvips, epstopdf, pdftops, etc)
・Prepare a C/C++ compiler for the experiments
(Under MacOS please install Xcode Command Line Tools or similar software, on Windows cygwin, MS Visual Studio or similar, and on Linux, try using the c++ and g++ commands to compile)
as well as a basic text editor.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29090 SJ10　U-ENG29 29090 SJ57　U-ENG29 29090 SJ55		
Course title (and course title in English)	基礎数理演習（数理） Exercise on Applied Mathematics and Physics	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Assistant Professor,YAMAGUCHI YOSHIYUKI Graduate School of Informatics Assistant Professor,KAMIOKA SHIYUUHEI Graduate School of Informatics Assistant Professor,TSUTSU HIROKI Graduate School of Informatics Assistant Professor,HARADA KENJI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Tue.3,4	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,1time,
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[Course requirements]

None

[Evaluation methods and policy]

Continue to 基礎数理演習（数理）(2)↓↓↓

基礎数理演習（数理）(2)

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 29091 SJ10　U-ENG29 29091 SJ54　U-ENG29 29091 SJ11		
Course title (and course title in English)	プログラミング演習（数理:H30以前入学者） Exercise on Programming	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Assistant Professor,HARADA KENJI Graduate School of Informatics Assistant Professor,IWASAKI ATSUSHI Graduate School of Informatics Assistant Professor,NEMOTO TAKAHIRO

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Mon.3,4	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

C言語によるプログラミング実習を行う。手続き型言語を用いたプログラミングの基礎となる、データ型・演算子・配列・関数・条件分岐・繰り返し処理・多次元配列・ファイル操作等を、数理工学での基礎的なアルゴリズム実装を題材にして学ぶ。

[Course objectives]

数理工学の各分野において、コンピュータを有効活用するために必要なプログラミングの知識と技術を修得する。

[Course schedule and contents]

第1回　ガイダンスとレポートの書き方
　　レポートの適切な書法と各種ツールの活用について学ぶ。

第2回～第4回　手続き型言語入門・条件分岐と繰り返し構造と関数
　　基本的な文法、基本的なデータ型、基本的な関数とそれを用いたサンプルプログラミングの実行方法までを学び、プログラムの基本パーツである条件分岐や繰り返し構造、関数について、数値積分（台形公式）、1変数非線形方程式の解法（ニュートン法）などのアルゴリズム実装を題材にして学ぶ。

第5回～第9回　多次元配列
　　多次元配列の使い方を、基本的な行列演算、行列固有値問題の数値解法（べき乗法）、線形方程式の数値解法（ガウスの消去法）などのアルゴリズム実装を題材に学ぶ。

第10回～第14回　データ構造とファイル操作
　　リストやツリーなどのデータ構造を表現するために、構造体、ポインタ、動的メモリ確保などをソーティングや動的計画法などのアルゴリズム実装を題材に学ぶ。さらに、ファイルからのパラメータ入力や結果の出力やリダイレクトを組み合わせたコード作成についても学ぶ。

第15回　学習到達度の確認
　　プログラミング技術の到達度を確認する。

[Course requirements]

本演習はBYODで行うため、演習時には各自ノートPCを持参すること。

Continue to プログラミング演習（数理:H30以前入学者）(2)↓↓↓

プログラミング演習（数理:H30以前入学者）(2)

[Evaluation methods and policy]

各項目ごとに出されるレポートと出席状況に基づき総合的に成績評価を行う。

[Textbooks]

Not used

[References, etc.]

（Reference books）
皆本晃弥 『やさしく学べるC言語入門』（サイエンス社）ISBN:978-4781913599
後藤良和、高田大二、中島寛和 『入門C言語』（実教出版）ISBN:978-4-407-33283-4
柴田望洋 『新・明解C言語 入門編』（SBクリエイティブ）ISBN:978-4797377026

[Study outside of class (preparation and review)]

演習時間を有効的につかうために、配布資料に基づく予習を行うこと。

（Other information (office hours, etc.)）

初回ガイダンスへの出席を必須とする。

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39094 LJ10　U-ENG29 39094 LJ57		
Course title (and course title in English)	物理統計学（数理） Statistical Physics	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,UMENO KEN

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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.

[Course requirements]

Fundamentals of calculus and linear algebra

[Evaluation methods and policy]

Based on quizzes and the semester final exam.

Continue to 物理統計学（数理）(2)↓↓↓

物理統計学（数理）(2)

[Textbooks]

None

[References, etc.]

（Reference books）

To be announced in the lecture

[Study outside of class (preparation and review)]

Reviews through solving the assigned quizzes are expected.

（Other information (office hours, etc.)）

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

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39096 LJ55　U-ENG29 39096 LJ10		
Course title (and course title in English)	確率離散事象論 Stochastic Discrete Event Systems	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,HONDA JUNYA Graduate School of Informatics Professor,TANAKA TOSHIYUKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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.

[Course requirements]

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

[Evaluation methods and policy]

Based on the scores of the term examination.

Continue to 確率離散事象論(2)↓↓↓

確率離散事象論(2)

[Textbooks]

Handouts are provided.

[References, 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}

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39098 LJ11		
Course title (and course title in English)	データベース（計算機） Databases	Instructor's name, job title, and department of affiliation	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	Year/semesters	2022/First semester
Days and periods	Mon.3	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, 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}

Continue to データベース（計算機）(2)↓↓↓

データベース（計算機）(2)

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. isbn{}{0201537710}

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG29 39099 LJ11		
Course title (and course title in English)	ソフトウェア工学（計算機） Software Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,Takayuki ITO Institute for Information Management and Communication Associate Professor,ATSUMI NORITOSHI Part-time Lecturer,HOSHINO HIROSHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Mon.4	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[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,

[Course requirements]

None

[Evaluation methods and policy]

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)

[Textbooks]

[References, etc.]

（Reference books）

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

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39103 LJ11		
Course title (and course title in English)	オペレーティングシステム（計算機） Operating Systems	Instructor's name, job title, and department of affiliation	Academic Center for Computing and Media Studies Professor,SHUDO KAZUYUKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29104 LJ11　U-ENG29 29104 LJ10		
Course title (and course title in English)	言語・オートマトン Languages and Automata	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,YAMAMOTO AKIHIRO

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

[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

[Course requirements]

None

[Evaluation methods and policy]

Will be specified in the lectures.

[Textbooks]

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

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 49108 SJ13　U-ENG29 49108 SJ12　U-ENG29 49108 SJ11		
Course title (and course title in English)	情報と職業 Information and Business	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KASHIMA HISASHI Academic Center for Computing and Media Studies Associate Professor,KONDO KAZUAKI

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Fri.3,4	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,1time,
,7times,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

Continue to 情報と職業(2)↓↓↓

情報と職業(2)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
An omnibus course delivered by invited lecturers and guest speakers from different companies, etc.

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG29 39109 LJ11		
Course title (and course title in English)	コンピュータネットワーク Computer Networks	Instructor's name, job title, and department of affiliation	Academic Center for Computing and Media Studies Professor,OKABE YASUO

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Tue.1	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

Students will understand the principles of computer networks and will be able to explain how they work. Students will be able to create simple programs to communicate over the Internet.

[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

[Course requirements]

None

[Evaluation methods and policy]

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

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)

[Textbooks]

Olivier Bonaventure 『Computer Networking : Principles, Protocols and Practice, 1st edition』（Saylor Foundation, 2011）ISBN:N/A（Free PDF 282 pages at the author's site http://cnp3book.info.ucl.ac.be/1st/html/）

[References, etc.]

（Reference books）

Norio Shiratori (ed.) 『Information Network』（Kyoritsu, 2011）ISBN:9784320123038（(in Japanese)）
Katsuo Ikeda (ed.) 『Computer networks』（Ohmsha, 2001）ISBN:4274132226（(in Japanese)）

[Study outside of class (preparation and review)]

Students are required to take the Kyoto University Information Security e-learning course.
http://www.iimc.kyoto-u.ac.jp/en/services/ismo/e-Learning/

（Other information (office hours, etc.)）

Questions can be submitted at any time via PandA or e-mail.

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 39111 LJ11		
Course title (and course title in English)	情報システム（計算機） Information Systems	Instructor's name, job title, and department of affiliation	Institute for Liberal Arts and Sciences Professor,TAJIMA KEISHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Wed.3	Class style	Lecture	Language of instruction	Japanese

[Overview 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, techniques for processing structured documents and semi-structured data used in Web information systems, theories for web information retrieval systems and other information retrieval systems, and techniques for graph data analysis.

[Course objectives]

The goals of this course are for students to have gained an understanding of architecture of Web information systems, techniques for processing structured documents and semi-structured data used in Web information systems, theories for web information retrieval systems and other information retrieval systems, and techniques for graph data analysis.

[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. 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 echniques 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.

3. 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). The user models that lies behind these measures will also be explained in overview.

4. 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,

Continue to 情報システム（計算機）(2)↓↓↓

latent semantic indexing (LSI), latent Dirichlet allocation (LDA), word2vec, probability model, binary independence model, and query likelihood model).

5. 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, techniques for creation of data set for evaluation of information systems, and information recommendation techniques such as collaborative filtering.

6. Web analysis (2 classes)
These lectures describe analysis techniques for graph structures of Web data. Taken up especially as representative analysis methods are PageRank, Topic-Specific PageRank, TrustRank, HITS, SimRank, etc.

7. 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.

8. Feedback (1 class)
Questions about the examination from students are answered.

[Course requirements]

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.

[Evaluation methods and policy]

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.

[Textbooks]

Lecture notes will be used as teaching materials.

[References, etc.]

（Reference books）
Introduced during class

[Study outside 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)

（Other information (office hours, etc.)）

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

tajima at i.kyoto-u (the remaining part is omitted)

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 19113 LJ12　U-ENG29 19113 LJ11　U-ENG29 19113 LJ10		
Course title (and course title in English)	計算機科学概論 Introduction to Computer Science	Instructor's name, job title, and department of affiliation	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,Takayuki ITO

Target year	1st year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.5	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Introduction to Computer Science.

[Course objectives]

[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,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 19114 LJ10　U-ENG29 19114 LJ55　U-ENG29 19114 LJ54		
Course title (and course title in English)	数理工学概論 Introduction to Applied Mathematics and Physics	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,YAMASHITA NOBUO Graduate School of Informatics Professor,Shimodaira, Hidetoshi Graduate School of Informatics Associate Professor,TERAMAE JUNNOSUKE

Target year	1st year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

Understanding basic ideas in applied mathematics and physics.

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

Evaluated by writing homework.

[Textbooks]

None

[References, etc.]

（Reference books）
None

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 19115 LJ11　U-ENG29 19115 LJ10		
Course title (and course title in English)	アルゴリズムとデータ構造入門 Introduction to Algorithms and Data Structures	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KASHIMA HISASHI

Target year	1st year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Mon.1	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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,

[Course requirements]

None

[Evaluation methods and policy]

Mid-term and final examinations

[Textbooks]

will be specified in the lectures

[References, etc.]

（Reference books）
will be specified in the lectures

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39116 LJ12		
Course title (and course title in English)	人工知能 Artificial Intelligence	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KANDA TAKAYUKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.3	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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

[Course requirements]

None

[Evaluation methods and policy]

By reports and a final examination.

[Textbooks]

Materials will be distributed.

[References, etc.]

（Reference books）

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

Continue to 人工知能(2)↓↓↓

人工知能(2)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG29 39117 LJ12		
Course title (and course title in English)	ヒューマンインタフェース Human Interface	Instructor's name, job title, and department of affiliation	Academic Center for Computing and Media Studies Professor,Ogata Hiroaki Academic Center for Computing and Media Studies Program-Specific Senior Lecturer,FLANAGAN, BrendanJohn Part-time Lecturer,YAMASHITA NAOMI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Wed.4	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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.

[Course requirements]

None

[Evaluation methods and policy]

By reports and a final examination.

[Textbooks]

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

[References, etc.]

（Reference books）

Continue to ヒューマンインタフェース(2)↓↓↓

ヒューマンインタフェース(2)

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

Please bring your notebook PC in each lesson.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 49118 LJ10　U-ENG29 49118 LJ55		
Course title (and course title in English)	数理解析 Analysis in Mathematical Sciences	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,YOSHIKAWA HITOSHI

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Thu.4	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 49119 LJ13　U-ENG29 49119 LJ66		
Course title (and course title in English)	生命情報学 Introduction to Computational Systems Bioinformatics	Instructor's name, job title, and department of affiliation	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	Year/semesters	2022/First semester
Days and periods	Tue.4	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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,

[Course requirements]

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

[Evaluation methods and policy]

See Japanese page for details.

[Textbooks]

Not used

[References, etc.]

（Reference books）

Textbooks or recommended books will be informed in the course as required. The latter part of the course, a

Continue to 生命情報学(2)↓↓↓

生命情報学(2)

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}**.**

[Study outside of class (preparation and review)]

See Japanese page for details.

（Other information (office hours, etc.)）

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

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 49121 LJ43　U-ENG29 49121 LJ24　U-ENG29 49121 LJ10		
Course title (and course title in English)	ビジネス数理（数理） Business Mathematics	Instructor's name, job title, and department of affiliation	Part-time Lecturer,KAI YOSHITAKA

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.3	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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.

[Course requirements]

None

[Evaluation methods and policy]

Report examination (80%),　and attendance and the class participation (20%)

[Textbooks]

Prints or PDF files are distributed before every lecture.

Continue to ビジネス数理（数理）(2)↓↓↓

ビジネス数理（数理）(2)

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

Course number	U-ENG29 39122 LJ10　U-ENG29 39122 LJ12		
Course title (and course title in English)	パターン認識と機械学習 Pattern Recognition	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KAWAHARA TATSUYA

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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

[Course requirements]

None

[Evaluation methods and policy]

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)↓↓↓

パターン認識と機械学習(2)

[Textbooks]

Lecture slides are provided via PandA CMS.

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

Excersize included in lecture slides

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39123 LJ57　U-ENG29 39123 LJ10		
Course title (and course title in English)	非線形動力学（数理） Nonliner Dynamics	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,AOYAGI TOSHIO

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Fri.3	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 19124 LJ11		
Course title (and course title in English)	プログラミング入門 Introduction to Programming	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,Takayuki ITO

Target year	1st year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Thu.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29125 EJ10　U-ENG29 29125 EJ55		
Course title (and course title in English)	数理工学実験（数理:H26以降入学者） Applied Mathematics and Physics Laboratory	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Assistant Professor,YAMAKAWA YUYA Graduate School of Informatics Assistant Professor,Aleksandar Shurbevski Graduate School of Informatics Assistant Professor,NAKAYAMA YUGO

Target year	2nd year students or above	Number of credits	4	Year/semesters	2022/Second semester
Days and periods	Mon.3,4,Tue.3,4	Class style	Experiment	Language of instruction	Japanese

[Overview and purpose of the course]

Applied Mathematics and Physics is a scientific discipline that gives a theoretical foundation to understand and explain the behavior of systems and physical phenomena around us, as well as give us means to solve various problems. This experiment class is a chance to see in action the basic principles of mathematical modeling behind engineering that have been learned in elementary mathematics and physics courses. In addition, students will work on developing their programming skills and learn how to produce scientific reports in the LaTeX system.

[Course objectives]

・Understand basic algorithms and develop skills to implement them in a programming language, as well as use experimental results to analyze, understand, and conjecture about certain phenomena.
・Become familiar on using the LaTeX writing system, and producing scientific reports.

[Course schedule and contents]

Day 1-2　: Class guidance and instructions on writing reports
・Guidance on the course of the classes, as well as using the BYOD class system
・General instructions on writing scientific reports
・Using gnuplot to produce plots of a set of data, including illustrations using the LaTeX system, etc.
Day 3-6 : Ordinary differential equations
Day 7-10 : Finite difference method of heat equations
Day 11-14: Numerical integration
Day 15-18: Finding function roots; Continuous optimization
Day 19-22: Least squares method
Day 23-26: Image generation by neural networks (VAE and GAN, etc)
Day 27-30: Combinatorial optimization

[Course requirements]

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

Continue to 数理工学実験（数理:H26以降入学者）(2)↓↓↓

数理工学実験（数理:H26以降入学者）(2)

[Evaluation methods and policy]

The evaluation will be based on a report for each of the class topics. It is necessary to submit reports for all topics in order to get credit for the class (note, it is not guaranteed that credit will be earned if all reports are submitted).
In addition, tardiness, absence from class, and re-submitting a report will incur reduction in the grade.

[Textbooks]

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

[References, etc.]

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

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

This class is in BYOD (Bring Your Own Device) style, and it is mandatory to bring your own computer for the class.

In addition, it is necessary to prepare the necessary environment and software for conducting the class:
・Prepare to use gnuplot to produce plots from data
・Prepare to use the LaTeX system to produce reports
(Please install a LaTeX compiler, dvipdfmx, dvips, epstopdf, pdftops, etc)
・Prepare a C/C++ compiler for the experiments
(Under MacOS please install Xcode Command Line Tools or similar software, on Windows cygwin, MS Visual Studio or similar, and on Linux, try using the c++ and g++ commands to compile)
as well as a basic text editor.

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 29127 LJ11		
Course title (and course title in English)	計算機の構成 Computer organization	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,TAKAGI NAOFUMI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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 class)
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)

[Course requirements]

Having knowledge on logic circuits is preferable.

[Evaluation methods and policy]

Evaluation is performed regarding each element of this course's end goals, namely, the term-end examination (approximately 90%) and exercises (approximately 10%). If an understanding is shown of 80% or higher on the term-end exam, then the student will pass the course.

[Textbooks]

David A. Patterson and John L. Hennessy, Translated in Japanese by M. Narita 『Computer Organization and Design - The Hardware/Software Interface - 6th ed. No. 1』 （Nikkei BP）ISBN:97848296070091

[References, etc.]

（Reference books）

David A. Patterson, John L. Hennessy 『Computer Organization and Design, The Hardware/Software Interface, MIPS Ed. Sixth Ed.』 （Morgan Kaufmann, 2021）ISBN:9780128201091

（Related URLs）

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

[Study outside 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 before the next class.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39128 LJ11		
Course title (and course title in English)	プログラミング言語処理系 Implementation of Programming Languages	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,SUENAGA KOUHEI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Mon.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

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

[Course objectives]

[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,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

Continue to プログラミング言語処理系(2)↓↓↓

プログラミング言語処理系(2)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG29 29129 LJ10　U-ENG29 29129 LJ11		
Course title (and course title in English)	情報符号理論 Information and Coding Theory	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,MINATO SHINICHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Tue.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

Instructed during class

[References, etc.]

（Reference books）

Introduced during class

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 29130 LJ11 U-ENG29 29130 LJ72		
Course title (and course title in English)	電気電子回路入門 Introduction to Electric and Electronic Circuit Theory	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science Professor,SHIMODA HIROSHI Graduate School of Energy Science Associate Professor,IWAO KAWAYAMA

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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
- Amplification circuit
- Oscillation circuit
- Operational amplifier circuit

Continue to 電気電子回路入門(2)↓↓↓

電気電子回路入門(2)

5. Digital electronic circuit　(3 times)
・Semiconductor switch element
・Semiconductor logic circuit
・Digital input/output interface circuit
6. Feedback (1 time)
・Q&A

[Course requirements]

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

[Evaluation methods and policy]

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%).

[Textbooks]

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

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 29131 LJ10		
Course title (and course title in English)	計算機科学のための数学演習 Mathematics in Practice for Computer Science	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,KAWAHARA JUN Graduate School of Informatics Associate Professor,YAMADA MAKOTO Graduate School of Informatics Assistant Professor,IWAMASA YUNI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Thu.4	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

Continue to 計算機科学のための数学演習(2)↓↓↓

計算機科学のための数学演習(2)

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 39132 EJ72　U-ENG29 39132 EJ10		
Course title (and course title in English)	システム工学実験（数理） System Analysis Laboratory	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,TSUJI TETSURO 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	Year/semesters	2022/First semester
Days and periods	Thu.4,5,Fri.4,5	Class style	Experiment	Language of instruction	Japanese

[Overview 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 applications of their knowledge to the three real systems, Active Silencer, Flexible-Link Manipulator, and Inverted Pendulum. Students will master control methods through computer simulations and pilot experiments. Students will be divided into three groups in the first guidance class in order to study all the three different systems in turn.

[Course objectives]

To understand the following theoretical knowledge through the control experiment of the real systems:
-- Physics modeling based on the first principle
-- Parameter identification from experiments
-- Analyses of frequency responses and stability
-- System stabilization and optimal control

To study how to obtain practical solutions for controlling real systems by observing behaviors of the real systems, considering a gap between theory and practice, and understanding the feature of the real systems.

To precisely express own understanding of the experiments through presentations and reports.

[Course schedule and contents]

Guidance, 1 time, Introduction of topics and dividing students into 3 groups

Active Silencer, 9 times,
1. Introduction to principle of active sliencer
2. Basic lecture on DSP and programming
3. Experiment
4. Analyses on responses in time and frequency
*The specialized software Scilab is used.

Flexible-Link Manipulator, 9 times,
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, 9 times,

Continue to システム工学実験（数理）(2)↓↓↓

システム工学実験（数理）(2)

1. Mechanical model of inverted pendulum and parameter identification
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.

[Course requirements]

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

[Evaluation methods and policy]

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

[Textbooks]

Each instructor will distribute his own text when necessary.

[References, etc.]

（Reference books）

Doyle, Francic and Tannenbaum 『Feedback Control Theory』 （Prentice Hall）ISBN:0023300116（(1992)）

Ljung 『System Identification』 （Prentice Hall）ISBN:0136566952（(1998)）

（Related URLs）

(Sutudents will be informed when necessary)

[Study outside of class (preparation and review)]

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

（Other information (office hours, 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.

未更新

Course number	U-ENG29 39133 LJ11				
Course title (and course title in English)	計算機アーキテクチャ Computer Architecture		Instructor's name, job title, and department of affiliation	Academic Center for Computing and Media Studies Professor,OKABE YASUO	
Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Mon.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

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

[Course objectives]

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

[Course requirements]

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

Continue to 計算機アーキテクチャ(2)↓↓↓

計算機アーキテクチャ(2)

[Evaluation methods and policy]

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

[Textbooks]

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}

[References, 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.)

[Study outside of class (preparation and review)]

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

（Other information (office hours, 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.

未更新

Course number	U-ENG29 39136 LJ10		
Course title (and course title in English)	統計的モデリング基礎 Foundations of Statistical Modeling	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KASHIMA HISASHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.4	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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

[Course requirements]

Basic knowledge of probability and statistics

[Evaluation methods and policy]

Mid-term and final examinations

[Textbooks]

None

Continue to 統計的モデリング基礎(2)↓↓↓

統計的モデリング基礎(2)

[References, etc.]

（Reference books）

They will be given in the lectures

（Related URLs）

(The course website will be given in the lectures)

[Study outside of class (preparation and review)]

Exercises on real data analysis.

（Other information (office hours, 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.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG29 29138 SJ11		
Course title (and course title in English)	計算機科学実験及演習 1 Computer Science Laboratory and Exercise 1	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,SUENAGA KOUHEI Graduate School of Informatics Assistant Professor,TAKEUCHI KOH Graduate School of Informatics Assistant Professor,ARISAKA RYUTA Graduate School of Informatics Assistant Professor,SEO Stela Hanbyeol

Target year	2nd year students or above	Number of credits	2	Year/semesters	2022/First semester
Days and periods	Wed.3,4	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

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

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

Continue to 計算機科学実験及演習 1 (2)↓↓↓

計算機科学実験及演習１(2)

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

Course number	U-ENG29 39140 LJ12		
Course title (and course title in English)	メディア情報処理 Mutimedia Processing	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KAWAHARA TATSUYA Academic Center for Computing and Media Studies Professor,NAKAMURA YUUICHI Academic Center for Computing and Media Studies Professor,MORI SHINSUKE

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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

[Course schedule and contents]

Speech processing (Kawahara)
1. Information in speech and music
2. Speech analysis
3. Speech recognition and synthesis
4. Spoken dialogue systems

Natural language processing (Mori)
5. Natural language analysis
6. Language model and Kana-Kanji conversion
7. Machine translation and Question Answering

Image Processing (Nakamura)
8. Composition and handling of image media
9. Color and perception
10. Signal Processing and Filtering (1): Basics of Filtering
11. Signal processing and filtering (2): feature extraction
12. Projection and reflection models and computer graphics
13. 3-D Perception and Computer Vision
14. Image recognition and neural networks

15. Examination and Feedback

[Course requirements]

None

Continue to メディア情報処理(2)↓↓↓

メディア情報処理(2)

[Evaluation methods and policy]

Based on the examination following the course

[Textbooks]

Lecture slides are provided via PandA CMS.

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

Exercises included in lecture slides.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG29 39141 SJ11		
Course title (and course title in English)	情報セキュリティ演習 Practice in Information Security	Instructor's name, job title, and department of affiliation	Academic Center for Computing and Media Studies Professor,OKABE YASUO Academic Center for Computing and Media Studies Assistant Professor,Kotani Daisuke

Target year	3rd year students or above	Number of credits	1	Year/semesters	2022/Intensive, First semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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 objectives]

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.

[Course requirements]

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

[Evaluation methods and policy]

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)

[Textbooks]

Hand out materials in class.

[References, etc.]

（Reference books）

Introduced during class

（Related URLs）

https://www.seccap.jp/basic/(This class is designated as an exercise course in the Basic SecCap program.)

[Study outside of class (preparation and review)]

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

（Other information (office hours, etc.)）

It is assumed that students will bring their own laptop computers. If you cannot bring your own, please contact the instructor in charge in advance.

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 39142 LJ72　U-ENG29 39142 LJ55　U-ENG29 39142 LJ10		
Course title (and course title in English)	情報符号理論続論（数理） Mathematical theory of information and communications	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Associate Professor,OBUCHI　TOMOYUKI Graduate School of Informatics Associate Professor,HONDA JUNYA

Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Tue.3	Class style	Lecture	Language of instruction	Japanese

[Overview 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 objectives]

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 (3 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 (4 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.

Mid-term review of learning achievement (1 class)
In order to check the level of students' learning achievement, we will ask them to write some reports and give them feedback through questions and explanations about the reports.

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

Network information theory (1 class)
Thanks to the development and spread of information and communications technologies, one-to-one

Continue to 情報符号理論続論（数理）(2)↓↓↓

情報符号理論続論（数理）(2)

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.

Final review of learning achievement (1 class)
In order to check the level of students' learning achievement, we will ask them to solve problems/questions etc., related to the course, and further advice will be provided.

[Course requirements]

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.

[Evaluation methods and policy]

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

[Textbooks]

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.）

[References, etc.]

（Reference books）

Other materials will be introduced in class as necessary.

[Study outside 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.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	プログラミング演習（数理:H31以降入学者） Exercise on Programming	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Assistant Professor,HARADA KENJI Graduate School of Informatics Assistant Professor,IWASAKI ATSUSHI Graduate School of Informatics Assistant Professor,NEMOTO TAKAHIRO

Target year	2nd year students or above	Number of credits	4	Year/semesters	2022/First semester

Days and periods	Mon.3,4	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

C言語によるプログラミング実習を行う。手続き型言語を用いたプログラミングの基礎となる、データ型・演算子・配列・関数・条件分岐・繰り返し処理・多次元配列・ファイル操作等を、数理工学での基礎的なアルゴリズム実装を題材にして学ぶ。

[Course objectives]

数理工学の各分野において、コンピュータを有効活用するために必要なプログラミングの知識と技術を修得する。

[Course schedule and contents]

第1回　ガイダンスとレポートの書き方
　　レポートの適切な書法と各種ツールの活用について学ぶ。

第2回～第4回　手続き型言語入門・条件分岐と繰り返し構造と関数
　　基本的な文法、基本的なデータ型、基本的な関数とそれを用いたサンプルプログラミングの実行方法までを学び、プログラムの基本パーツである条件分岐や繰り返し構造、関数について、数値積分（台形公式）、1変数非線形方程式の解法（ニュートン法）などのアルゴリズム実装を題材にして学ぶ。

第5回～第9回　多次元配列
　　多次元配列の使い方を、基本的な行列演算、行列固有値問題の数値解法（べき乗法）、線形方程式の数値解法（ガウスの消去法）などのアルゴリズム実装を題材に学ぶ。

第10回～第14回　データ構造とファイル操作
　　リストやツリーなどのデータ構造を表現するために、構造体、ポインタ、動的メモリ確保などをソーティングや動的計画法などのアルゴリズム実装を題材に学ぶ。さらに、ファイルからのパラメータ入力や結果の出力やリダイレクトを組み合わせたコード作成についても学ぶ。

第15回　学習到達度の確認
　　プログラミング技術の到達度を確認する。

[Course requirements]

本演習はBYODで行うため、演習時には各自ノートPCを持参すること。

Continue to プログラミング演習（数理:H31以降入学者）(2)↓↓↓

プログラミング演習（数理:H31以降入学者）(2)

[Evaluation methods and policy]

各項目ごとに出されるレポートと出席状況に基づき総合的に成績評価を行う。

[Textbooks]

Not used

[References, etc.]

（Reference books）
皆本晃弥 『やさしく学べるC言語入門』（サイエンス社）ISBN:978-4781913599
後藤良和、高田大二、中島寛和 『入門C言語』（実教出版）ISBN:978-4-407-33283-4
柴田望洋 『新・明解C言語 入門編』（SBクリエイティブ）ISBN:978-4797377026

[Study outside of class (preparation and review)]

演習時間を有効的につかうために、配布資料に基づく予習を行うこと。

（Other information (office hours, etc.)）

初回ガイダンスへの出席を必須とする。

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 19144 LJ10		
Course title (and course title in English)	最適化入門 Introduction to Optimization	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,YAMASHITA NOBUO

Target year	1st year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Thu.4	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

数理最適化は，データ解析や機械学習，金融工学など様々な分野で使われる基礎的技術である． 数理最適化の基本的な方法のひとつである線形計画法を中心に、数理最適化モデルの構築法や線形計画問題の解法について講述する。

本科目は「線形計画」の科目名を変更したものである。「線形計画」を既に習得済みの場合は、本科目を習得しても卒業に必要な単位とならない。

[Course objectives]

基本的な最適化モデルの考え方と定式化手法を習得するとともに，線形計画問題の理論的性質と解法を理解する．

[Course schedule and contents]

数理最適化とは,1回,数理最適化の概要を紹介する．また，本授業で必要となる数学的事項，特に線形代数について復習する．
数理最適化モデル,4回,代表的な数理最適化モデルである線形計画モデル、ネットワーク最適化モデル、非線形最適化モデル、組合せ最適化モデルを，機械学習などにあらわれる簡単な例を用いて紹介する。
線形計画問題と基底解,2回,線形計画問題を標準形に定式化し、基底解、実行可能基底解、最適基底解などの基本的な概念を説明する。
シンプレックス法(単体法),2回,線形計画問題の古典的な解法であるシンプレックス法(単体法)の基本的な考え方とその具体的な計算法について述べる。さらに、実行可能解を見出すための二段階法を説明する。
双対性と感度分析,3回,線形計画問題の重要な数学的性質である双対性について述べ、さらに問題を総合的に分析し意思決定を行う際に非常に有力な手段である感度分析の考え方を説明する。
発展的話題,2回,上回生科目である「最適化」につながる最適化の理論やアルゴリズムの考え方について述べる。
補足とまとめ,1回,講義内容のまとめ、補足および学習到達度の確認を行う。

[Course requirements]

線形代数の基本的な事項(行列とベクトルの掛け算，2×2の行列の逆行列計算など)を履修していることが望ましい．

Continue to 最適化入門(2)↓↓↓

最適化入門(2)

[Evaluation methods and policy]

期末試験の成績による.

[Textbooks]

福島雅夫 『新版・数理計画入門』（朝倉書店）ISBN:9784254280043

[References, etc.]

（Reference books）

Introduced during class

[Study outside of class (preparation and review)]

授業前に，必要とする線形代数を復習すること.
また，授業で指示したスライドは一読すること.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number					
Course title (and course title in English)	流体力学（数理） Fluid Dynamics		Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,TAGUCHI Satoshi	
Target year	3rd year students or above	Number of credits	2	Year/semesters	2022/Second semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

流体（液体・気体）や弾性体をはじめとする連続体の力学的挙動を理解するための入門として，流体力学の初歩について講義する。内容は流体力学に焦点をあてるが弾性体についても多くの事項は共通である。

[Course objectives]

流体の変形および運動を解析するための基礎的事項および数理的手法を習得することを目標とする。とくに微分方程式等を通した流体運動の記述やその解析における微分積分学の役割を理解し，流体運動の初等的な解析ができるようになること。完全流体、粘性流体の物理的および数理的特徴に関する理解を深めること。

[Course schedule and contents]

第1回　連続体の概念
連続体の概念について説明し，連続体を取り扱う方法の大枠を述べる。質点系の力学と連続体の力学の類似点，相違点について説明する。

第2回　物質微分と加速度
連続体の記述ラグランジュ的記述とオイラー的記述について説明する。物質微分（ラグランジュ微分）を導入する。流体における速度と加速度について説明する。

第3回　質量保存則と輸送定理
質量保存則である連続の式を導く。またレイノルズの輸送定理を導く。非圧縮性の意味を説明する。

第4～5回　連続体の運動方程式
運動方程式を導く準備として応力を導入する。その物理的意味，表現法（応力ベクトル，応力テンソル）について説明する。さらに，接線応力と法線応力，および主応力と応力の主軸について説明する。ニュートンの運動方程式から応力テンソルを用いた連続体の運動方程式を導く。

第6回　エネルギー方程式
エネルギーの保存則から，応力テンソルと熱流ベクトルを用いた連続体のエネルギー方程式を導く。３保存則（連続の式，運動方程式，エネルギー方程式）を概観しまとめる。

第7回　連続体の局所運動の表現
流体の局所変形を記述するために歪み速度テンソルを導入し，その意味について説明する。渦度を導入する。連続体の局所運動が局所変形と局所回転の合成であることを示す。

Continue to 流体力学（数理）(2)↓↓↓

流体力学（数理）(2)

第8回　ナビエ・ストークス方程式
ニュートン流体を定義する。ニュートン流体における歪み速度テンソルと応力テンソルの関係式について説明し，圧力の意味付けおよび粘性係数の定義と意味について説明する。熱流に対するフーリエの法則を説明する。これらをもとに粘性流体の支配方程式であるナビエ・ストークス方程式系を導く。方程式とともに用いられる境界条件について説明する。さらに非圧縮性流体に対するナビエ・ストークス方程式を導く。

第9回～10回　粘性流体の力学
ナビエ・ストークス方程式の厳密解としてクエット流やポワズイユ流といった基本的な流れを説明する。また，レイノルズの相似法則とレイノルズ数の意味を説明する。平行二平板間の流れ，円柱を過ぎる流れなどの代表的な流れについて，その特徴や関連した重要な概念（流れの安定性，乱流への遷移，境界層とその剥離，渦度とカルマン渦列など）を説明する。

第11回～12回　非粘性流体の力学
完全流体の基礎事項について述べる。オイラー方程式からベルヌーイの定理を導き，その意味を説明する。また渦に関連して循環を導入し，非粘性流体で成り立つ渦の諸定理を説明する（ケルビンの循環定理，ヘルムホルツの渦定理）。

第13回　圧縮性流体と音波
圧縮性流体の基礎方程式に基づいて，音波の性質を説明する。

第14回　総括
講義の振り返りを行う。連続体理論の優れたところを概観するとともにその限界についても述べる。

<<期末試験>>

第15回　フィードバック

履修者の理解度や当該年度の講義の進み具合を考慮して、一部の内容を変更する場合がある。

[Course requirements]

微分・積分の基礎的事項（とくに偏微分，線積分，面積分，体積積分など），線形代数の基礎的事項（直交行列，対称行列，固有値，固有ベクトル，行列の対角化など），力学の基礎的事項（質点の運動。力のモーメント，角運動量保存則など），ベクトル解析の基礎的事項（内積，ベクトル積，発散(div)，回転(rot)，勾配(grad)，ラプラシアンなど）。

[Evaluation methods and policy]

到達目標に対する達成度を定期試験の結果に基づいて評価を行うことを原則とするが、詳細は講義開始時に説明する。

[Textbooks]

Not used

Continue to 流体力学（数理）(3)↓↓↓

流体力学（数理）(3)

[References, etc.]

（Reference books）

Introduced during class

[Study outside of class (preparation and review)]

予習・復習が必要であり、授業で導出した式やその内容は復習を通して各自で理解しておくことが求められる。また、レポート課題が指示された場合は、その内容をよく理解しておくこと。

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 49991 GJ12　U-ENG29 49991 GJ11　U-ENG29 49991 GJ10		
Course title (and course title in English)	特別研究１（計算機） Graduation Thesis 1	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KASHIMA HISASHI

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/Intensive, First semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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 objectives]

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

[Course requirements]

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。

[Evaluation methods and policy]

一連の研究活動の実施状況に基づいて行う。

[Textbooks]

各学生の研究課題に応じて教員が指示する。

[References, etc.]

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

[Study outside of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Other information (office hours, etc.)）

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Course number	U-ENG29 49991 GJ12　U-ENG29 49991 GJ11　U-ENG29 49991 GJ10		
Course title (and course title in English)	特別研究１（計算機） Graduation Thesis 1	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KASHIMA HISASHI

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/Intensive, Second semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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。

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[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１２～１５回　先行研究の調査等

[Course requirements]

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。

[Evaluation methods and policy]

一連の研究活動の実施状況に基づいて行う。

[Textbooks]

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[References, etc.]

（Reference books）
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[Study outside of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 49991 GJ12　U-ENG29 49991 GJ11　U-ENG29 49991 GJ10		
Course title (and course title in English)	特別研究１（数理） Graduation Thesis 1	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,TAGUCHI Satoshi

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/Intensive, First semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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 objectives]

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１０～１１回　研究計画の立案
第１２～１５回　先行研究の調査等

[Course requirements]

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。

[Evaluation methods and policy]

一連の研究活動の実施状況に基づいて行う。

[Textbooks]

各学生の研究課題に応じて教員が指示する。

[References, etc.]

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

[Study outside of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 49991 GJ12　U-ENG29 49991 GJ11　U-ENG29 49991 GJ10		
Course title (and course title in English)	特別研究１（数理） Graduation Thesis 1	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,TAGUCHI Satoshi

Target year	4th year students or above	Number of credits	2	Year/semesters	2022/Intensive, Second semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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 objectives]

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１０～１１回　研究計画の立案
第１２～１５回　先行研究の調査等

[Course requirements]

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。

[Evaluation methods and policy]

一連の研究活動の実施状況に基づいて行う。

[Textbooks]

各学生の研究課題に応じて教員が指示する。

[References, etc.]

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

[Study outside of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 49992 GJ12　U-ENG29 49992 GJ11　U-ENG29 49992 GJ10		
Course title (and course title in English)	特別研究２（計算機） Graduation Thesis 2	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KASHIMA HISASHI

Target year	4th year students or above	Number of credits	3	Year/semesters	2022/Intensive, First semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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 objectives]

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

[Course requirements]

「特別研究１」を修得済みであること。

[Evaluation methods and policy]

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。

[Textbooks]

各学生の研究課題に応じて教員が指示する。

[References, etc.]

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

[Study outside of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 49992 GJ12　U-ENG29 49992 GJ11　U-ENG29 49992 GJ10		
Course title (and course title in English)	特別研究２（計算機） Graduation Thesis 2	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KASHIMA HISASHI

Target year	4th year students or above	Number of credits	3	Year/semesters	2022/Intensive, Second semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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。

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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。

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第１３～１４回　報告書の作成
第１５回　　試問会での発表準備

[Course requirements]

「特別研究１」を修得済みであること。

[Evaluation methods and policy]

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。

[Textbooks]

各学生の研究課題に応じて教員が指示する。

[References, etc.]

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

[Study outside of class (preparation and review)]

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（Other information (office hours, etc.)）

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Course number	U-ENG29 49992 GJ12　U-ENG29 49992 GJ11　U-ENG29 49992 GJ10		
Course title (and course title in English)	特別研究２（数理） Graduation Thesis 2	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,TAGUCHI Satoshi

Target year	4th year students or above	Number of credits	3	Year/semesters	2022/Intensive, First semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview 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。

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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

[Course requirements]

「特別研究１」を修得済みであること。

[Evaluation methods and policy]

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。

[Textbooks]

各学生の研究課題に応じて教員が指示する。

[References, etc.]

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

[Study outside of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG29 49992 GJ12　U-ENG29 49992 GJ11　U-ENG29 49992 GJ10		
Course title (and course title in English)	特別研究２（数理） Graduation Thesis 2	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,TAGUCHI Satoshi

Target year	4th year students or above	Number of credits	3	Year/semesters	2022/Intensive, Second semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

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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

[Course requirements]

「特別研究１」を修得済みであること。

[Evaluation methods and policy]

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。

[Textbooks]

各学生の研究課題に応じて教員が指示する。

[References, etc.]

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

[Study outside of class (preparation and review)]

各学生の研究課題に応じて教員が指示する。

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.