| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Thermo-Physical Engineering | | | Tetsuaki Takeda / Koji Toriyama / Shumpei Funatani | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV701 | 2 | System Integration Engineering Course | 2nd Semester | Wed.／II | Japanese |

[Outline and purpose]

It is a technologically important problem to increase the conversion efficiency of the thermal energy. Transport, storage, and conversion of the thermal energy are explained. In addition, effective utilization of thermal energy in the practical system is described.

[Objectives]

Generation, conversion, and use of the thermal energy can be understood.
The utilization efficiency of the thermal energy can be evaluated.

[Requirements]

Thermodynamics, Hydrodynamics, Thermal engineering, Fluid engineering, Numerical analysis

[Evaluation]

Report & examination : 60%
Presentation skill : 40%

[Textbooks]

Not specify

[References]

Not specify
Distribute research papers, if necessary

[Schedule]

1 Introduction
2-4 Production, storage, and transport of thermal energy
5 Evaluation of thermal energy system by theoretical approach and numerical analysis
6-8 Heat transport by thermal conduction, forced convection, natural convection, and thermal radiation
9-10 Conversion system of thermal energy and thermal efficiency
11-12 Renewable energy systems, such as solar thermal energy, wind energy, hydraulic energy, geothermal energy, etc.
13 Nuclear energy system and nuclear safety
14 Flow visualization techniques
15 Heat utilization systems such as thermoelectric conversion element, ground source heat pump system, etc.

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Turbulent Transport Engineering | | | Hiroyuki Tsunoda / Yoshinobu Yamamoto | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV702 | 2 | System Integration Engineering Course | 2nd Semester | Fri.／I | Japanese |

[Outline and purpose]

Many of practical flows appearing in the field of mechanical engineering are turbulent of high Reynolds numbers. Turbulent flow is known to have remarkably effective transport ability in comparison with laminar flow. In order to understand physical features of the turbulent flow, students will study the fluid-mechanical difference between laminar and turbulent flows, flow instability problems related with the turbulence transition and the statistical properties of turbulence. Then, the fundamental ideas how the turbulent flow is statistically described are discussed in the case of isotropic turbulence for which theoretical approaches have been completed as being most elementary and simplest turbulent flow. These statistical techniques for the isotropic turbulence can be applied to the analysis of more practical anisotropic turbulent shear flows such as pipe flow, boundary-layer flow or free shear flows. By investigating the momentum and thermal transport equations, students will learn experimental and numerical analysis methods for these flows.

[Objectives]

In the design and the development of various machines or apparatuses, there are many practical problems related with fluid engineering. This course aims to educate engineers who can manage these problems and moreover who have an ability to apply their knowledge to the creation of new technology. For this objective, students are expected to complete the following goals:

1. to understand the fundamental idea of turbulence
2. to understand the statistical methods for analyzing turbulent flows and to apply them to practical flows
3. to discuss turbulent flows based on the governing equations

[Requirements]

Overall knowledge on fluid engineering and fluid dynamics studied in the under-graduate and graduate courses, fundamental and applied knowledge on calculus, fundamental knowledge on vector calculus

[Evaluation]

homework：80%
presentation：20%

[Textbooks]

[References]


1. Davidson, P.A.: Turbulence: An Introduction for Scientists and Engineers, Oxford Univ. press, 2004, ISBN 0198529481
2. 日野幹雄 ： 流体力学, 朝倉書店, ISBN 4254200668 (in Japanese).
3. Tennekes, H. and Lumley, J.L.：A First Course in Turbulence, The MIT press, 1972, ISBN 0262200198.
4. Pope, S.B.：Turbulent Flows, Cambridge University Press, 2000, ISBN 0521598869.


[Schedule]

1. Introduction
2. Laminar and turbulent flows #1
3. Laminar and turbulent flows #2
4. Flux and turbulent transport
5. Isotropic turbulence #1
6. Isotropic turbulence #2
7. Reynolds equations
8. Turbulent shear flows
9. Turbulent flow in pipe
10. Boundary layer
11. Free shear flows
12. Several turbulence models and DNS
13. Measurement techniques of turbulent flows #1
14. Measurement techniques of turbulent flows #2
15. Summary

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Materials Engineering | | | Yoshihiro Nakayama / Yasumi Ito/ Yoshiyuki Kagiyama | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV703 | 2 | System Integration Engineering Course | 1st Semester | Fri.／I | Japanese |

[Outline and purpose]

The aim of this module is to introduce students to the advanced materials researches, which include metallic materials, biocompatible materials, and biomaterials, and to provide students with in-depth knowledge of "materials science". In the first half of the term, we will focused on structural characteristics of metallic materials and the application examples. In the latter half of the term, we will focused on biocompatible materials, which have been developed in medical engineering, and failure accident investigation of machines and structures.

[Objectives]

1. To understand the advanced applications of metallic materials and biocompatible materials
2. To understand the safety evaluation of metallic materials and biocompatible materials
3. To understand the failure accident investigating method of machines and structure

[Requirements]

Materials science and engineering
Basic strength of materials

[Evaluation]

Homework: 50%
Presentation work: 50%

[Textbooks]

N. A.

[References]

伊藤安海，鍵山善之，イラスト医工学　ーバイオメカニクスから医療機器・科学捜査までー，アドスリー，ISBN:978-4-904419-69-4

[Schedule]

1. Orientation, Metallic materials for infrastructure materials
2. Structure and properties of metallic materials
3. Application example 1 of metallic materials
4. Application example 2 of metallic materials
5. Research trend of metallic materials
6. Metallic materials in medical applications
7. Biocompatible materials
8. Artificial joint implants
9. Finite element analysis of artificial joint implants
10. Advanced researches in medical engineering
11. Biomechanical material and biomechanics
12. Mechanical properties of biological tissue
13. Material and dynamics in medical engineering
14. Failure accident investigating method of machines and structures from mechanical property
15. Psychiatry theoretical structure based on strength of materials and summary

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Material and Manufacturing Processing | | | Yasutake Haramiishi / Yoshiaki Ukita | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV704 | 2 | System Integration Engineering Course | 1nd Semester | Tue.／III | Japanese |

[Outline and purpose]

In the production processing science, it is necessary to understand mutual properties in addition to knowledge of materials, tools, and machine tools. These fields are various, but in this lecture we will study and understand current research cases in the field of production processing and machine tools.

[Objectives]

Understand the classification and characteristics of various processing methods used in the manufacture of industrial products.In addition, understand the latest machining technology, machine tools, tools, grinding wheels, machining measurement, machining control, NC, production systems, automation technology.

[Requirements]

Fundamental knowledge of material mechanics, plastic deformation and industrial materials of undergraduate level.

[Evaluation]

Periodic examination: 50%
Homework and report: 50%

[Textbooks]

[References]

1.機械工作法, 平井三友、和田任弘、塚本晃久,コロナ社, ISBN:4339044814
2.機械加工学の基礎, 奥山繁樹, 宇根篤暢, 由井明紀, 鈴木浩文,コロナ社, ISBN:978-4339046328
3.工業塑性力学, 益田森治, 室田忠雄,養賢堂
4.研削加工と砥粒加工, 河村末久, 矢野章成, 樋口誠宏, 杉田忠彰, 共立出版, ISBN:978-4320080324
5.弾塑性力学の基礎, 吉田総仁, 共立出版

[Schedule]

1 Introduction
2 Understand the basics of cutting, grinding, polishing, precision processing, etc.
3 Understand the basics of electro-discharge machining, laser machining, and chemical machining.
4 Understand the basics of forming and shaping.
5 Understand the basics of machines, tools, grinding wheel, and abrasive grains.
6 Understand the basics of machining measurement, machining control, NC(Numerical Control), etc.
7 Understand the basics of production systems, automation technology, and eco-machining.
8 ~ 14 Research survey and presentation.
15 General overview and periodic examination.

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Transportational Systems Engineering | | | Junichiro Aoyagi / Shigenobu Okazawa | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV706 | 2 | System Integration Engineering Course | 1nd Semester | Mon.／II | Japanese/ Englixh |

[Outline and purpose]

Comprehensive transportation systems engineering about automobile and spacecraft will understand through this lecture.

[Objectives]

To be well explainable the following subjects:
*Computational method to evaluate performance of automobile
*Strength, vibration and impact analysts for automobile
*Optimize design of automobile
* Design concept of a spacecraft and its mission
* Spacecraft subsystems and its required specification
* Principle of space propulsion and orbit transfer

[Requirements]

Deeply knowledge of mechanical engineering such as mechanics, thermodynamics, fluid dynamics and material dynamics, as well as mathematics and English

[Evaluation]

Report and presentation about space engineering/ 50 %
Report and presentation about automobile engineering/ 50 %

[Textbooks]

Peter Fortescue, Graham Swinerd and John Stark, Spacecraft Systems Engineering, Wiley, 9780470750124

[References]

[Schedule]

01.(Aoyagi) Spacecraft environment and its effect on design
02.(Aoyagi) Dynamics of spacecraft
03.(Aoyagi) Celestial mechanics
04.(Aoyagi) Mission analysis
05.(Aoyagi) Propulsion systems
06.(Aoyagi) Spacecraft structures
07.(Aoyagi) Thermal control of spacecraft
08.(Okazawa) Development and manufacturing of automobile
09.(Okazawa) History and environment of automobile
10.(Okazawa) Model-based design of automobile
11.(Okazawa) Technology in performance evaluation of automobile 1
12.(Okazawa) Technology in performance evaluation of automobile 2
13.(Okazawa) Structural analysis of automobile
14.(Okazawa) Impact safety of automobile
15.(Aoyagi and Okazawa) Conclusion

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Color Image Technology | | | Shinji Kotani<br>Hiromi Watanabe | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV707 | 2 | System Integration Engineering Course | 1<br>nd<br>Semester | Wed.／Ⅳ | Japanese |

[Outline and purpose]

Starting with how our eyes recognize color, we will explain important issues such as color space, measurement of color and their practical applications for engineering design.

[Objectives]

1. Being able to explain how our eyes recognize colors.
2. Understand several color systems and difference between them.
3. Instrument of measuring color
4. translate Analog figures to digital ones
5. Get used to tools for handling color and simulate color images on PC.

[Requirements]

Fundamental knowledge about spectra of light and some mathematical skill for vector space

[Evaluation]

final examination: 50%
presentation: 50%

[Textbooks]

Not Specified.

[References]

Not Specified.

[Schedule]

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Wave Application Engineering | | | Takaaki Ishii / Toshiya Kitamura | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV708 | 2 | System Integration Engineering Course | 2nd Semester | Wed.／Ⅳ | Japanese |

[Outline and purpose]

Wave is basic physical phenomenon. A lot of applications are widely used in our society and understanding wave technology is very important. Deep and thorough understanding of the fundamentals and applications of wave is greatly expected in this course.

[Objectives]

1. to understand the fundamentals and applications of the wave

[Requirements]

Fundamental knowledge of the acoustics, physics, mathematics, chemistry, materials, mechanical engineering, electrics and electronic engineering, etc.

[Evaluation]

Report：80%
Attitude：20%

[Textbooks]

None

[References]

1. 山田伸志, 黒崎茂, 小坂敏文, 松村志真秀, 吉村靖夫, 渡辺敏夫：振動工学入門, パワー社 2001 年 (in Japanese)
2. Kenji Uchino：Ferroelectric devices, Marcel Dekker (2000)
3. Kenji Uchino, Jayne Giniewicz：Micromechatronics, Marcel Dekker (2003)
4. 城戸健一：ディジタルフーリエ解析(II), コロナ社 2007 年 (in Japanese)

[Schedule]

1. Fundamentals and applications of ferroelectrics
2. Fundamentals and applications of ultrasonics
3. Fundamentals and applications of the acoustics
4. Measurements and applications of the analysis technology

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Wave Application Engineering | | | Takaaki Ishii / Toshiya Kitamura | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV708 | 2 | System Integration Engineering Course | 2nd Semester | Wed.／Ⅳ | Japanese |

[Outline and purpose]

Wave is basic physical phenomenon. A lot of applications are widely used in our society and understanding wave technology is very important. Deep and thorough understanding of the fundamentals and applications of wave is greatly expected in this course.

[Objectives]

1. to understand the fundamentals and applications of the wave

[Requirements]

Fundamental knowledge of the acoustics, physics, mathematics, chemistry, materials, mechanical engineering, electrics and electronic engineering, etc.

[Evaluation]

Report：80%
Attitude：20%

[Textbooks]

None

[References]

1. 山田伸志, 黒崎茂, 小坂敏文, 松村志真秀, 吉村靖夫, 渡辺敏夫：振動工学入門, パワー社 2001 年 (in Japanese)
2. Kenji Uchino：Ferroelectric devices, Marcel Dekker (2000)
3. Kenji Uchino, Jayne Giniewicz：Micromechatronics, Marcel Dekker (2003)
4. 城戸健一：ディジタルフーリエ解析(II), コロナ社 2007 年 (in Japanese)

[Schedule]

1. Fundamentals and applications of ferroelectrics
2. Fundamentals and applications of ultrasonics
3. Fundamentals and applications of the acoustics
4. Measurements and applications of the analysis technology

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Applied Robotics | | | Hidetsugu Terada/Kazuyoshi Ishida | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV709 | 2 | System Integration Engineering Course | 2nd Semester | Mon.／II | Japanese |

[Outline and purpose]

Learning about the mechanism and control of robots by the latest robotics papers, then the design method of robots will be discussed.

[Objectives]

(1) to understand the structure of robot mechanism and be able to design various robots.
(2) to understand professional item of robot control technology.
(3) to understand the latest trends in robotics research

[Requirements]

Grounding in calculus, algebra, knowledge of kinematics, dynamics, mechanical design and material, assuming knowledge of robotics. Also and in some cases, the materials are written in English.

[Evaluation]

1. Small test and Presentation 80%
2. Routine test and Report 20%

[Textbooks]

Textbook is not used. Materials will be provided.

[References]

1. Control system design, McGRAW-HILL, ISBN:0486442780
2. SIGNALS AND LINEAR SYSTEMS,Jhon Wiley & Sons,ISBN:0471838217
3. 現代制御理論入門, コロナ社, ISBN:4339031615 (In Japanese)
4. Mark E. Rosheim, Robot Evolution -The Development of Authrobotics-, John Wiley & Sons, Inc., ISBN:0471026220

[Schedule]

Do a lecture on the content of the following from the perspective of designing a robot.
1. Mechanism of the robot (1-5 times)
To discuss about the forward kinematics and the inverse kinematics solution and the derivation techniques of three-dimensional mechanism with the singular points analysis of serial and parallel robots, focusing on the differences in particular.
2. Robot control (6 to 10)
To discuss about the control algorithm of Point to Point and Continuous path control, explaining about the practical path control and interpolation method. Communication systems and servo mechanism with the examples be explained.
3. Intelligent Robots (11 times to 15 times)
To discuss how intelligent robot will be constructed using smart sensor system, and be explained a variety of image recognition techniques and algorithms in robot.

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Human-Machine Interface | | | Yoshimi Suzuki / Hiromitsu Nishizaki | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV710 | 2 | System Integration Engineering Course | 2nd Semester | Fri.／Ⅳ | Japanese |

[Outline and purpose]

In this course, the lecturers instruct on some information technologies which help a human-machine (robot) communication. For example, the lecturers explain on speech processing, natural language (text) processing, and image processing. In addition, they also explain artificial intelligence algorithms such as deep learning and genetic algorithm.

[Objectives]

(1) The students can understand artificial intelligence (AI) algorithms (such as deep learning and genetic algorithm) and can program AI-related processing.
(2) The students can make some applications on a robot or a computer using these AI-related algorithms.

[Requirements]

Programming skills for Python languages are required.

[Evaluation]

Reports: 100%

[Textbooks]

Nothing

[References]

Kohji Makino et al., "Deep Learning with arithmetic & Raspberry Pi," CQ publishing Co. Ltd., 2018
(牧野浩二ほか，算数&ラズパイから始めるディープラーニング，CQ 出版社，2018)

[Schedule]

1. Introduction (outline of AI technologies)
2. Outline of speech processing
3. Outline of natural language processing
4. Deep learning basic edition No.1: neural network
5. Deep learning basic edition No.2: convolutional neural network
6. Deep learning basic edition No.3: recurrent neural network
7. Deep learning advanced No.1: application for speech processing
8. Deep learning advanced No.2: application for temporal sequence data
9. Deep learning advanced No.3: application for image processing
10. Deep learning advanced No.4: application for text processing
11. Genetic algorithm basic edition
12. Genetic algorithm advanced edition
13. Discussion of recent research on AI No.1
14. Discussion of recent research on AI No.2
15. Discussion of recent research on AI No.3

【Note】This is an example of the course content. The purpose of this course is to learn more about the relationship between artificial intelligence and humans. The content of the course will be designed in consideration of the students.

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Robot Design | | | Shinji Kotani / Miyoshi Okamura /Shin-ichiro Hira / Tsutomu Tanzawa | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV711 | 2 | System Integration Engineering Course | 1nd Semester | Fri.／III | Japanese |

[Outline and purpose]

In order to design a robot, it is indispensable to integrate engineering systems of mechanical technology, electronic technology, information communication technology, control technology.
The purpose of this class is to cultivate indispensable essentials for robot design.

[Objectives]

・to explain the purpose, background and meaning of the robot to be designed
・to decide and explain mechanism, actuator, electronic, information communication, and control system
・to propose and explain evaluation method of the designed robot

[Requirements]

Basic knowledge of mathematics, physical, mechanical elements, material dynamics, electronic circuits and measurement engineering

[Evaluation]

assignment 25%、presentation 25%、discussion 50%

[Textbooks]

specify in the class

[References]

specify in the class

[Schedule]

1. Introduction of conventional Robot Design
2. Requests to Robots under various environments
3. Ethics and Philosophy in Robot Design
4. Autonomous Robot
5. Symbiosis of Humans and Robots
6. Summary ( presentation & discussion)
7. Materials (1)_Structural Materials (guide for choice, strength tests, processing methods)
8. Materials (2)_Functional Materials (purpose of use, application cases)
9. Structure ( mechanism, actuator)
10. Summary ( presentation & discussion)
11. Sensing
12. Software , Network
13. Electronic Circuit , Safety Function
10. Summary ( presentation & discussion)
15. Presentation & Discussion

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Optical Engineering | | | Masayuki Morisawa /Tsuyoshi Shimizu / Lianhua Jin | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTV712 | 2 | System Integration Engineering Course | 1nd Semester | Mon.／Ⅳ | Japanese |

[Outline and purpose]

Numerous contemporary sensing techniques using optical methodology and image processing have been developed and applied to various products. Taking into consideration the rapid developments of prospective precision instruments and measurement instruments, acquisition of basic technology is extremely valuable. This course covers following optical sensing techniques and its applications.

1. Basic of polarization instrumentation and its application to nano-technology (Responsible: Prof. Jin)
2. Instrumentation with optical fiber and its application (Responsible: Prof. Morisawa)
3. Imaging processing and its application (Responsible: Prof. Shimizu)

This lecture aims to help the student cultivate fundamental ability to utilize above techniques to various engineering systems.

[Objectives]

(A) Understand polarization phenomenon and polarization measurements.
(B) Explain spectroscopic polarization instrumentation and its application.
(C) Understand the operation principles of optical fiber sensor for measurement of physical quantities such as temperature, pressure etc.
(D) Explain the operation principles of chemical optical fiber sensor for detection of various gases.
(E) Understand the geometry optics of the camera and illumination system.
(F) Explain the image processing method and its application.

[Requirements]

A grounding in algebra, analytics, statistics, and physics

[Evaluation]

Homework: 100%

[Textbooks]

[References]

[Schedule]

1. Reflection and polarized light
2. Polarization measurement system
3. Spectroscopic ellipsometry
4. Spectroscopic ellipsometry and nanotechnology
5. Summary (Part 1)
6. Fundamentals of optical fiber sensors
7. The optical fiber sensor for measurement of physical quantities
8. Fundamentals of chemical optical fiber sensor
9. Application of chemical optical fiber sensor
10. Summary (Part 2)
11. Geometric camera model and geometric camera calibration
12. Radiometry, lightning and image processing
13. Visual inspections
14. Image processing and machine learnings
15. Summary (Part 3)

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Optical Waves and Ultrasonic Engineering | | | Shoji Kakio | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTW702 | 2 | System Integration Engineering Course | 2nd Semester | Tue.／II | Japanese |

[Outline and purpose]

The development of high-performance communication devices that utilize optical waves and ultrasonic waves (elastic waves) is indispensable for the development of communication technology that supports the highly information-oriented society. The basis for this is an understanding of various linear and non-linear effects in functional materials, and the mechanism and operation of typical devices can be understood through lectures.

[Objectives]

The goal of this lecture is to understand the physics of high-performance communication devices that utilize optical waves and ultrasonic waves, and to be able to participate in discussions and proposals on the development and application of new communication devices.

[Requirements]

Understanding of electromagnetism is required.

[Evaluation]

Lecture comprehension: 100%

[Textbooks]

Lecture materials will be provided.

[References]

[Schedule]

1. Linear / nonlinear optical effects and optical wave propagation analysis in a medium
2. Application to high-performance optical devices
3. Physics and ultrasonic (elastic wave) propagation analysis in piezoelectric medium
4. Application to high-performance ultrasonic (elastic wave) devices

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Signal Processing | | | Makoto Ohki | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTW705 | 2 | System Integration Engineering Course | 2nd Semester | Fri.／II | English／Japanese |

[Outline and purpose]

This lecture treats topics of signal processing engineering, especially multi-dimensional signal processing and adaptive signal processing.

[Objectives]

1. to explain multi-dimensional signals
2. to explain multi-dimensional linear transforms such as the Fourier transform
3. to explain the multi-dimensional sampling theorem
4. to describe multi-dimensional systems using the transfer function or the state-space model
5. to explain how multi-dimensional filters work
6. to explain how fundamental multi-dimensional adaptive algorithms work

[Requirements]

fundamental knowledge of signal processing such as Fourier transform, Laplace transform, z-transform, the concept of filters

[Evaluation]

report: 100%

[Textbooks]

[References]

Woods, John W. : Multidimensional Signal, Image, and Video Processing and Coding (second edition), Academic Press, 2012.

[Schedule]

1. Multi-dimensional signals
2. Multi-dimensional Fourier transform
3. Multi-dimensional sampling theorem
4. Multi-dimensional Laplace transform and z-transform
5. Multi-dimensional systems
6. Multi-dimensional FIR filters
7. Multi-dimensional IIR filters
8. Multi-dimensional adaptive filters

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Software Development Engineering | | | Masakazu Takahashi / Yoshimichi Watanabe | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTW708 | 2 | System Integration Engineering Course | 2nd Semester | Mon.／V | Japanese |

[Outline and purpose]

Software engineering is a research domain which aims at the construction of the software based on information communication technology. System engineering includes several techniques, such as system development, quality, security, and safety.

This course develops the outline of software engineering, the fundamental knowledge to software development, construct a new business model or system, fundamental knowledge and techniques and skills for providing the solution services, analytical problem solving, design-problem solving, and the quality assurance of system solution.

[Objectives]

1. to understand the fundamental knowledge.
2. to understand the technology and skill which are needed in order to develop software.
3. to understand analytical problem solving and design-problem solving.
4. to understand the quality assurance of system solutions.
5. to understand matters required in order to develop a high quality solution and to acquire the means for constructing such a solution.

[Requirements]

Fundamental knowledge of software engineering, information processing, and quality management

[Evaluation]

report : 50%
discussion : 50%

[Textbooks]

[References]

[Schedule]

1. Concept of System Solution
2. Basic Technologies Supporting System Solution
   (1) Information technology
   (2) Analytical problem solving and design-problem solving
   (3) Quality assurance and customer satisfaction
3. Practical system solutions
   (1) The solution in a computer vender
   (2) The solution in a software provider
   (3) The solution in an information communication common carrier
4. Future works of system solution

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Artifact Design Methodology | | | Kentaro Go /Masaki Omata | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTW709 | 2 | System Integration Engineering Course | 2nd Semester | The.／V | Japanese |

[Outline and purpose]

In this lecture, we discuss information processing and communication as the essential nature of human activity, which includes human information processing, communication between human and artifact, human-to-human communication via artifact, and technology and design to realize these relationships. Topics in the lecture include:
1. models for human information processing and multi-modal interface
2. design methods for communication between human and artifact

[Objectives]

To understand the following topics:
1. models for human information processing and multi-modal interface
2. design methods for communication between human and artifact

[Requirements]

Basic knowledge on Human-Computer Interaction and multi-modal interfaces.

[Evaluation]

Report / presentation: 100%

[Textbooks]

Lecture handouts will be provided as necessary.

[References]

John M. Carroll (ed.), HCI Models, Theories, and Frameworks: Toward a Multidisciplinary Science, Elsevier, 2003.

[Schedule]

1. Introduction
[Lecturer: Masaki Omata]
2. Sensation and Perception
3. Multimodal Interfaces
4. Memory and Emotion
5. Affective and Physiological Interfaces
6. Practice: Collecting Behavioral and Physiological Metrics
7. Practice: Analysing Usability Metrics
8. Mid-term presentation
[Lecturer: Kentaro Go]
9. Interface Design
10. Interaction Design
11. Service and Experience Design
12. Practice: Survey and Research
13. Practice: Design
14. Practice: Evaluation
15. Final presentation

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Kansei and Intelligent Information Systems | | | Motonobu Hattori / Yuichiro Kinoshita /Masayuki Morisawa | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTW710 | 2 | System Integration Engineering Course | 2nd Semester | Fri.／V | Japanese |

[Outline and purpose]

Improvement in computing speed of today's computer is remarkable, and it is possible to instantaneously perform calculations that human beings can not solve even if it takes a lifetime. Meanwhile, information processing on Kansei and realization of higher-order information processing such as thinking and reasoning, which human beings are good at, are not yet sufficient. As necessary knowledge concerning such Kansei and intelligence information systems, this course aims at understanding to computational models imitating the information processing methods of the brain, understanding to the methods of analyzing and modeling Kansei information, and understanding to sensors which are input devices of Kansei information.

[Objectives]

1. To understand the basic information processing in artificial neural network models
2. To understand the basic methods of analyzing and modeling Kansei information
3. To understand the basic technology of the taste sensor

[Requirements]

A grounding in algebra, analytics, statistics, and physics

[Evaluation]

Homework: 100%

[Textbooks]

[References]

[Schedule]

(Computational models of the brain)
1. Biological neuron and neural network
2. Neuron and neural network models
3. Learning of neural network models
4. Examples of neural network models
5. Summary (Part 1)

(Kansei evaluation models)
6. Introduction to Kansei evaluation
7. Basic methods of multivariate statistics
8. Modelling with quantification theory
9. Modeling with fuzzy reasoning
10. Summary (Part 2)

(Taste sensors and electronic nose)
11. Taste sensors using the membrane potential change
12. Optical taste sensors
13. Electronic nose
14. Other sensor devices
15. Summary (Part 3)

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Speech and Acoustical Information Processing | | | Kenji Ozawa | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTW711 | 2 | System Integration Engineering Course | 2nd Semester | Tue.／V | Japanese |

[Outline and purpose]

Speech and acoustic information processing is an indispensable technology for developing human-computer interfaces. This course addresses the technology to separate sound signals from multiple sound sources. This is used for the preprocessing to extract only the speech signals of a specific user in order to improve the speech recognition accuracy under noisy environments. In addition, it leads to advanced applications such as extracting the sound of each musical instrument from the sound in which multiple musical instrument sounds are mixed. To realize this, we need to understand mathematical basics and artificial intelligence technology.

[Objectives]

1. To understand the history and the state-of-the-art technology related to speech information processing and array signal processing.
2. To understand how technologies related to speech information processing and array signal processing are used in the world, and to apply these techniques to actual problems.

[Requirements]

A grounding in mathematical analysis, linear algebra, and statistics

[Evaluation]

Report work and weekly examination: 100%

[Textbooks]

Masahito Togami, *Sound Source Separation with Python*, Impress Pub., Tokyo, 2020. (in Japanese)

[References]

F. Asano, *Acoustical Array Signal Processing,* Corona Pub., Tokyo, 2011. (in Japanese)
S. Makino, *Audio Source Separation* (*Signals and Communication Technology*), Springer, 2019.
K. Sekihara, *Bayesian Signal Processing*, Kyoritsu Pub., Tokyo, 2015. (in Japanese)

[Schedule]

The way of the lecture shall be decided in consultation with the students. (Face-to-face classes/ Live classes by MS-Teams/ Other options are also available)
1. Fundamentals of array signal processing, basic concept of sound source separation
2. Handling and visualization of voice data
3. Drawing spectrum and spectrograms
4. Mathematical basis for sound source separation
5. Optimization techniques
6. Sound synthesis by simulator
7. Classical sound source separation method (Part 1): Delay sum array, minimum variance beamformer
8. Classical sound source separation method (Part 2): Maximum SNR beamformer, Wiener filter
9. Sound source separation based on sound source direction estimation
10. Separation of sound sources based on statistical models (Part 1): Independent component analysis
11. Sound source separation based on statistical models (Part 2): Independent vector analysis and independent low-rank analysis
12. Sound source separation based on statistical model (Part 3): Multichannel variation Gaussian model
13. Reverberation removal
14. Integration of sound source separation and reverberation rejection
15. Summary

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Visual Computing | | | Xiaoyang Mao /Hidetoshi Ando /Masahiro Toyoura | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTW712 | 2 | System Integration Engineering Course | 2nd Semester | Mon.／IV | Japanese |

[Outline and purpose]

Visual computing is a term that describes all aspects of computer-based visual information processing technology. In this lecture, we will introduce the latest research and learn about advanced technologies related to image processing, computer graphics, data visualization, and the application of these technologies. The course will be mainly taught in an interactive style by referring to recently published research papers. Students will need to survey presentations. If COVID-19 infection has not ended, it will be carried out online.

[Objectives]

Acquire the latest knowledge and algorithms related to image processing, CG and data visualization.

[Requirements]

Basic knowledge about mathematics, image processing and computer graphics.

[Evaluation]

Students will be asked to do survey presentation and implement some new algorithms.

[Textbooks]

None.

[References]

Recently published research papers which will be specified by the instructors during the course.

[Schedule]

1. What is visual computing?
2. Object detection by deep learning
3. Image generation by deep learning
4. Image style transfering by deep learning
5. Visual computing and e-health
6. Visual computing and smart factories
7. Visual computing and smart farming
8. Real-time CG by GPU
9. Real-time CG technology application by GPU
10. GPU-based high-speed parallel computing and visualization
11. Digital fabrication
12. Modeling and printing
13. Sensor characteristics and data collection
14. Sensor data pattern analysis
15. Visualization of sensor data

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Computing Systems | | | Tomohiro Suzuki | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTW714 | 2 | System Integration Engineering Course | 2nd Semester | Tue.／II | Japanese |

[Outline and purpose]

In recent years, demand for both size and precision in scientific computing is increasing. In such computing, it is essential to use high-performance computers such as parallel computers using multi-core CPUs or ones with accelerators. Also, many scientific computations are resolved into solving the linear system of equations, and various fast algorithms are developed to solve them with high-performance computers. In this class, students will learn such programming technique and efficient algorithms in scientific computing.

[Objectives]

At the end of this course, the students should be able to acquire knowledge and skills for large-scale scientific computing with a high-performance computer.

[Requirements]

Programming skill (C or C++)

[Evaluation]

Papers (50%) Configuration of report writing and deepness of thinking about problems.
Presentation (50%) Comprehension level about the contents of the presentation.

[Textbooks]

Relevant materials will be presented during the lectures.

[References]

Relevant materials will be presented during the lectures.

[Schedule]

1. Introduction
2. Processor architecture
3. Parallel programming
4. Numerical linear algebra 1 (Linear system)
5. Numerical linear algebra 2 (Linear system)
6. Numerical linear algebra 3 (Linear system)
7. Numerical linear algebra 4 (Eigenvalue problem)
8. Numerical linear algebra 5 (Eigenvalue problem)
9. Numerical linear algebra 6 (Eigenvalue problem)
10. Optimization and performance tuning 1
11. Optimization and performance tuning 2
12. Optimization and performance tuning 3
13. Presentation 1
14. Presentation 2
15. Presentation 3

| [Title] | | | [Instructor] | | |
|---|---|---|---|---|---|
| Advanced Intelligent Media Processing | | | Ryutarou Ohbuchi / Fumiyo Fukumoto | | |
| [Code] | [Credits] | [Program] | [Semester] | [Hours] | [Language of instruction] |
| PTW715 | 2 | System Integration Engineering Course | 2nd Semester | Mon.／V | Japanese |

[Outline and purpose]

The study of information science which takes information as computation starts in the middle of the 20th century and forms one of the major bases of computer science. This computational approach covers a wide range of information such as textual information and visual information sources. The purpose of this course is to understand information from the viewpoint of intelligent computational processing.
The first part addresses the issue of the semantics of natural languages and introduces computational models of the interpretation of semantics.
The second half of the lecture will focus on semantic processing of visual information sources, such as 2D images and 3D images/shape models. Fundamental theoretical approaches as well as practical techniques onf visual information processing will be discussed. Topics on cross-modal information processing, such as annotating images with text, or retrieving 3D objects from hand written sketches, will also be discussed.

[Objectives]

For the first half:
Understanding the basics and the state-of-the-art of statistical natural language semantic analysis
For the second half:
Understanding theory and algorithms for comparison, retrieval, translation, among 2D images or 3D images and/or geometrical objects.

[Requirements]

Required mathematical foundation include linear algebra, integral and differential calculus, and introductory statistics. Basic knowledge and some experience on machine learning, such as clustering algorithms, classifiers such as support vector machine and random forest, as well as deep neural network is expected. Programing skills in Python and/or C++ will be required for some assignments. Familiarity with one of the deep learning frameworks, such as Tensorflow, Keras, and/or PyTorch would be helpful.

[Evaluation]

Grade is based on assignments.
Some assignments would involve implementing algorithms on semantic analysis and translation of text, image and/or other medial types.

[Textbooks]

None.

[References]

None.

[Schedule]

1. Theories in semantics: formal semantics, lexical semantics, and conceptual semantics
2. Acquisition techniques: rule-based, example-based, and corpus-based techniques
3. Acquisition of semantics: synonyms, antonyms, polysemy, and bilingual word expressions
4. Metaphor: metaphor and conceptual metaphor
5. Application: machine translation
6. Application: information retrieval
7. Application: question answering, and summarization
8. Human visual system, visual information and meaning
9. Visual media data types
10. Visual data and their low level features
11. Visual data, high level features their meaning
12. Case study: 2D image recognition and object detection
13. Case study: 2D image translation and annotation
14. Case study: 3D shape recognition and retrieval
15. Case study: Cross-media analysis between 2D image, 3D shape, text, and other data types