[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 Production Processing			Yasutake Haramiishi Yoshiaki Ukita		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTV704	2	System Integration Engineering Course	1st Semester	Tue.／Ⅳ	Japanese

[Outline and purpose]

The material processing is the important process for manufacture of engineering products. The aim of this lecture is to deeply understand the main material processing, such as removal processing, plastic deformation processing, and melt processing. In addition, the purpose is to know the latest processing trends.

[Objectives]

1. To understand the characteristic and classification of the processing methods for the manufacturing of engineering products.
2. Investigate and understand the latest trends in the above processing methods.

[Requirements]

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

[Evaluation]

Report: 50%
Presentation: 50%

[Textbooks]

[References]

Not Specified.

[Schedule]

1. Orientation, overview of processing method
2. Understand the basics of cutting, grinding, polishing, precision machining, etc.
3 ~ 14. Investigate research cases related to the above themes, Have a presentation and discussion.
15. Summary

[Title]			[Instructor]		
Advanced Theory of Vibration Control			Atsushi Fujimori / Yoshiyuki Noda		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTV705	2	System Integration Engineering Course	2nd Semester	Fri.／II	Japanese

[Outline and purpose]

In most of mechanical systems, it is important to suppress the vibration occurred in the motion control. The analytical method of the vibration with the property fluctuation and the design method of robust control with consideration of model error are given in this lecture.

[Objectives]

1. To design the vibration control using MATLAB/Simulink
2. To identify the vibration properties and model parameters using MATLAB/Simulink

[Requirements]

Knowledge of optimal dynamic regulators with linear-quadratic-gaussian design based on state space representation

[Evaluation]

Report : 100%

[Textbooks]

Atsushi Fujimori: *Robust Control*, Corona Publishing, Tokyo, 2001, ISBN: 4-339-03180-1 (in Japanese).

[References]

[Schedule]

1. State Space Representation
2. Basic Robust Control
3. H-infinity Control, Mu synthesis
4. LMI and Gain-scheduling Control
5. Practice of MATLAB and Simulink
6. Vibration Control of flexible Structure
7. Active Vibration Control Aeroelastic Airfoil
8. Basis of System Identification
9. Identification Method in Time-domain
10. Identification Method in Frequency-domain
11. Identification Method Using Eigen Value
12. Identification of Vibration Mode
13. Identification Using Kalman Filter
14. Identification to Slip Ratio of Tire

[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 Hiromi Watanabe		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTV707	2	System Integration Engineering Course	1st 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]		
Applied Robotics			Hidetsugu Terada/Kazuyoshi Ishida/Koji Makino		
[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 / /Shin-ichiro Hira / Tsutomu Tanzawa		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTV711	2	System Integration Engineering Course	1st 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 Robots
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
14. 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 Sensing and Control Engineering			Satoshi Honma		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTW701	2	System Integration Engineering Course	1nd Semester	Fri.／II	Japanese

[Outline and purpose]

Light waves are used to process, inspect, and analyze various materials, as well as to communicate and record information. Light wave control and detection methods are important for building advanced information function systems. In this lecture, we will explain how to control and measure parameters such as light intensity, phase, wavelength, and propagation direction. Related topics include liquid crystal devices, computer generated holograms, electro-optic effects, optical spatial modulators, digital holography, and optical memory. The purpose of this lecture is to understand the principles of operation and measurement methods of these devices.

[Objectives]

The goal is to understand the behavior of light as waves, and to be able to understand and explain the principles of optical technology. For this objective, students are expected to complete the following goals:
(A) Understanding the state of a beam propagating in free space
(B) Explain the principles of basic optical elements such as lenses and diffraction gratings.
(C) Explaining the operating principle of spatial light modulation devices
(D) Explain the principle of holography.
(E) Explain the principle of wavefront measurement of light waves using holography.
(F) Explain the principle of modulation of the wavefront of light using holography.

[Requirements]

Requires knowledge of electromagnetism. In particular, the ability to understand Maxwell's basic equations and transform them into various forms.

[Evaluation]

homework : 80% discussion: 20%

[Textbooks]

[References]

[Schedule]

1: Maxwell's Fundamental Equations
2: Wave Equation and Wave Propagation
3: Wave Propagation in Free Space
4: Lenses and Fourier Transform
5: Periodic Structures and Wave Propagation
6: Spatial Light Modulators
7: Principles of Electro-Optic and Photorefractive Effects
8: Principles and Applications of Holograms 1: Optical Memory
9: Principles and Applications of Holograms 2: Optical Information Processing
10: Optical Measurement Techniques 1: Measurement with Digital Holography
11: Optical Measurement Techniques 2: Measurement with Digital Holography
12: Wavefront Control of Light: Wavefront Generation with Computer-Generated Holograms
13: Introduction to the Latest Applications of Optics
14: Introduction to the Latest Applications of Optics
15: Discussion, summary and conclusion

[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 or English

[Outline and purpose]

The development of high-performance communication devices that utilize optical waves and ultrasonic waves (acoustic 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 analysis of ultrasonic (acoustic wave) propagation in piezoelectric medium
4. Application to high-performance ultrasonic (acoustic wave) devices

[Title]			[Instructor]		
Advanced Communication Systems			Masanori Hanawa		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTW703	2	System Integration Engineering Course	1st Semester	Mon.／II	Japanese/English

[Outline and purpose]

In this lecture, an overview will be given of advanced signal processing technologies used in communication systems. Lectures will cover topics such as the behavior of communication systems in noisy environments based on stochastic processes, optimal signal detection theory, linear equalizers, various adaptive algorithms and adaptive equalizers, and adaptive antennas.

[Objectives]

1. Can explain fundamental concepts relating to random variables and stochastic processes
2. Can explain the behavior of analog communication systems in noisy environments
3. Can explain the behavior of digital communication systems in noisy environments
4. Can explain optimal signal detection theory
5. Can explain linear equalizers
6. Can explain the steepest descent method
7. Can explain the operation of the LMS adaptive algorithm
8. Can explain the operation of the normalized LMS adaptive algorithm
9. Can explain the operation of the RLS adaptive algorithm

[Requirements]

Knowledge of digital signal processing techniques and communication theory covered in the undergraduate courses Signals and Systems, Information and Communication I, Information and Communication II offered by the Department of Electrical and Electronics Engineering

[Evaluation]

Students will pass if they have completed 80% or more of the class reflections and assignments.

[Textbooks]

1. J. H. McClellan, R. W. Schafer, and M. A. Yoder, DSP First Second Edition, Prentice Hall, 2015.
2. Sayed, Ali H., Adaptive Filters, Wiley, 2008.
3. M. Nakazawa, et al, High Spectral Density Optical Communication Technologies, Springer, 2010.

[References]

Additional reading assignments would be given arbitrarily.

[Schedule]

1. Basics of Probability Theory: Random variables, central limit theorem, correlation, least squares estimation
2. Stochastic Processes: From random variables to stochastic processes, power spectral density of stochastic processes, Multidimensional stochastic processes, linear system transmission of stochastic processes, bandpass stochastic processes
3. Optimal filtering (Wiener-Hopf filter)
4. Behavior of Analog Systems in Noisy Environments: Bandpass systems, amplitude modulation systems, angle modulation systems, Pulse modulation systems, optimal pre-emphasis and de-emphasis
5. Behavior of Digital Communication Systems in Noisy Environments: Optimal threshold detection, optimal binary receiver, carrier systems, Spread spectrum systems, M-ary communication, synchronization
6. Optimal Signal Detection: Geometric representation of signals, Gaussian stochastic processes, optimal receiver, colored noise, maximum likelihood sequence receiver
7. Linear Equalizers: MSE equalizer, fractional spaced equalizer, baseband equalizer, bandpass equalizer, decision feedback equalizer
8. Steepest Descent Method: Concept of steepest descent method, application to Wiener filter, stability of steepest descent method
9. LMS Algorithm: Minimum mean square adaptive algorithm, LMS algorithm and steepest descent method, upper limit of step size parameter
10. Normalized LMS Algorithm: Normalized LMS algorithm, stability of normalized LMS algorithm, affine projection adaptive filter, RLS Algorithm:Matrix inversion lemma, exponentially weighted recursive least squares algorithm, Choice of forgetting factor parameter, convergence analysis of RLS algorithm

[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 Superconducting Electronics			Naoto Sekiya		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTW706	2	System Integration Engineering Course	2nd Semester	Thu.／II	Japanese

[Outline and purpose]

The applications using superconductors can realize highly sensitive and high-performance devices that cannot be realized by conventional technologies and have been put to practical use in the fields of medicine, radio astronomy, and telecommunications.
In this course, students learn the principles and applications of superconducting electronic devices.

[Objectives]

To explain superconducting SQUIDs and their applications
To explain superconducting Josephson devices and their applications
To explain superconducting microwave microstrip devices.

[Requirements]

Basic knowledge of electric circuit, electromagnetism, and high frequency circuit is necessary.

[Evaluation]

Report 100%: Research latest microwave superconducting devices.

[Textbooks]

[References]

Additional reading assignments would be given arbitrarily.

[Schedule]

1. History of Superconductivity
2. Superconducting SQUIDs and their applications (1)
3. Superconducting SQUIDs and their applications (2)
4. Superconducting Josephson devices and their applications (1)
5. Superconducting Josephson devices and their applications (2)
6. Microwave superconductivity
7. Microstrip line structure
8. Distributed constant circuits
9. Superconducting filters and their applications (1)
10. Superconductive filters and their applications (2)
11. Superconducting wires and their high-frequency applications (1)
12. Superconducting wires and their applications for high frequency (2)
13. Introduction to the latest superconducting electronics (1)
14. Introduction to the latest superconducting electronics (2)
15. Introduction to the latest superconducting electronics (3)

[Title]			[Instructor]		
Advanced Laser and Plasma Engineering			Kazukuki Uno		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTW707	2	System Integration Engineering Course	2nd Semester	Tue.／III	Japanese

[Outline and purpose]

In our daily lives, there are many products created using laser technology and plasma technology, as well as products utilizing laser technology and plasma technology. This course aims to understand the principles of lasers, the characteristics of lasers, the applications of lasers, the principles of plasma, the characteristics of plasma, and the applications of plasma.

[Objectives]

・Be able to explain the principles and characteristics of lasers.
・Be able to describe everyday laser technologies.
・Be able to explain the principles and characteristics of plasma.
・Be able to describe everyday plasma technologies.

[Requirements]

Proficiency in electromagnetism, quantum mechanics, and high-voltage engineering is desirable.

[Evaluation]

Exam, 60%, Questions will be asked about the principles and characteristics of lasers and plasmas.
Report, 40%, Reports will be required to investigate and evaluate everyday laser and plasma technologies.

[Textbooks]

[References]

Kurosawa Kou, ISBN:978-4902312553, in Japanese
Takamura Shuichi, ISBN:978-4627782310, in Japanese

[Schedule]

The course will cover the following topics:

1) Characteristics of lasers
2) Principles of lasers
3) Optics
4) Visit to laser equipment (laboratory)
5) Visit to laser equipment (laboratory)
6) Laser applications 1
7) Laser applications 2
8) Investigation of the latest laser technologies
9) Characteristics of plasma
10) Principles of plasma
11) Discharge
12) Plasma applications 1
13) Plasma applications 2
14) Investigation of the latest plasma technologies
15) Final exam and exam review

[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 of 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 solutions.

[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 (Lessons 1-4)
2. Fundamental Technologies Supporting System Solution (Lessons 5 - 8)
   (1) Information technology
   (2) Analytical problem solving and design-problem solving
   (3) Quality assurance and customer satisfaction
3. Practical system solutions (Lessons 9-12)
   (1) The solution in a computer vendor
   (2) The solution in a software provider
   (3) The solution in an information communication common carrier
4. Future works of system solution (Lessons 13-15)

[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	Thu.／V	English / 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		
[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, and understanding to the methods of analyzing and modeling 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

[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. Error-correction learning
4. Learning based on error evaluation
5. Energy minimization principle
6. Examples of neural network models
7. Summary (Part 1)

(Kansei evaluation models)

8. Introduction to Kansei evaluation
9. Visualisation of Kansei data
10. Basic methods of multivariate statistics
11. Modelling with quantification theory
12. Modeling with fuzzy reasoning
13. Modeling with machine learning
14. Summary (Part 2)

15. Overall summary

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

[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 transferring 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 Discrete Structure Systems			Koji Iwanuma / Hidetomo Nabeshima / Dominik Köppl		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTW713	2	System Integration Engineering Course	2nd Semester	The.／V	Japanese

[Outline and purpose]

Regarding information as a product obtained from computation began in the mid-20th century. Nowadays, mathematical theories of symbolic and/or discrete computation becomes ones of the most important foundations for computer science and information engineering. For example, data mining technologies can derive a new valuable knowledge from a huge amount of information. The purpose of this course is to understand some essential features of information science from the viewpoint of computation. This course consists of three parts. The first part is for transactional/sequential data mining. The second part of the course introduces Boolean satisfiability testing (SAT) which is one of important subjects in computer science, and shows the state-of-the-art techniques of modern SAT solvers and their various application areas. In the third part, we study succinct data structures for big data. We cover the theoretical foundations of data structures up to the latest research results, enabling the acquisition of techniques for efficient data management and analysis. For that, we include fundamental concepts of data structures, the study of algorithm efficiency, and criteria for selecting data structures based on efficiency. The course shows the latest case study in each topic and discusses the current status and challenges.

[Objectives]

1. To understand the basics and state-of-the-art of data mining technologies for discrete data.
2. To understand the basics and state-of-the-art of Boolean propositional satisfiability testing and its applications.
3. To understand and apply data structures, evaluate algorithms based on their efficiencies, and select and design data structures.

[Requirements]

A grounding in algorithms and data structure, information theory, discrete mathematics and mathematical logic

[Evaluation]

Students are evaluated primarily based on homework.

[Textbooks]

None

[References]

- J. Han and M. Kamber, Data Mining – Concepts and Technique – Second Edition, Morgan Kaufmann Pub.(ISBN:1558609016)
- P. Tan, M. Steinbach and V. Kumar, Introduction to Data Mining, Adison-Wesley (ISBN:0321464494)
- Armin Biere et.al., Handbook of Satisfiability 2nd Edition, IOS-Press (ISBN: 9781643681603)
- Gonzalo Navarro: "Compact Data Structures: A Practical Approach", Cambridge University Press, 2016, ISBN 978-1316588284
- Veli Mäkinen, Djamal Belazzougui, Fabio Cunial, Alexandru I. Tomescu: "Genome-Scale Algorithm Design: Biological Sequence Analysis in the Era of High-Throughput Sequencing", Cambridge University Press, 2nd edition , 2023, ISBN 978-1009341257

[Schedule]

First part: Data-mining

1. Introduction of data mining for big discrete data
2. Association rule mining: compression based on closed/maximal itemsets
3. Fast support computation: hash-tree, vertical format computation
4. Mining based on divide and conquer: database reduction and FP-growth method
5. More advanced technology: Prefix-Span, BIDE

Second part: SAT and its applications

6. Foundations of Boolean satisfiability testing
7. Principles of Modern SAT Solvers
8. Constraint Optimization Problem and SAT Encoding
9. SAT-based system verification
10. SAT scheduling and planning

Third part: Succinct Data Structures

11. Overview of Indexing Discrete Big Data
12. Efficient Pattern Matching
13. Succinct Data Structures
14. Compressed Data Structures
15. Extensions and Variations of Pattern Matching

[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			Takahiko Furuya / Jiyi Li		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTW715	2	System Integration Engineering Course	1st Semester	Tue.／III	Japanese / English

[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 (1) to understand information from the viewpoint of intelligent computational processing, and (2) to develop scientific communication skills through presentations on scientific research related to intelligent media processing.
The first part will focus on the semantic processing of language. The goal is to deepen understanding of the foundational theories and technologies in this area and then clarify the essence of computation. On the other hand, we will also learn methodologies for solving complex problems through the combination of human and computer capabilities in the realm of intelligent media processing.
The second part 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 on visual information processing will be discussed. Topics on cross-modal information processing such as annotating/generating images with text will also be discussed.
In the presentation part, students present research by himself/herself or by others.

[Objectives]

For the first half of the lecture:
Understanding methods for handling semantic processing of language from a computational perspective, involving machine processing. Being familiar with the field and technology of crowdsourcing and human computation, which aim for collaborative problem-solving between humans and computers.
For the second half of the lecture:
Understanding fundamental theory and algorithms for deep learning for 2D/3D vision, including DNN architectures, optimization algorithms, regularization techniques, and cross-modal information processing techniques.
For the presentation part:
Developing scientific communication skills through presentation and discussion.

[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.

[Evaluation]

Grade is based on presentation and discussion.
Lecturers evaluate students in terms of their understanding of lectures, presentation skills, and proactive attitude to scientific communication.

[Textbooks]

None.

[References]

None.

[Schedule]

1. Guidance, introduction of own research by students (1)
2. Introduction of own research by students (2)
3. Crowdsourcing and Human Computation
4. Recurrent Neural Networks and Language Models for Natural Language Processing
5. Attention and Transformers for Natural Language Processing
6. Pretraining for Natural Language Processing
7. Neural Language Generation for Natural Language Processing
8. Human vision, data representation of 2D image
9. Architecture of DNN for 2D image analysis
10. Effective training of DNN for 2D image analysis
11. Recent developments in 2D image analysis
12. Deep learning for 3D shape analysis
13. Presentation, by students, of latest research on intelligent media processing (1)
14. Presentation, by students, of latest research on intelligent media processing (2)
15. Presentation, by students, of latest research on intelligent media processing (3)

[Title]			[Instructor]		
Advanced Natural Language and Speech Media Processing			Kenji Ozawa / Fumiyo Fukumoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTW716	2	System Integration Engineering Course	1st Semester	Tue.／IV	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 speech and study the fundamental theories and techniques related to speech recognition corresponding to semantic processing.

[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 the algorithms of classical speech recognition models, including acoustic models, pronunciation dictionaries, and language models, followed by implementing modern End-to-End models.

[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. Additionally, it is desirable to have a basic understanding of representations of acoustic signals and fundamental filtering techniques.

[Evaluation]

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

[Textbooks]

Ryouichi Takashima, Speech recognition with Python, Impress, Tokyo (2021). ISBN: 9784295011385 (in Japanese)

[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. Summary of the First Half: The mechanism of speech recognition
9. Fundamental equations of speech recognition
10. Basics of speech processing and feature extraction
11. Solving the alignment problem in speech recognition
12. Speech recognition with GMM-HMM
13. Speech recognition with DNN-HMM
14. Continuous speech recognition with End-to-End models
15. Implementation of End-to-End models