[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 Color Image Technology			Shinji Kotani		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTV707	2	System Integration Engineering Course	1 nd 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]		
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			Tomoo Munehisa / 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) communications. 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 also 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 C and 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 researches on AI No.1
14. Discussion of recent researches on AI No.2
15. Discussion of recent researches on AI No.3

[Title]			[Instructor]		
Advanced Robot Design			Shinji Kotani / Miyoshi Okamura /Shinichiro 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 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 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]

This course covers major topics in speech and acoustical array signal processing. The first part of the course addresses speech information processing from past to present. There are many applications, for example, Text-To-Speech synthesis system and singing synthesizer have been widely used all over the world. The second part of the course addresses issues of acoustical array signal processing and introduces techniques to record the sound from a focused sound source. Array signal processing is essential in advanced human-computer-interaction systems such as a car navigation system.

[Objectives]

1. To understand the history and state-of-the-art techniques of speech and acoustical array signal processing. To understand the ways how speech and acoustical array signal processing techniques are used in our daily lives and to apply these techniques to own problems to be solved.

[Requirements]

A grounding in mathematical analysis, linear algebra, and statistics

[Evaluation]

Report work and weekly examination: 100%

[Textbooks]

M. Morise, *Speech Analysis and Synthesis*, Corona Pub., Tokyo, 2018. (in Japanese)
F. Asano, *Acoustical Array Signal Processing,* Corona Pub., Tokyo, 2011. (in Japanese)

[References]

[Schedule]

1. History of speech processing 1: Vocoder, Cepstrum, and Linear Predictive Coding (LPC)
2. History of speech processing 2: High-quality speech synthesis and its applications
3. Voice conversion technique: Voice conversion and voice morphing
4. *Kansei* information processing in speech: Voice personality, emotion and likability
5. Singing information processing
6. Statistical parametric speech synthesis
7. Infrastructure in speech and singing
8. Basis of array signal processing: modelling of sound propagation using complex sinusoids and matrices
9. Basis of parameter estimation 1: Non-Bayesian inference
10. Basis of parameter estimation 2: Bayesian inference
11. Sound source separation using a beamformer
12. Sound source localization by the subspace method
13. Sound source localization by the sparse modelling
14. Application of array signal processing
15. Summary

[Title]			[Instructor]		
Advanced Computing Systems			Hidetoshi Mino / 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, Chainer, 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