

| [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.<br>The utilization efficiency of the thermal energy can be evaluated.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                       |                                                  |         |                           |
| [Requirements]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                       |                                                  |         |                           |
| Thermodynamics, Hydrodynamics, Thermal engineering, Fluid engineering, Numerical analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                                       |                                                  |         |                           |
| [Evaluation]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                       |                                                  |         |                           |
| Report & examination : 60%<br>Presentation skill : 40%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |                                       |                                                  |         |                           |
| [Textbooks]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                                       |                                                  |         |                           |
| Not specify                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                                       |                                                  |         |                           |
| [References]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                       |                                                  |         |                           |
| Not specify<br>Distribute research papers, if necessary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                       |                                                  |         |                           |
| [Schedule]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                                       |                                                  |         |                           |
| 1 Introduction<br>2-4 Production, storage, and transport of thermal energy<br>5 Evaluation of thermal energy system by theoretical approach and numerical analysis<br>6-8 Heat transport by thermal conduction, forced convection, natural convection, and thermal radiation<br>9-10 Conversion system of thermal energy and thermal efficiency<br>11-12 Renewable energy systems, such as solar thermal energy, wind energy, hydraulic energy, geothermal energy, etc.<br>13 Nuclear energy system and nuclear safety<br>14 Flow visualization techniques<br>15 Heat utilization systems such as thermoelectric conversion element, ground source heat pump system, etc. |           |                                       |                                                  |         |                           |

| [Title]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                       | [Instructor]                             |         |                           |
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| Turbulent Transport Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |                                       | Hiroyuki Tsunoda /<br>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:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                                       |                                          |         |                           |
| <ol style="list-style-type: none"> <li>1. to understand the fundamental idea of turbulence</li> <li>2. to understand the statistical methods for analyzing turbulent flows and to apply them to practical flows</li> <li>3. to discuss turbulent flows based on the governing equations</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                       |                                          |         |                           |
| [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]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                                       |                                          |         |                           |
| <ol style="list-style-type: none"> <li>1. Davidson, P.A.: Turbulence: An Introduction for Scientists and Engineers, Oxford Univ. press, 2004, ISBN 0198529481</li> <li>2. 日野幹雄 : 流体力学, 朝倉書店, ISBN 4254200668 (in Japanese).</li> <li>3. Tennekes, H. and Lumley, J.L. : A First Course in Turbulence, The MIT press, 1972, ISBN 0262200198.</li> <li>4. Pope, S.B. : Turbulent Flows, Cambridge University Press, 2000, ISBN 0521598869.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                                       |                                          |         |                           |
| [Schedule]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                       |                                          |         |                           |
| <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Laminar and turbulent flows #1</li> <li>3. Laminar and turbulent flows #2</li> <li>4. Flux and turbulent transport</li> <li>5. Isotropic turbulence #1</li> <li>6. Isotropic turbulence #2</li> <li>7. Reynolds equations</li> <li>8. Turbulent shear flows</li> <li>9. Turbulent flow in pipe</li> <li>10. Boundary layer</li> <li>11. Free shear flows</li> <li>12. Several turbulence models and DNS</li> <li>13. Measurement techniques of turbulent flows #1</li> <li>14. Measurement techniques of turbulent flows #2</li> <li>15. Summary</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |                                       |                                          |         |                           |

| [Title]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                                       | [Instructor]                                         |         |                           |
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| Advanced Materials Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                       | Yoshihiro Nakayama / Yasumi Ito/<br>Yoshiyuki Kagiya |         |                           |
| [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<br>2. To understand the safety evaluation of metallic materials and biocompatible materials<br>3. To understand the failure accident investigating method of machines and structure                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                                       |                                                      |         |                           |
| [Requirements]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                       |                                                      |         |                           |
| Materials science and engineering<br>Basic strength of materials                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                                       |                                                      |         |                           |
| [Evaluation]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                                       |                                                      |         |                           |
| Homework: 50%<br>Presentation work: 50%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                                       |                                                      |         |                           |
| [Textbooks]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                       |                                                      |         |                           |
| N. A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |                                       |                                                      |         |                           |
| [References]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                                       |                                                      |         |                           |
| 伊藤安海，鍵山善之，イラスト医工学 ―バイオメカニクスから医療機器・科学捜査まで―，アドスリー，ISBN:978-4-904419-69-4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                       |                                                      |         |                           |
| [Schedule]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                                       |                                                      |         |                           |
| 1. Orientation, Metallic materials for infrastructure materials<br>2. Structure and properties of metallic materials<br>3. Application example 1 of metallic materials<br>4. Application example 2 of metallic materials<br>5. Research trend of metallic materials<br>6. Metallic materials in medical applications<br>7. Biocompatible materials<br>8. Artificial joint implants<br>9. Finite element analysis of artificial joint implants<br>10. Advanced researches in medical engineering<br>11. Biomechanical material and biomechanics<br>12. Mechanical properties of biological tissue<br>13. Material and dynamics in medical engineering<br>14. Failure accident investigating method of machines and structures from mechanical property<br>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 | 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.<br>2. Understand several color systems and difference between them.<br>3. Instrument of measuring color<br>4. translate Analog figures to digital ones<br>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%<br>presentation: 50%                                                                                                                                                                                                                                                |           |                                       |               |         |                           |
| [Textbooks]                                                                                                                                                                                                                                                                                |           |                                       |               |         |                           |
| Not Specified.                                                                                                                                                                                                                                                                             |           |                                       |               |         |                           |
| [References]                                                                                                                                                                                                                                                                               |           |                                       |               |         |                           |
| Not Specified.                                                                                                                                                                                                                                                                             |           |                                       |               |         |                           |
| [Schedule]                                                                                                                                                                                                                                                                                 |           |                                       |               |         |                           |
|                                                                                                                                                                                                                                                                                            |           |                                       |               |         |                           |

| [Title]                                                                                                                                                                                                                                                                         |           |                                       | [Instructor]                     |         |                           |
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| 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%<br>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)<br>2. Kenji Uchino : Ferroelectric devices, Marcel Dekker (2000)<br>3. Kenji Uchino, Jayne Giniewicz : Micromechatronics, Marcel Dekker (2003)<br>4. 城戸健一 : デ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<br>2. Fundamentals and applications of ultrasonics<br>3. Fundamentals and applications of the acoustics<br>4. Measurements and applications of the analysis technology                                                       |           |                                       |                                  |         |                           |

| [Title]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                                       | [Instructor]                                           |         |                           |
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| Applied Robotics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |                                       | Nobuyuki Furuya /<br>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.<br>(2) to understand professional item of robot control technology.<br>(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%<br>2. Routine test and Report 20%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                       |                                                        |         |                           |
| [Textbooks]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                       |                                                        |         |                           |
| Textbook is not used. Materials will be provided.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |                                       |                                                        |         |                           |
| [References]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                       |                                                        |         |                           |
| 1. Control system design, McGRAW-HILL, ISBN:0486442780<br>2. SIGNALS AND LINEAR SYSTEMS, Jhon Wiley & Sons, ISBN:0471838217<br>3. 現代制御理論入門, コロナ社, ISBN:4339031615 (In Japanese)<br>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.<br>1. Mechanism of the robot (1-5 times)<br>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.<br>2. Robot control (6 to 10)<br>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.<br>3. Intelligent Robots (11 times to 15 times)<br>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]                                          |         |                           |
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| 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.<br>(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<br>(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)<br>2. Outline of speech processing<br>3. Outline of natural language processing<br>4. Deep learning basic edition No.1: neural network<br>5. Deep learning basic edition No.2: convolutional neural network<br>6. Deep learning basic edition No.3: recurrent neural network<br>7. Deep learning advanced No.1: application for speech processing<br>8. Deep learning advanced No.2: application for temporal sequence data<br>9. Deep learning advanced No.3: application for image processing<br>10. Deep learning advanced No.4: application for text processing<br>11. Genetic algorithm basic edition<br>12. Genetic algorithm advanced edition<br>13. Discussion of recent researches on AI No.1<br>14. Discussion of recent researches on AI No.2<br>15. Discussion of recent researches on AI No.3 |           |                                       |                                                       |         |                           |

| [Title]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                                       | [Instructor]                                                          |          |                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------------------------------|-----------------------------------------------------------------------|----------|---------------------------|
| Advanced Robot Design                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                                       | Shinji Kotani / Miyoshi Okamura<br>/Shinichiro 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.<br>The purpose of this class is to cultivate indispensable essentials for robot design.                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                       |                                                                       |          |                           |
| [Objectives]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |                                       |                                                                       |          |                           |
| <ul style="list-style-type: none"> <li>• to explain the purpose, background and meaning of the robot to be designed</li> <li>• to decide and explain mechanism, actuator, electronic, information communication, and control system</li> <li>• to propose and explain evaluation method of the designed robot</li> </ul>                                                                                                                                                                                                                                                                                                                                                              |           |                                       |                                                                       |          |                           |
| [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<br>2. Requests to Robots under various environments<br>3. Ethics and Philosophy in Robot Design<br>4. Autonomous Robot<br>5. Symbiosis of Humans and Robots<br>6. Summary ( presentation & discussion)<br>7. Materials (1)_Structural Materials (guide for choice, strength Tests, processing methods)<br>8. Materials (2)_Functional Materials (purpose of use, application cases)<br>9. Structure ( mechanism, actuator)<br>10. Summary ( presentation & discussion)<br>11. Sensing<br>12. Software , Network<br>13. Electronic Circuit , Safety Function<br>10. Summary ( presentation & discussion)<br>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 | 1st Semester                                      | Mon./IV | Japanese                  |
| [Outline and purpose]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |                                       |                                                   |         |                           |
| <p>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.</p> <ol style="list-style-type: none"> <li>1. Basic of polarization instrumentation and its application to nano-technology (Responsible: Prof. Jin)</li> <li>2. Instrumentation with optical fiber and its application (Responsible: Prof. Morisawa)</li> <li>3. Imaging processing and its application (Responsible: Prof. Shimizu)</li> </ol> <p>This lecture aims to help the student cultivate fundamental ability to utilize above techniques to various engineering systems.</p> |           |                                       |                                                   |         |                           |
| [Objectives]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                       |                                                   |         |                           |
| <p>(A) Understand polarization phenomenon and polarization measurements.<br/>         (B) Explain spectroscopic polarization instrumentation and its application.<br/>         (C) Understand the operation principles of optical fiber sensor for measurement of physical quantities such as temperature, pressure etc.<br/>         (D) Explain the operation principles of chemical optical fiber sensor for detection of various gases.<br/>         (E) Understand the geometry optics of the camera and illumination system.<br/>         (F) Explain the image processing method and its application.</p>                                                                                                                                                                                                                                                                               |           |                                       |                                                   |         |                           |
| [Requirements]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                                       |                                                   |         |                           |
| A grounding in algebra, analytics, statistics, and physics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                                       |                                                   |         |                           |
| [Evaluation]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                       |                                                   |         |                           |
| Homework: 100%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                                       |                                                   |         |                           |
| [Textbooks]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |                                       |                                                   |         |                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                                       |                                                   |         |                           |
| [References]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                       |                                                   |         |                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                                       |                                                   |         |                           |
| [Schedule]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                                       |                                                   |         |                           |
| <ol style="list-style-type: none"> <li>1. Reflection and polarized light</li> <li>2. Polarization measurement system</li> <li>3. Spectroscopic ellipsometry</li> <li>4. Spectroscopic ellipsometry and nanotechnology</li> <li>5. Summary (Part 1)</li> <li>6. Fundamentals of optical fiber sensors</li> <li>7. The optical fiber sensor for measurement of physical quantities</li> <li>8. Fundamentals of chemical optical fiber sensor</li> <li>9. Application of chemical optical fiber sensor</li> <li>10. Summary (Part 2)</li> <li>11. Geometric camera model and geometric camera calibration</li> <li>12. Radiometry, lightning and image processing</li> <li>13. Visual inspections</li> <li>14. Image processing and machine learnings</li> <li>15. Summary (Part 3)</li> </ol>                                                                                                    |           |                                       |                                                   |         |                           |