**IESC横断型科目**

| 科目ナンバリング | G-ENE20 63132 LE24 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | System Safety<br>System Safety | | | | | 担当者所属・職名・氏名 | エネルギー科学研究科 教授 下田 宏 | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・後期 | 曜時限 | 水4 | 授業形態 | 講義 | 使用言語 | 英語 |

**[授業の概要・目的]**

From the viewpoint of keeping safety and reliability in the context of relationship between advanced technologies and human society, basic knowledge and applications of risk assessment for large-scale and complicated modern energy systems will be lectured.

**[到達目標]**

Regarding risk assessment to secure safety of energy systems, the students learn the following knowledge and techniques;
1. Qualitative analysis method of risk.
2. Quantitative risk analysis method of mechanical systems.
3. Human reliability analysis method.

**[授業計画と内容]**

The following themes will be lectured in regard to basic knowledge and application of risk assessment of large-scale and complicated technology systems.

1. Safety system for social relief (1).
2. Features and problems of large-scale and complicated technology systems (1).
3. Risk assessment of large-scale and complicated technology systems (3).
4. Probabilistic risk assessment(PRA) as quantitative assessment method (6).
5. Basic knowledge of human factor (1).
6. Analysis of human error and its countermeasures (1).
7. Human reliability analysis(HRA) (1).
8. Feedback (1).

**[履修要件]**

**特になし**

**[成績評価の方法・観点]**

The grade will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science. Concretely,
Active participation in the classes (20%),
Exercises in the class and assignments (50%), and
Final report subject (30%).

**System Safety(2)へ続く↓↓↓**

**System Safety(2)**

**[教科書]**

Learning materials will be given in the class.

**[参考書等]**

**（参考書）**
**授業中に紹介する**

**[授業外学修（予習・復習）等]**

Preparation, review and homework will be given in the class.

**（その他（オフィスアワー等））**

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63167 SE17 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Energy and SD<br>Energy Systems and Sustainable Development | | | 担当者所属・職名・氏名 | エネルギー科学研究科 教授 MCLELLAN, Benjamin | | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・後期 | 曜時限 | 火2 | 授業形態 | 講義 | 使用言語 | 英語 |

**[授業の概要・目的]**

This course will introduce key concepts of sustainable development, and engage students in understanding the interconnections of energy systems in the larger picture of sustainable development. The course finishes with a workshop applying these concepts to energy systems planning.

**[到達目標]**

The goals of the course are for students to understand the breadth and complexity of sustainability and its implications for energy systems. Students will learn key concepts and frameworks, and apply critical thinking and team processes to the planning of sustainable energy systems in a given context. Technical, environmental and socio-economic topics and approaches will be covered.

**[授業計画と内容]**

The course will consist of lectures and interactive sessions on the following key themes (order to be clarified in first session):
The course will consist of lectures and interactive sessions on the following key themes (order to be clarified in first session):
1. Introduction / Concepts in Sustainability
2. Energy in Lifecycles / Energy Systems
3. Renewable Energy Technologies
4. Non Renewable “Clean” Energy Technologies
5. Natural resource usage and sustainability
6. Emissions, Energy and Sustainability
7. Energy system configurations
8. Transitions and policy
9. Energy and Development
10. Global and local energy sustainability
11. Measuring Sustainability
12. Decision-making in Sustainable Development
13. Energy system design workshop I (12.5%)
14. Energy system design workshop II (12.5%)
15. Feedback

**[履修要件]**

特になし

**[成績評価の方法・観点]**

Students will be evaluated on three major elements:
1. Participation in class activities and submission of out-of-class tasks aimed to solidify learning of concepts (40%)
2. Participation in the 2-3 week workshop capping-off the course (30%)

Energy and SD (2)へ続く↓↓↓

**Energy and SD (2)**

3. Submission of a final report (30%)

Will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

**[教科書]**

**使用しない**

**[参考書等]**

**（参考書）**

Suggested reading:
Sustainable Energy: Choosing among options (Tester et al., 2005)
Other reading supplied via PandA

**[授業外学修（予習・復習）等]**

Students will be required to do occasional out-of-class preparation exercises.
Slides will be provided before the lecture via PandA so that pre-reading can be undertaken.
Other references will be given in class.

**（その他（オフィスアワー等））**

Available by appointment.

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63170 SE28 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Future Energy:Hydrogen Economy<br>Future Energy:Hydrogen Economy | | | 担当者所属・職名・氏名 | エネルギー科学研究科 教授 MCLELLAN, Benjamin | | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・前期 | 曜時限 | 水1 | 授業形態 | 講義 | 使用言語 | 英語 |

**[授業の概要・目的]**

This course will introduce the concepts and technology of the Hydrogen Economy. The course is intended to give insight into this topical area of research and its potential benefits and impacts.

**[到達目標]**

The aim for the class is for students to understand each of the major phases in hydrogen energy infrastructure, and the main technologies considered. Students will learn technical, social, environmental and economic aspects of the systems. Through class discussions and a final report, students will hone their skills in argument and learn to identify critical criteria for technology assessment.

**[授業計画と内容]**

The course will consist of lectures on key supporting technologies and system-wide aspects of hydrogen energy systems. The following themes will be discussed (order may change):
1. Introduction
2. Hydrogen sources and limitations
3. Hydrogen production #8211 Carbon fuels
4. Bio-hydrogen production
5. Hydrogen production #8211 Electro / thermo / chemical
6. Assessment: In-class discussion #8211 1
7. Hydrogen storage and distribution
8. Hydrogen utilisation #8211 fuel cells I
9. Hydrogen utilisation #8211 fuel cells II
10. Hydrogen utilisation #8211 engines / turbines / non-fuel
11. Assessment: In-class discussion #8211 2
12. Hydrogen economy safety and society
13. Hydrogen economy economics and resources
14. Hydrogen economy environmental aspects
15. Feedback

**[履修要件]**

特になし

**[成績評価の方法・観点]**

The following items of assessment are used (shown below). The specific requirements and assessment criteria are distributed in class.

Final report (Technology assessment in a specific country context) [50%]
Class discussion 1 - Hydrogen production (Discussion and handout) [10%]
Class discussion 2 - Hydrogen storage and utilisation (Discussion and handout) [20%]

Future Energy:Hydrogen Economy(2)へ続く↓↓↓

**Future Energy:Hydrogen Economy(2)**

Small exercises [20%]

Will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

**[教科書]**

**使用しない**

**[参考書等]**

**（参考書）**
**授業中に紹介する**

**[授業外学修（予習・復習）等]**

Students will need to spend time researching a specific allocated country`s energy system and determining how to develop an appropriate hydrogen economy. This will be particularly before each class discussion.

**（その他（オフィスアワー等））**

Basic knowledge of energy concepts and ability to apply mathematics is required.
Contact may be made via email for out-of-class discussion.

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

未更新

| 科目ナンバリング | G-ENE20 63172 LE28 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Energy Policy<br>Energy Policy | | | 担当者所属・職名・氏名 | 複合原子力科学研究所 教授 宇根崎 博信 | | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・後期 | 曜時限 | 水1 | 授業形態 | 講義 | 使用言語 | 英語 |

**[授業の概要・目的]**

Energy is dispensable for the welfare of humankind and sound development of social activities in the modern society. The stable supply of energy is influenced by circumstances of political issues and technological development. Based on the mid- to long-term forecast of energy supply and demand, various specific issues related to energy policy, including energy resources, environmental issues, trends in major countries, forecasts and predictions, will be discussed in this course.

**[到達目標]**

To achieve ability
- to describe various energy resources used in modern society from both natural and social science,
- to describe the structure and objectives of energy policy of major countries including Japan,
- to comprehensively understand energy statistics and other data and describe it with relation to world energy trends

**[授業計画と内容]**

Total of 15 classes will be provided.

1. Overview of energy policy
2. Energy resource: characteristics, supply and demand (1)
3. Energy resource: characteristics, supply and demand (2)
4. Renewable energy: characteristics, policy implementation (1)
5. Renewable energy: characteristics, policy implementation (2)
6. Nuclear energy: characteristics, policy implementation (1)
7. Nuclear energy: characteristics, policy implementation (2)
8. Energy and environment
9. Energy efficiency and energy policy
10. Energy policy of Japan and major countries (1)
11. Energy policy of Japan and major countries (2)
12. Forecasts and outlooks of energy supply and demand (1)
13. Forecasts and outlooks of energy supply and demand (2)
14. Energy poverty, Energy and Water, recent topics
15. Summary

**[履修要件]**

Students who have already taken 「**エネルギー政策論**」（3146000）(Spring Semester / in Japanese) are not allowed to take this class.

**[成績評価の方法・観点]**

By attendance (30%) and research presentation / final report (70%).

**Energy Policy(2)へ続く↓↓↓**

**Energy Policy(2)**

Note: attendance to research presentation / submission of final report is not allowed in case of class attendance rate is less than 80%

[evaluation policy] Will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

**[教科書]**

Lecture materials will be distributed via PandA.

Attendees are recommended to review their own countries' recent energy policy trends, as well as the IEA World Energy Outlook executive summary, which could be downloaded from IEA Web page.

**[参考書等]**

**（参考書）**

Recommendation of related references (books, reports, journal papers etc) will be given during the class.

**[授業外学修（予習・復習）等]**

Recent energy situation are extremely fluctuating and dynamic; attendees are recommended to collect up-to-date information on energy policy and related topics.

**（その他（オフィスアワー等））**

- Technical tour to power plants and energy-related facilities may be included as a part of the class.

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63174 LE17 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Energy, materials and resources<br>Energy, materials and resources | | | | | 担当者所属・職名・氏名 | エネルギー科学研究科 教授 MCLELLAN, Benjamin | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・後期 | 曜時限 | 水2 | 授業形態 | 講義 | 使用言語 | 英語 |

**[授業の概要・目的]**

Energy and materials are vitally linked, in their production and utilisation, and are crucial for society. All energy and materials are ultimately reliant on various resources, principal among which are the non-renewable mineral resources. This course will examine the bi-directional link of materials and energy, and the resources on which they are dependent - particularly critical minerals.

**[到達目標]**

Students will obtain an understanding of various materials and the energy use in their production, as well as the use of various materials in energy systems. The concepts of material criticality will be introduced, and the students will obtain an understanding of the key elements of criticality assessment and its strategic importance.

**[授業計画と内容]**

The general course topics will be as follows:
1. Overview of materials, energy and resources
2. Typical materials and energy lifecycles 1
3. Typical materials and energy lifecycles 2
4. Non-renewable resources and models
5. Renewable resources and models
6. Material criticality frameworks
7. Material criticality 1 - Supply Risk
8. Material criticality 2 - Vulnerability to Supply Restriction
9. Recycling and renewability
10. Substitutes and substitutability
11. Material criticality 3 - Environmental Impacts
12. Energy scenarios and materials - 1
13. Energy scenarios and materials - 2
14. Resource curse and social implications of energy
15. Feedback

The exact order of topics may change. Some additional topics - particularly classes with a focus on a particular material - may be added.

The final class will have student presentations.

Energy, materials and resources(2)へ続く↓↓↓

**Energy, materials and resources(2)**

**[履修要件]**

**特になし**

**[成績評価の方法・観点]**

Evaluation in the subject will be based on:
Class performance: participation and short mid-term exercises (40%)
Final week presentation (10%)
Final report (50%)

These will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

**[教科書]**

**使用しない**

**[参考書等]**

**（参考書）**
Reading list will be supplied on PandA.

**[授業外学修（予習・復習）等]**

Some short exercises will be provided for students to undertake out of class.
Pre-reading may be provided.

**（その他（オフィスアワー等））**

Office hours are not set - consultation is available by prior appointment.

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63392 LE28　G-ENE20 63392 LE77 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Fusion Energy Science and Technology<br>Fusion Energy Science and Technology | | | | | 担当者所属・職名・氏名 | エネルギー理工学研究所 教授 長崎 百伸<br>エネルギー理工学研究所 准教授 森下 和功<br>エネルギー理工学研究所 准教授 八木 重郎<br>エネルギー理工学研究所 准教授 小林 進二 | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・後期 | 曜時限 | 火1 | 授業形態 | Lecture | 使用言語 | 英語 |

**[授業の概要・目的]**

Subjects on the science and technology of the latest information on the development of fusion energy are offered from viewpoints of energy generation, technology, material and utilization

**[到達目標]**

To understand basic knowledge and latest topics on energy generation, conversion, control and utilization of fusion energy from the aspect of technology, materials and application.
To analyze and critically evaluate the energy systems technology on which each students will be studying, and to discuss a strategy of study from social, technical, environmental and sustainability aspects.

**[授業計画と内容]**

Latest topics about the development of fusion reactor, its energy conversion systems, and material issues are lectured by 15 times of classes including feed back.

1. Fusion Energy Conversion (Yagi)
 (1)Development of Fusion Devices
 (2)Fusion Energy Conversion System
 (3)Fusion Safety
 (4)Energy, environment, and economics

2. Control of fusion energy (Nagasaki)
 (5)Ignition condition
 (6)Magnetic confinement system
 (7)Confinement, transport and stability
 (8)Plasma heating

3. Magnetically confined fusion plasma experiments (Kobayashi)
 (9) Control of fusion plasmas
 (10) Plasma diagnostic
 (11) Analytical technique for fusion plasmas

4. Recent Progress in Fusion Structural Materials R&D (Morishita)
 (12)Fusion blanket structural materials and their requirements for fusion application
 (13)Effects of high energy neutron irradiation
 (14)Modeling of radiation damage process in fusion materials
 (15)Current status of fusion materials R&D

Fusion Energy Science and Technology(2)へ続く↓↓↓

**Fusion Energy Science and Technology(2)**

**[履修要件]**

特になし

**[成績評価の方法・観点]**

Attendance and report(term paper) will be required.  Evaluation will be based on the scores of each reports to be given as 100 point maximum.

**[教科書]**

Original materials are provided. Some materials are available on the web with limited access.

**[参考書等]**

**（参考書）**

to be introduced in the lecture

**[授業外学修（予習・復習）等]**

Occasional homeworks may be given to consider an energy related topics.

**（その他（オフィスアワー等））**

always available upon appointments.

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63393 LE77　G-ENE20 63393 LE71　G-ENE20 63393 LE28 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Energy Conversion System Design<br>Energy Conversion Systems and Functional Design | | | | | 担当者所属・職名・氏名 | エネルギー科学研究科 教授　今谷　勝次<br>エネルギー科学研究科 教授　川那辺　洋<br>エネルギー科学研究科 教授　澄川　貴志 | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・後期 | 曜時限 | 火1 | 授業形態 | Lecture | 使用言語 | 英語 |

**[授業の概要・目的]**

Subjects on the conversion, control and utilization of various kinds of energy from viewpoints of science and engineering are offered.

**[到達目標]**

To understand problems, measures and their academic backgrounds in technologies for improving energy conversion efficiencies with greater safety and reliability of energy systems.

**[授業計画と内容]**

Some topics on energy conversion systems and functional designs are lectured.

1. Internal Combustion Engines (4-5 weeks)
- Fundamentals of reciprocating internal combustion engines
- Spark-ignition and diesel engines
- Technologies for clean and high-efficiency engines

2. Mechanical Properties of Nano-/Micro-sized Materials (4-5 weeks)
- Fundamentals of Mechanical Properties of Materials
- Fracture Mechanics on Nano-scale Stress Singular Field
- Fatigue of Micro-sized Metals

3. Modeling and Analyses of Solids and Structures (4-5 weeks)
- Elements of continuum mechanics
- Constitutive modeling of complex materials
- Computational mechanics of solids and structures

Courses are provided totally for 14 weeks with 1 week for feedback.

**[履修要件]**

特になし

**[成績評価の方法・観点]**

The evaluation is based on attendance and report. The report subject will be provided by each lecturer. Both the attendance rate and the result of report are important for the final score.

Energy Conversion System Design(2)へ続く↓↓↓

**Energy Conversion System Design(2)**

**[教科書]**

Handouts

**[参考書等]**

**（参考書）**
**授業中に紹介する**

**[授業外学修（予習・復習）等]**

To be announced in class if necessary.

**（その他（オフィスアワー等））**

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63607 LE79 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Applied Chemistry for Biomass Conversion<br>Applied Chemistry for Biomass Conversion | | | | | 担当者所属・職名・氏名 | エネルギー科学研究科 特定助教 QU, Chen | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・後期 | 曜時限 | 火3 | 授業形態 | | 使用言語 | 英語 |

**[授業の概要・目的]**

Biomass is a renewable and abundant feedstock, which has the potential to become a future alternative to fossil resources. This course is aimed at introducing the basic knowledge of biomass, providing overview of biomass processing chemistry, and illustrating biomass conversion strategies for value-added chemicals, fuels and materials. Furthermore, the evaluation and characterization methods of biomass components will also be introduced in this course.

**[到達目標]**

To understand the principal concepts and developments in wood chemistry and biomass conversion technology.

**[授業計画と内容]**

1. Chemical composition and distribution of biomass
2. Mono-sugars
3. Cellulose: chemistry and its application (I)
4. Cellulose: chemistry and its application (II)
5. Cellulose: chemistry and its application (II)
6. Hemicellulose
7. Lignin: chemistry and its application (I)
8. Lignin: chemistry and its application (II)
9. Lignin: chemistry and its application (II)
10. Extractives
11. UV and IR method for biomass analysis.
12. MASS method for biomass analysis.
13. NMR method for biomass analysis.
14. Final presentation (I)
15. Final presentation (II)

**[履修要件]**

None

**[成績評価の方法・観点]**

Evaluation will be based on oral presentation and/or reports (60 points) and class performance (40 points).
Oral presentation and/or reports will be assessed on the basis of achievement level for course goals.
Evaluation for class performance includes attendance and active participation.
Evaluated results of the points should be 60 and above out of 100.

60 and above: Passed
59 and below: Failed

Applied Chemistry for Biomass Conversion(2)へ続く↓↓↓

**Applied Chemistry for Biomass Conversion(2)**

**[教科書]**

Not used

**[参考書等]**

**（参考書）**

Chinnappan Baskar, Shikha Baskar, Ranjit S. Dhillon 『Biomass Conversion -The Interface of Biotechnology, Chemistry and Materials Science』（Springer）
David N.S. Hon, Nobuo Shiraishi 『Wood and Cellulosic Chemistry』（CRC Press）
『Wood Chemistry - Fundamentals and Application』

**[授業外学修（予習・復習）等]**

Depending on the progressive of the course, attendees will conduct a research and consider their assigned parts.

**（その他（オフィスアワー等））**

*Please visit KULASIS to find out about office hours.

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63608 LE28　G-ENE20 63608 LE51　G-ENE20 63608 LE60<br>G-ENE20 63608 LE61　G-ENE20 63608 LE62 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名<br><英訳> | Polymer Chemistry for Energy Science<br>Polymer Chemistry for Energy Science | | | | | 担当者所属・職名・氏名 | エネルギー科学研究科 助教　岡崎　豊 | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・後期 | 曜時限 | 月2 | 授業形態 | | 使用言語 | 英語 |

**[授業の概要・目的]**

This course will focus on polymer chemistry, which is an essential subject to design and characterize the organic-, inorganic-, and/or their composite-materials in relation to energy science.

**[到達目標]**

To understand the basic concepts and theories of polymer chemistry, which is an essential subject to design and characterize the organic-, inorganic-, and/or their composite-materials in relation to energy science.

**[授業計画と内容]**

In principal, the course will be offered as the following plan. However, it may change the order or the number of times for each theme depending on the progressive of the course.
(1) What is “Polymers”?
(2) Basic properties of polymers
(3) Polymer synthesis, degradation, and recycle
(4) Thermal and mechanical properties
(5) Electrical properties
(6) Optical and photonic properties
(7) Supramolecular polymers
(8) Polymer gels
(9) Inorganic polymers
(10) Carbon materials
(11) Biopolymers
(12) Polymers for solar cells
(13) Polymers for fuel cells
(14) Polymers for vehicles
(15) Polymers for LEDs

**[履修要件]**

None

**[成績評価の方法・観点]**

Evaluation will be based on oral presentation and reports (80 points) and class performance (20 points).
Oral presentation and reports will be assessed on the basis of achievement level for course goals. Evaluation for class performance includes attendance and active participation.

Polymer Chemistry for Energy Science(2)へ続く↓↓↓

**Polymer Chemistry for Energy Science(2)**

**[教科書]**

Not used

**[参考書等]**

**（参考書）**

Introduced during class

**[授業外学修（予習・復習）等]**

Depending on the progressive of the course, attendees will conduct a research and consider their assigned parts.

**（その他（オフィスアワー等））**

*Please visit KULASIS to find out about office hours.

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63615 LE43 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Environmental Economics<br>Environmental Economics | | | | 担当者所属・職名・氏名 | 地球環境学舎 教授　　竹内　憲司 | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・前期 | 曜時限 | 月1 | 授業形態 | 講義 | 使用言語 | 英語 |

**[授業の概要・目的]**

This course will provide a basic understanding on the economics of environmental policy at the introductory level. The course covers normative and positive analysis of environmental issues from the economic point of view.

**[到達目標]**

Students learn how to frame and discuss environmental issues and policy in terms of economic theory and empirical evidence.

**[授業計画と内容]**

Session 1. The Environment and Economics [1], Normative and Positive Economic Analysis [2]
Session 2. Social Choice [3], Efficiency and Markets [4], Market Failure [5]
Session 3. Making Decisions about Environmental Programs [6], Demand for Environmental Goods [7]
Session 4. Hedonic Price Theory [8]
Session 5. Household Productions [9]
Session 6. Constructed Markets [10]
Session 7. Regulating Pollution [11]
Session 8. Feedback
Session 9. Emission Prices and Fees [12]
Session 10. Property Rights [13]
Session 11. Regulation with Unknown Control Costs [15], Audits, Enforcement, and Moral Hazard [16]
Session 12. International and Interregional Competition [19]
Session 13. Environment, Growth, and Development [20]
Session 14. Discussion
Session 15. Feedback
* Numbers in square brackets are chapters in the textbook.

**[履修要件]**

特になし

**[成績評価の方法・観点]**

Contribution to discussion session  50%
Final Exam  50%

Environmental Economics(2)へ続く↓↓↓

**Environmental Economics(2)**

**[教科書]**

Charles D. Kolstad 『Environmental Economics』 （Oxford University Press, 2011）

**[参考書等]**

**（参考書）**

**授業中に紹介する**

A reading list will be available by the start of the course.

**[授業外学修（予習・復習）等]**

Students are expected to read the assigned papers and prepare for the discussion in the class.

**（その他（オフィスアワー等））**

Office Hours: Please schedule an appointment by email.

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63616 LE28 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Energy Future of the Asia-Pacific Region<br>Energy Future of the Asia-Pacific Region | | | | | 担当者所属・職名・氏名 | エネルギー科学研究科 教授 石原 慶一<br>(一財)アジア太平洋エネルギー研究センター 入江 一友 | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・前期 | 曜時限 | 金4 | 授業形態 | 講義 | 使用言語 | 英語 |

**[授業の概要・目的]**

This course aims to provide an overview of energy issues and future projections of energy demand and supply in the Asia Pacific region. It is based on the results of research focused on current energy issues and challenges in the Asia Pacific region, specifically APEC rnernber economies.

**[到達目標]**

The goals of the course are to convey to students the diversity and dynamics of energy markets in the Asia Pacific region, including demand and supply challenges facing APEC member economies and how the APEC member governments are planning to address those challenges.

**[授業計画と内容]**

The course will consist of lectures and interactive sessions on the following key themes:

1. Introduction: Overview of the APEC Energy Demand and Supply Outlook and modelling approach
2. Energy statistics and energy demand/supply analysis
3. Energy Demand in the buildings and agriculture sectors
4. Industrial energy demand
5. Transport energy demand
6. Power and heat
7. Coal
8. Natural gas
9. Oil
10. Renewable energy
11. Hydrogen
12. Possibility of Net-zero or carbon neutrality
13. Energy investment
14. Implications for energy security and resilience

**[履修要件]**

特になし

**[成績評価の方法・観点]**

Students will be evaluated on two major elements:

1. Participation in class activities (50%)
2. Submission of a final report (50%)

Grading is done according to the evaluation policy of the Graduate School of Energy Science.

Energy Future of the Asia-Pacific Region(2)へ続く↓↓↓

**Energy Future of the Asia-Pacific Region(2)**

**[教科書]**

**使用しない**

**[参考書等]**

**（参考書）**

『APEC Energy Demand and Supply Outlook 8th Edition (to be published in 2022)』

**[授業外学修（予習・復習）等]**

**（その他（オフィスアワー等））**

Available by appointment.

**※オフィスアワーの詳細については、**KULASIS**で確認してください。**

| 科目ナンバリング | G-ENE20 63617 LE11　G-ENE20 63617 LE59 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Simulation and Data Science<br>Simulation and Data Science | | | | | 担当者所属・職名・氏名 | エネルギー科学研究科 准教授　今寺　賢志 | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・後期 | 曜時限 | 木3 | 授業形態 | 講義 | 使用言語 | 英語 |

**[授業の概要・目的]**

現代科学の根幹をなす計算機を用いた研究アプローチとして，「シミュレーション科学」と「データ科学」が挙げられる．「シミュレーション科学」は，何らかの数値計算手法を用いて，与えられた支配方程式の近似解を求めるという演繹的方法論と定義できる一方，「データ科学」は，何らかの統計数理的手法を用いて，得られたデータの背後にある法則性を抽出・推定するという帰納的方法論である．

本講義では、この「シミュレーション科学」と「データ科学」の基礎理論を理解すると共に，学生自身がそのプログラミングを自らの手で行うことで，実用レベルの能力を身に付けることを目指す．

**[到達目標]**

(1) プログラム言語Pythonで自らプログラミングできる能力を習得する．
(2) シミュレーション科学の基礎として，常微分方程式の解法を理解する．
(3) データ科学の基礎として，回帰分析とニューラルネットワークモデルを理解する．
(4) (2), (3)で学んだ方法論が研究の最前線で実際にどのように活用されているかを学び，自らの研究分野に応用するイメージを形成する．

**[授業計画と内容]**

第1回：ガイダンス
本講義のガイダンスを行った後，PythonをWebブラウザ上で実行できる開発環境Jupyter Notebook を各自のノートPCに導入する．

第2回：ハードウェアの基礎・数値計算の基礎
数値計算を行うハードウェアの基礎としてCPU/GPUやメモリシステムについて理解する．また，数値計算の基礎として数の内部表現や誤差について理解する．

第3-5回：Pythonの基礎
Pythonの文法の基礎として変数の設定，繰り返し計算，条件分岐，グラフの描画方法等を習得し，それらのプログラミングを行う．

第6-7回：常微分方程式の数値解法
数値積分法として矩形積分と台形積分を理解した後，常微分方程式の解法としてEuler法とCrank-Nicolson法を理解し，それらのプログラミングを行う．

第8-9回：回帰分析
最小二乗法や最急降下法を用いた単回帰モデルと，ロジスティック回帰を用いた統計的回帰モデルについて理解し，それらのプログラミングを行う．

第10-12回：ニューラルネットワークモデル

Simulation and Data Science(2)へ続く↓↓↓

**Simulation and Data Science(2)**

データ科学の主たる方法論の一つであるニューラルネットワーク(Neural Network, NN)モデルについて理解した後，手書き文字の自動認識を行うためのNNモデルの構築と，データから常微分方程式を推論するためのNNモデルの構築を行う．

第13-14回：プラズマ物理におけるシミュレーション/データ科学
実際にシミュレーション/データ科学が重要な方法論となっているプラズマ物理分野を例に，研究の最前線でそれらがどのように活用されているかを学ぶと共に，今後の可能性について議論する．

第15回：フィードバック授業

**[履修要件]**

大学1回生で学修する微分積分学を前提とする．プログラミングの初歩的技術を習得していることが望ましいが，前提要件ではない．

**[成績評価の方法・観点]**

(A)各コマ中に出題される小テストの点数と，(B)2コマに1回程度出題されるプログラミングに関する宿題の点数，(C)期末レポートの点数の合計で評価する．点数配分は，(A)：(B)：(C)=3：3：4とする．

**[教科書]**

使用しない．各講義で使用する資料等は原則，事前にPandAにアップロードする．

**[参考書等]**

（参考書）
プラズマ・核融合学会 『プラズマシミュレーション 多階層複雑現象の解明へ』（京都大学学術出版会）ISBN:9784814001835

**[授業外学修（予習・復習）等]**

本講義は事前学習を重視して構成しており，以下の予習と復習を求めている．
予習：PandAにアップロードされた講義資料を講義前に熟読し，例題を予め解く．
復習：2コマに1回程度出題される宿題を解く．

**（その他（オフィスアワー等））**

※オフィスアワーの詳細については、KULASISで確認してください。

| 科目ナンバリング | G-ENE20 63618 LE28 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 授業科目名 <英訳> | Carbon Neutrality<br>Carbon Neutrality | | | | | 担当者所属・職名・氏名 | エネルギー科学研究科 教授 石原 慶一<br>エネルギー科学研究科 教授 MCLELLAN, Benjamin<br>エネルギー理工学研究所 講師 ARIVAZHAGAN RAJENDRAN | | | | | |
| 配当学年 | 修士 | 単位数 | 2 | 開講年度・開講期 | 2022・前期 | 曜時限 | 金2 | 授業形態 | 講義 | 使用言語 | 英語 | |

**[授業の概要・目的]**

To deepen the knowledge of carbon neutrality and discuss the barriers and strategies.

**[到達目標]**

By the end of the course, students will have advanced knowledge and a high-level understanding of carbon neutrality.

**[授業計画と内容]**

The course will cover the following topics over 15 weeks, including feedback. The order will be announced on the first day of class.

(introduction)

1. Definition of carbon neutrality

(measurements)

2. Life Cycle Assessment (LCA) and carbon neutrality

3. Carbon footprints - standards and methods

(technology)

4-8. Technology for zero-carbon energy (I) (Non-carbon fuels and power)

i) Solar energy

ii) Wind energy

iii) Geothermal energy

iv) Biomass energy

Materials for carbon-free energy production and conservation

9. Technology for zero-carbon energy (II) (CCS)

10. Negative-emissions technology (BECCS)

11. Energy Efficiency

**Carbon Neutrality(2)へ続く↓↓↓**

**Carbon Neutrality(2)**

(policy #8211 promotion mechanism)

12. Carbon offsets, carbon pricing

13. Sectoral approaches for net-zero emissions (ZEH, ZEB)

14. Policy for institutional innovation (National; International)

15. Feedback

**[履修要件]**

No requirements

**[成績評価の方法・観点]**

The evaluation is based upon these factors. Out of a possible 100 points:
1. Essays (60 points).
2. Class participation and short exercises (40 points).

[evaluation policy]
Will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

**[教科書]**

**[参考書等]**

**（参考書）**
Reference books will be introduced in class.

**[授業外学修（予習・復習）等]**

Students are recommended to read the textbook in advance of the lectures.

**（その他（オフィスアワー等））**

**※オフィスアワーの詳細については、KULASISで確認してください。**