Space Engineering International Course
Syllabus 2021

English XA（英語　ＸＡ）

Subject code, Lecturer, Credit
26009663, RUXTON Ian, Credit 1

1. Course Description

To teach students how to write technical abstracts, and full research papers that meet global standards. Students will bring in content that is related to their thesis, and will learn to build up their academic writing ability. They will learn more technical terminology, and various aspects of how to best structure their academic paper and thesis. They will learn to summarize academic papers.
They will be exposed to spoken English (videos of lectures etc.) related to their research field.

Classes will be conducted with weekly Zoom meetings and Moodle.

*Intended for students of the Space Engineering International Course (SEIC).

2. Schedule

1. Course overview, summary and paraphrasing and avoiding plagiarism. Step-by-step introduction to characteristics of a good abstract.
2. Review of summarizing and paraphrasing; introduction to self- and peer-evaluation techniques; Abstract introduction and method. Homework as directed by the instructor: Summary of research.
3. Abstract discussion and conclusion. Turn in your study's summary.
4. Introduction to common errors
5. Presenting your research (1) (practice); Self-evaluation and goal setting; Editing.
6. Presenting your research (2); Peer-reviewing (structure, format and language conventions review).
7. Summarizing academic papers (1) Choosing an appropriate topic
8. Summarizing academic papers (2); Homework as directed by the instructor
9. Writing research introduction; Researching the topic background; Describing aims and writing good research questions; Write a summary about your study's introduction, literature, problem and research questions; Homework as directed by the instructor
10. Writing research method; Poster Session writing: Turn in summary of study's introduction.
11. Writing research results; Poster Session writing; Turn in summary of research method. Homework as directed by the instructor
12. Write the discussion and significance of your research results. How to present results; Poster writing, facts, details and delivery. Turn in summary of research results. Homework as directed by the instructor.
13. Writing research references and citations . Presenting your research (practice), as well as on student self-evaluation, goal setting, along with reviewing the fundamentals of abstract and academic writing. Turn in completed summary; Homework as directed by the instructor.
14. Presenting your research (1); Peer-editing (structure, format and language conventions review). Homework as directed by the instructor.
15. Peer-editing; Turn-in Final Paper
16. Final Exam and student survey

3. Purpose

1. Understand the basic conventions of an abstract
2. Understand how to concisely state research objectives, explain the research background, describe the research design and present results
3. Understand how to use appropriate register and tone for the specific genre of writing
4. Be able to write grammatically accurate sentences using appropriate vocabulary

4. Method of evaluation

20% Summary of Student's Study
20% Research Drafts
20% Teacher Discretion
40% Final Exam

5. Notification

All class sessions are conducted in English. This class has informal conversation, peer-assisted learning and writing practice.

6. Additional work

Active participation is expected in class activities. Students are expected to prepare for class warm-up each week and assist each other.

Students are expected to set aside 0.5 hours a week as time for class preparation.

7. Textbook, reference book

Writing Research Papers (published by Macmillan)
English-English dictionaries will be helpful.

8. Key words

Descriptive writing, evaluation, cooperative / autonomous learning, creative process: brainstorming, organizing, drafting, reviewing, revising, publishing

9. Email address

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Japanese for Beginners（日本語入門）

Subject code, Lecturer, Credit
42000809, ISHIKAWA Tomoko, Credit 1

1. Course Description
   This course is for international students of the Space Engineering International Course only.
   The purpose of the course are (1) to get used to Japanese phoneme system, (2) to master basic Japanese sentence patterns and vocabulary, (3) to be able to speak simple Japanese, and (4) to master HIRAGANA and KATAKANA

2. Schedule
   (1) Basic greeting expressions and self introduction
   (2) Counting system and time-measuring system
   (3) Sentences using nouns
   (4) Numeral and Japanese counter words
   (5) Shopping conversation
   (6) Sentences to express existence
   (7) Expressions of dates and periods of time
   (8) Review
   (9) Introduction of basic verbs
   (10) Sentences using verbs
   (11) Conversation using basic verbs (non-past)
   (12) Conversation using basic verbs (past)
   (13) Two types of adjectives and their usage
   (14) Introduction of "Te-form"
   (15) Sentences using "Te-form"
   (16) Review and Test

3. Purpose
   1. to get used to Japanese phoneme system,
   2. to master basic Japanese sentence patterns and vocabulary
   3. to be able to speak simple Japanese

4. Method of evaluation
   Class participation, assignments, the final written and oral tests

5. Notification
   We will use a romanized Japanese textbook and concentrate on developing the basic hearing and speaking abilities required in daily life.

6. Additional work
   Students are expected to set aside 30 minutes a week as time for class preparation..
   Do every assignment and review the lesson.

7. Textbook
   （1）Textbook: Beginner's Japanese for KIT Foreign Students
   （2）Exercise book: Exercise Book of Beginner's Japanese for KIT Students
   Reference: Nihongo Kiite Hanashite（The Japan Times）

8. Key words

9. Email address
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Space Environment Testing Workshop（宇宙環境試験ワークショップ）

Subject code, Lecturer, Credit
26000813, CHO Mengu, Credit 1

1. Course Description and Purpose
A satellite is exposed to extreme environments such as vacuum, radiation and plasma. It is also exposed to severe vibration and shock onboard a rocket. Satellites have to operate maintenance-free and need to be tested thoroughly before the launch. The purpose of this subject is to learn the actual tests through hands-on laboratory workshop.

*Space Environment Testing Workshop is a subject for the Space Engineering International Course (SEIC).
*The classes will be laboratory workshops.

2. Schedule
1. Vibration - overview
2. Vibration - preparation
3. Vibration test
4. Vibration - analysis
5. Shock - overview
6. Shock - preparation
7. Shock test
8. Shock - analysis
9. Thermal vacuum - overview
10. Thermal vacuum - preparation
11. Thermal vacuum test
12. Thermal vacuum - analysis
13. Thermal cycle overview and preparation
14. Thermal cycle test
15. Thermal cycle - analysis

3. Purpose
1. Obtain hands-on experience of spacecraft testing
2. Understand the testing principle

4. Method of evaluation
Report

5. Notification
This workshop is for students who register the Space Engineering International Course only. Students are supposed to finish Space Environment Testing.

6. Additional work
Download and read the lecture material before each lecture.

7. Textbook and Reference book
Text book: None
References:
HARRIS' SHOCK AND VIBRATION HANDBOOK, Allan G. Piersol, Thomas L Paez, Macgrawhill,
Spacecraft Thermal Control Handbook, David G. Gilmore, Aerospace Press
JAXA-JERG-2-130「宇宙機一般試験標準」
SMC-S-016 "TEST REQUIREMENTS FOR LAUNCH, UPPER-STAGE AND SPACE VEHICLES"
ISO-15864 "Space systems — General test methods for space craft, subsystems and units"
ECSS-ST-10-03 "Space Engineering – Testing"

8. Key words
Spacecraft Environment, Testing

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Space Systems PBL I（宇宙システム PBL Ⅰ）

Subject code, Lecturer，Credit
26990824, CHO Mengu, Credit 1

Space Systems PBL Ⅱ （宇宙システム PBL Ⅱ）

Subject code, Lecturer，Credit
26990825, CHO Mengu, Credit 1

1. Course Description

Space system spans a wide range of fields such as mechanical, electrical, material and other engineerings and consists of a huge number of parts and numerous softwares. It is also required to function maintenance-free for a long time in the extreme environment in space. A satellite flies over any countries regardless the border. Therfore, its usage requires a glbal point of view. It is not sufficient to learn via textbooks and lectures, in order to learn how to design the system elements, combine them, test and operate to bring the satellite value to the users. Students carry out a project in a group made of a few numbers to develop hypothetical space system or real nano-satellite, rocket, spacecraft and others. Students organize the user requirements and perform system conceptual design by incorporating them into the system requirements and the design requirements. This PBL will be conducted in English as a subject of Space Engineering International Course.

*Space Systems PBL I and Space Systems PBL II is a subject for the Space Engineering International Course (SEIC).

*To be announced by the project supervisors.

2. Schedule

To be announced by the project supervisors.

3. Purpose

1. Obtain experience of space system design
2. Obtain experience of inter-cultural communication

4. Method of evaluation

To be announced for each project.

5. Additional work

To be announced for each project.

6. Textbook and Reference book

To be announced for each project.

7. Key words

To be announced for each project.

8. Email address

To be announced for each project.

Thesis Research for Degree（工学講究）

Subject code, Lecturer，Credit

26990833, Primary supervisor, Credit 2

Course Description

In the course of writing a master's thesis, students will be instructed on research plans, methods of research, and how to summarize research results regarding the master thesis subject. The course will guide students to write theis writing focusing thesis organization, research planning, problem solving methods, summarizing the results.

Special Laboratory Work（工学特別実験）

Subject code, Lecturer，Credit

26990834, Primary supervisor, Credit 1

Course Description

In the course of writing a master's thesis, students will be instructed on research plans, methods of research, and how to summarize research results regarding the master thesis subject. The course will guide students to do laboratgory works regarding data management, safety, experimental practice and other practical aspects of the research.

Advanced Embedded Systems（組み込みシステム特論）

Subject code, Lecturer，Credit
26100001, ASAMI Kenichi, Credit 2

1. Course Description
   This lecture provides design methodology, working principles, and organization of embedded systems. Fundamentals of computer architecture, digital circuits, and systems modeling languages will be introduced.

2. Schedule
   (1) Embedded systems
   (2) Logic circuits (1)
   (3) Logic circuits (2)
   (4) Verilog HDL (1)
   (5) Verilog HDL (2)
   (6) FPGA (1)
   (7) FPGA (2)
   (8) ARM microprocessor (1)
   (9) ARM microprocessor (2)
   (10) UML/SysML (1)
   (11) UML/SysML (2)
   (12) SystemC (1)
   (13) SystemC (2)
   (14) Presentation (1)
   (15) Presentation (2)

3. Purpose
   1. Students expand understanding of embedded systems design.
   2. Students enhance understanding of digital systems development.
   3. Students utilize understanding of systems modeling languages.

4. Method of evaluation
   The grade is evaluated by mini-tests, presentation, and final report.

5. Notification
   Students are required to review the lecture slides.

6. Additional work
   Students are expected to set aside 4 hours a week as time for class preparation.

7. Textbook
   The lecture slides will be provided on Moodle.
   Reference book
   [1] Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design 2nd Edition, Morgan Kaufmann, 2008.
   [2] Sarah Harris, David Harris, Digital Design and Computer Architecture ARM Edition, Morgan Kaufmann, 2015.
   [3] Clive Maxfield, The Design Warrior's Guide to FPGAs, Newnes, 2004.

8. Key words
   Embedded systems, FPGAs, ARM microprocessor, UML/SysML, SystemC

9. Email address

Advanced Mechanics of Materials（材料力学特論）

Subject code, Lecturer, Credit
26450810, YAMAGUCHI Eiki, Credit 2

1. Course Description and Purpose

For a good prediction of structural behavior, the modeling of material behavior (stress-strain relationship) is very important. To this end, plasticity-based modeling of material behavior is studied in this course.

2. Schedule

1. One-Dimensional (1D) Material Modeling
2. Plasticity-Based Modeling of 1D
3. Plasticity-Based Modeling of 1D
4. Example Problem
5. Essentials of Stress
6. Essentials of Stress
7. Essentials of Strain
8. Essentials of Stress-Strain Relationship
9. Plasticity Theory in Multi-Dimension
10. Plasticity Theory in Multi-Dimension
11. Plasticity Theory in Multi-Dimension
12. Stress-Strain Relationship
13. Stress-Strain Relationship
14. Example Problem
15. Example Problem

3. Method of evaluation

Examinations

4. Notification

5. Additional work

It is required to understand thoroughly each lecture.
Students are expected to study for 4 hours a week for this coursein in addition to the lectures.

6. Textbook and Reference book

Reference book:
Plasticity for Structural Engineers, Wai-Fah Chen and Da-Jian Han
J. Ross Publishing

7. Key words

8. Email address

To be announced during the lecture

Advanced Architectural Structure（建築構造特論）

Subject code, Lecturer，Credit
26450902, CHEN Pei-Shan, Credit 2

1. Course Description
This course will introduce you to the study of nonlinear behavior of structures, including the basic theories on buckling analysis of space frames, analysis of cable structures, and Elasto-Plastic analysis of rigid frames. Furthermore, this course will equip you with the knowledge to anchor your understanding of structural design of space structures, high-rise buildings and mechanical structures. This is also a course of Space Engineering, and the lectures will be given in English.

2. Schedule
(1) Introduction, Nonlinear analysis (Part 1): Nonlinear Analysis of a 2-Bar system
(2) Nonlinear analysis (Part 2): Principle of stationary potential energy
(3) Nonlinear analysis (Part 3): Iteration and incremental analysis (Geometric stiffness)
(4) Nonlinear analysis (Part 4): Coordinate transformation and nonlinear element stiffness matrices
(5) Nonlinear analysis (Part 5): Nonlinear stiffness matrices by principle of virtual work
(6) Nonlinear analysis (Part 6): Incremental analysis and convergence
(7) Nonlinear analysis (Part 7): Nonlinear buckling analysis and bifurcation of space frames
(8) Nonlinear analysis (Part 8): Linear buckling analysis
(9) Cable structure (Part 1): Suspension cables (parabolic profile)
(10) Cable structure (Part 2): Suspension cables (catenary profile), Influence of boundary condition
(11) Cable structure (Part 3): Prestressing analysis of tensegric structures
(12) Cable structure (Part 4): Linear and nonlinear analysis of tensegric Structures
(13) Elasto-plastic analysis (Part 1): Homogeneous Beams
(14) Elasto-plastic analysis (Part 2): Combined Bending and axial force
(15) Elasto-plastic analysis (Part 3): Elasto-plastic analysis of structures

3. Purpose
The acquisition of the fundamentally advanced knowledge:
1. Nonlinear analysis of space frames and mechanical structures
2. Structural analysis of cable structures
3. Elasto-plastic analysis of building and mechanical structures

4. Method of evaluation
The overall grade will be decided based on short reports and the attendance.

5. Notification
It is desirable that the attendees have the basic knowledge of Structural Mechanics.

6. Additional work
Attendees of this course should spend more than 7 hours and 30 minutes to study the concerning knowledge and review the lessons provided in undergraduate curricula. Furthermore, the attendees should prepare to explain and/or solve questions in turn during lectures. Reports should be submitted in time.

7. Textbook and Reference book
No textbook. Reference books may be introduced during the lecture.

8. Key words
Nonlinear analysis, Buckling analysis, Space frames, Elasto-plastic analysis

9. Email address
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High-speed Gas Dynamics（高速気体力学特論）

Subject code, Lecturer, Credit
26440903, TSUBOI Nobuyuki, Credit 2

1. Course Description and Purpose

Rockets, airplanes, and space vehicles fly under severe environments. The flight velocity changes from subsonic speed to supersonic and hypersonic speeds. The flight environment changes from a continuum regime to a low-density regime. This course presents fluid dynamics under such the flight environments of the space vehicles to understand the fundamental of the fluid dynamics.

2. Schedule

1. Introduction
2. Fundamental theory of compressible flow
3. Hypersonic gas dynamics
   (1) What is hypersonic low?
   (2)Experimental approach
   (3) Various approximate solution methods
   (4) Inviscid hypersonic flow
   (5)Viscous hypersonic flow
   (6)Real gas effects
   (7)Radiation
   (8)Wind tunnel testing for hypersonic flow
4. Rarefied gas dynamics
   (1)What is rarefied gas dynamics?
   (2)Feature of gas dynamics from microscopic view
   (3)Feature of gas under equilibrium state
   (4)Gas-surface interaction
   (5)Numerical simulation on rarefied gas dynamics
5. Examination

3. Purpose

Understand the following topics:

1. Feature of hypersonic flow
2. Various approximation methods
3. Real-gas effects
4. Rarefied gas dynamics

4. Method of evaluation

Grade is evaluated by attendance of class, reports, and final examination.

5. Notification

It is desirable or recommended for the students to take courses related to “Fluid Dynamics”, “Compressible Fluid Dynamics” and so on in the undergraduate course.

【Notes on course】
It is desirable to have a basic knowledge of thermofluid dynamics, especially compressible fluid dynamics. Lecture according to the above items.
In order to promote understanding of the content of the lecture, exercises, review reports, and reports for preparation are imposed.

【Class form: Distance class (online or on-demand classes)】

(1) Form: Synchronous classes by Zoom connection

(2) Number of the classes: 16

(3)

-How to take this class: Take by Zoom connection. Download the lecture slide from Moodle. Submit your reports through Moodle.

-Attendance confirmation method: Check attendance by Moodle.

-Examination method: Remote examination by Zoom connection (details will be informed separately)

(4) Others

If there are foreigners, this lecture will be conducted in English.

6. Additional work

You should read distributed materials before the lecture and investigate some technical home works. Students are expected to set aside 4 hours a week as time for class preparation.

7. Textbook

Distributed prints

References

(1) J.D.Andarson, Jr., Hypersonic and High Temperature Gas Dynamics, McGraw-Hill (1989)

(2) Bird, G.A., Molecular Gas Dynamics and the Direct Simulation of Gas Flow, Oxford (1994)

(3) 日本機械学会 編，原子・分子の流れ，共立出版(1996)

(4) 小林敏夫 編，数値流体力学ハンドブック，丸善(2003)

8. Key words

Hypersonic Flow, Compressible Flow, Reentry, Rarefied Gas Flow

9. Email address

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Advanced Space Robotics（宇宙ロボティクス特論）

Subject code, Lecturer，Credit

26630001, NAGAOKA Kenji, Credit 2

1. Course Description and Purpose

Currently, robotics technologies have been required for various space applications to support or replace human space activities. In particular, robotics exploration is necessary for deep space exploration. This course introduces fundamentals and applications of space robotics. Specifically, this course expects students of learning and better understanding of fundamental mechanics, control technique, and autonomous technology of space robotics.

*2021 年度の本講義は Moodle と Zoom によるオンライン形式を基本とする.

This lecture is mainly provided based on Moodle and Zoom.

2. Schedule

1. Introduction of Space Robotics
2. Kinematics and Dynamics of Space Manipulator
3. Control of Space Manipulator
4. Contact Dynamics of Space Manipulator
5. Object Capture by Space Manipulator
6. Vibration Suppression Control of Flexible Space Structure
7. Tele-Operation Technology and Autonomy
8. Locomotion Mechanism of Planetary Robot
9. Terramechanics for Planetary Robotics (1)
10. Terramechanics for Planetary Robotics (2)
11. Autonomous Technology for Planetary Robotics (1)
12. Autonomous Technology for Planetary Robotics (2)
13. Robotics for Minor Body Exploration
14. Drilling Technology on Extraterrestrial Body
15. Backup and Introduction of State-of-the-Art Topics

3. Method of evaluation

Comprehensive evaluation of attendance and reporting assignments.

4. Notification

This lecture is provided in English. It is desirable for students to have fundamentals of robotics and control engineering.

5. Additional work

Four-hour-a-week of self-learning for preparation based on the lecture materials and reference books.

6. Textbook

N/A.

References

[1] Y. Xu and T. Kanade, Space Robotics: Dynamics and Control, Kluwer Academic Publishers.
[2] A. Elley, An Introduction to Space Robotics, Springer.
[3] J. Y. Wong, Theory of Ground Vehicles, Wiley.
[4] G. H. Heiken et al., Lunar Sourcebook: A User's Guide to the Moon, Cambridge University Press.

7. Key words

Robotics, Control Engineering, Space Technology, Contact Dynamics, Terramechanics

8. Email address

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Advanced High Velocity Impact Engineering（高速衝突工学特論）

Subject code, Lecturer, Credit

26440810, AKAHOSHI Yasuhiro, Credit 2

1. Course Description and Purpose

The objective of this lecture is to gain the knowledge of the basic theory of high velocity impact such as fan blade off damage on fan case or hypervelocity impact on space structure such as space debris impact on International Space Station. In this lecture stress propagation and mechanism of hypervelocity impact phenomena will be addressed. The course's aim is also to further one's understanding in a specialised field through English.

2. Schedule

(1) Introduction of space debris
(2) Introduction of low, high, hypervelocity impact
(3) Fundamental relationships(1)
(4) Fundamental relationships(2)
(5) Material response(1:metals and ceramics)
(6) Material response(2:composites)
(7) Impedance
(8) Non-penetrating impacts
(9) Strength Effect
(10) Tate model
(11) HVI: semi-infinite target
(12) HVI: finite target
(13) Hydrocode
(14) Scale Modeling
(15) Final Examination
(16) Summary

3. Purpose

1. Understand strain rate effect
2. Understand spall fracture
3. Understand features of ballistic limit curve
4. Understand conservation equations and simple models such as Tate model

4. Method of evaluation

Grade is evaluated by taking the score of short quizzes and final examination into account.

5. Notification

It is desirable or recommended for the students to take courses related to "Strength of Material", "Solid Mechanics" and so on in the undergraduate course.

6. Additional work

Students are expected to set aside 4 hours a week as time for class preparation.

7. Textbook

None

Reference book

(1) Zukas et al, Impact Dynamics, KRIEGER, 1982
(2) Melosh, Impact Cratering, OXFORD, 1989
(3) Horie and Sawaoka, Shock Compression Chemistry of Materials, KTK Scientific Publishers, 1993

(4) Norman Jones, Structural Impact, Cambridge University Press, 1990
(https://doi.org/10.1017/CBO9780511624285)

8. Key words
Hypervelocity Impact, Space Debris, Shock Wave

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Advanced Space Dynamics（スペースダイナミクス特論）

Subject code, Lecturer，Credit
26440819, HIRAKI Koju, Credit 2

1. Course Description and Purpose
   This course aims to promote the understandings of the basic formulations of two-body problems in three-dimensional coordinates, taking an artificial satellite and a spacecraft as examples. The lectures are given in English.

   *How to conduct the lecture
   About half of the total number of lectures will be held face-to-face, but it may be switched to a remote class depends on the situation. The lecture materials will be provided on the Moodle page.

2. Schedule
   （1）Keplerian orbit
   （2）Elliptical orbit
   （3）Kepler's law
   （4）Kepler's equation
   （5）Oribital elements
   （6）Orbits of planets in solar system
   （7）Transformations to Earth-centered frames
   （8）Shape of Earth
   （9）Prediction of orbit of ISS
   （10）Observation of ISS
   （11）Hohmann transfer
   （12）Inerplanetary trajectory
   （13）Launch window
   （14）Design of trajectory of interplanetary travel
   （15）Creation of future mission

3. Purpose
   This course aims to understand how a spacecraft can be sent to the deep space.
   1. Understand orbital elements
   2. Predict the positions of a satellite on the orbital element
   3. Understand a launch window

4. Method of evaluation
   Several assingments will be given. Students are required to submit documents for them. For some assingments students are requested to make presentations in front of attendee.

5. Notification
   Questions are acceptable through e-mails, as well as during the lectures.
6. Additional work
   The basics are given in the course. The assignments are achievable based on the knowledge given in the lectures. You are required to spend on works at home about four hours per week.
7. Textbook and Reference book
   Textbook: Not specified
   References: 茂原正道、鳥山芳夫「衛星設計入門」 培風館
8. Key words
   spacecraft, trajectory prediction, deep-space exploration

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Heat Transfer（熱輸送特論）

Subject code, Lecturer, Credit

26000814, MIYAZAKI Koji, Credit 2

1. Course Description and Purpose

In this class, we intend to teach an introductory heat transfer such as heat conduction, convective heat transfer, and radiative heat transfer. We teach a few simple numerical methods for heat transfer problems to understand the heat transfer.

* This class is scheduled for the students in the international space engineering course.

2. Schedule

(1) Modes of heat transfer
(2) Heat conduction, Thermal resistance model
(3) 1 Dimensional unsteady state heat conduction
(4) Unsteady state heat conduction, Heisler-type charts
(5) Numerical simulation for heat conduction
(6) Introduction to radiative heat transfer
(7) Radiative heat transfer, Shape factor
(8) Radiatvie heat transfer, Electrical network analogy
(9) Radiative heat transfer, Gray body
(10) Radiative heat transfer and Heat conduction
(11) Convection, Dimensional analysis
(12) Convective heat transfer
(13) Numerical simulation for convective heat transfer
(14) Turbulent convective heat transfer
(15) Applications (Heat pipes, Heat exchangers, Thermoelectric)

3. Purpose

1. Understanding of heat conduction
2. Understanding of radiative heat transfer
3. Understanding of convective heat transfer

4. Method of evaluation

Students will be evaluated by attendance reports, results of class assignments, and the results of a final assignment.

5. Notification

The students must have studied basic physics and computer programming for engineering.

6. Additional work

Students are expected to set aside 4 hours a week as time for class preparation.

7. Textbook

A.F. Mills, Heat Transfer, Prentice Hall

J. H. Lienhard, A Heat Transfer Textbook, Prentice Hall

Reference book

P.V. Bockh, T. Wetzel, Heat Transfer Basic and Practice, Springer

8. Key words

9. Email address

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Introduction to Satellite Engineering（衛星工学入門）

Subject code, Lecturer, Credit
26500908, CHO Mengu, Credit 2

1. Course Description and Purpose
   The purpose of this lecture is to provide an overview of satellite engineering with its emphasis on micro- and nano-satellite technologies and systems engineering approach such as verification and test.

2. Schedule
   1. Introduction
   2. Propulsion Basics
   3. Propulsion System
   4. Orbital Mechanics
   5. Mission Analysis part.1
   6. Mission Analysis part.2
   7. Mission Analysis (constellation)
   8. Electrical Power Systems
   9. Prelaunch Environment and Spacecraft Structures
   10. Spacecraft Dynamics and Attitude Control part.1
   11. Spacecraft Dynamics and Attitude Control part.2
   12. Thermal Control
   13. Communication part.1
   14. Communication part.2
   15. Small Satellite Engineering

   * The lectures will be done according to the schedule above. Some of the lectures will be done remotely.

3. Purpose
   Understand the basic of satellite system

4. Method of evaluation
   Home works and discussion in the class

5. Notification
   This lecture is provided in English.

6. Additional work
   Download and read the lecture material before each lecture.
   Students are expected to set aside 4 hours a week as time for class preparation.

7. Textbook
   Textbook:
   1. Spacecraft Systems Engineering, edited by Peter Fortescue et al., Wiley
   Reference book:
   2. Space Mission Analysis and Design, Third Edition, edited by James Werts and Wiley Larson, Space Technology Library
   3. Space Vehicle Design, second edition, Michael Griffin and Jame French, AIAA

8. Key words
   Satellite engineering, Spacecraft Systems Engineering

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Satellite Power System Ⅰ （衛星電力システム特論Ｉ）

Subject code, Lecturer, Credit
26500928, CHO Mengu, NOZAKI Yukishige, OKUMURA Teppei, Credit 1

1. Course Description and Purpose
   Power system is one of the most important subsystems to determine the fate of satellite mission. Without power, a satellite is useless. This lecture provides introduction of satellite power system from individual elements to overall pictures, as well as future prospect.

2. Schedule
   1. Architecture of electrical power system
   2. Photovoltaic-Battery System
   3. Power system design
   4. Solar cell principle
   5. Space solar cell state-of-art
   6. Environmental effect
   7. Environmental effect
   8. Solar array system

   * The lectures will be done according to the schedule above. Some of the lectures will be done remotely.

3. Purpose
   Understand the satellite power system

4. Method of evaluation
   Reports and mini tests

5. Notification
   This lecture is provided in English. It is desirable for students to take Space Systems Engineering (宇宙システム工学) and/or Introduction to Satellite Engineering (衛星工学入門) as well. It is strongly recommended to take Satellite Power System Ⅱ with this subject.

6. Additional work
   Read a paper listed as reference during each lecture.
   Students are expected to set aside 2 hours a week as time for class preparation.

7. Textbook and Reference book
   Textbook:
   None

   Reference book:
   Spacecraft Power Systems by Mukun R. Patel, CRC Press, 2005

8. Key words
   Satellite Power, Solar Array, Battery, Power Control, Power Distribution

9. Email address
   To be announced during the lecture

Satellite Power System II（衛星電力システム特論 II）

Subject code, Lecturer，Credit

26500929, CHO Mengu, NAITOU Hitoshi, KUSAWAKE Hiroaki, Credit 1

1. Course Description and Purpose

   Power system is one of the most important subsystem to determine the fate of satellite mission. Without power, a satellite is useless. This lecture provides introduction of satellite power system from individual elements to overall pictures, as well as future prospect.

2. Schedule

   1. Battery
   2. Space battery state-of-art
   3. Battery safet
   4. Power control algorithm
   5. Power control hardware
   6. Reliability
   7. High voltage power system
   8. Small satellite power system

   * The lectures will be done according to the schedule above. Some of the lectures will be done remotely.

3. Purpose

   Understand the satellite power system

4. Method of evaluation

   Reports and mini tests

5. Notification

   This lecture is provided in English. It is desirable for students to take Space Systems Engineering (宇宙システム工学) and/or Introduction to Satellite Engineering (衛星工学入門) as well. It is strongly recommended to take Satellite Power System I before taking this subject.

6. Additional work

   Read a paper listed as reference during each lecture.
   Students are expected to set aside 2 hours a week as time for class preparation.

7. Textbook and Reference book

   Textbook: None
   Reference book;
   Spacecraft Power Systems by Mukun R. Patel, CRC Press, 2005

8. Key words

   Satellite Power, Solar Array, Battery, Power Control, Power Distribution

9. Email address

   To be announced during the lecture

Space Environment Testing（宇宙環境試験）

Subject code, Lecturer, Credit
26500915, CHO Mengu, Credit 2

1. Course Description and Purpose

A satellite is exposed to extreme environments such as vacuum, radiation and plasma. It is also exposed to severe vibration and shock onboard a rocket. Satellites have to operate maintenance-free and need to be tested thoroughly before the launch. The purpose of the lectures is to understand from the basics about necessity, background of test levels and conditions, judgment criteria of each test.

* The lectures will be done according to the lecture schedule above. Some of the lectures will be given remotely.

2. Schedule

1. Space environment tests, why necessary?
2. Satellite development and test strategy
3. Vibration test principle
4. Vibration test methods and analysis
5. Shock test principle
6. Shock test and analysis
7. Thermal vacuum test principle
8. Thermal vacuum test method and analysis
9. Thermal vacuum or thermal cycle
10. Antenna and communication test
11. EMC test
12. Outgas test
13. Radiation test
14. Radiation test
15. Test standard

3. Purpose

1. Understand the effects of space environment on spacecraft
2. Understand spacecraft verification processes
3. Understand rationales of each testing
4. Understand testing procedures

4. Method of evaluation

Reports and mini-test

5. Notification

This lecture is provided in English. It is desirable for students to take space system related subjects, such as Space Systems Engineering and Introduction to Satellite Engineering. Also, laboratory workshop will be held in Space Environment Testing Workshop.

6. Additional work

Download and read the lecture material before each lecture.
Students are expected to set aside 4 hours a week as time for class preparation.

7. Textbook and Reference book

Textbook: None
References:
HARRIS' SHOCK AND VIBRATION HANDBOOK, Allan G. Piersol, Thomas L Paez, Macgrawhill,
Spacecraft Thermal Control Handbook, David G. Gilmore, Aerospace Press
JAXA-JERG-2-130「宇宙機一般試験標準」

SMC-S-016 “TEST REQUIREMENTS FOR LAUNCH, UPPER-STAGE AND SPACE VEHICLES”
ISO-15864 “ Space systems — General test methods for space

8. Key words
Space Environment, Verification, Testing

9. Email address
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Space Systems Engineering I（宇宙システム工学Ｉ）

Subject code, Lecturer，Credit

26500950, MIHARA Shoichiro, Credit 1

1. Course Description and Purpose

Systems Engineering for Space Systems will be lectured based upon NASA handbook. The lectures covers Stakeholder Expectations Definition, Technical Requirements Definition, Logical Decomposition, Design Solution Definition, Product Implementation, Product Integration, Product Verification, Product Validation, Product Transition, Technical Planning, Requirements Management, Interface Management, Technical Risk Management, Configuration Management, Technical Data Management, Technical Assessment, Decision Analysis, Concurrent Engineering, Technical Margin Management and so on. The content of this course is indispensable as a common language for those who are or will be working for space project, space industry, academia around the world.

Space Systems Engineering I is a subject for the Space Engineering International Course (SEIC). Space System Project Management will be lectured by Space Systems Engineering I (3rd semester) and Space Systems Engineering II (4th semester). In Space Systems Engineering I, lectures will be focused on Systems Engineering, and in Space Systems Engineering II, lectures will be focused on program and project planning and control (PP & C) and so on. Technical areas, such as satellite orbits, space environment, technical design for satellite components or satellites, are not covered in this course.

2. Schedule

1. Introduction to Systems Engineering
   Fundamentals of Systems Engineering, NASA Program/Project life Cycle
2. System Design Processes
   Stakeholder Expectations Definition, Technical Requirements Definition, Logical Decomposition, Design Solution Definition
3. Product Realization
   Product Implementation, Product Integration, Product Verification, Product Validation, Product Transition
4. Crosscutting technical management 1: Technical Planning, Requirement Management
   Technical Planning, Requirements Management,
5. Crosscutting technical management 2: Interface Management, Technical Risk Management, etc.
   Interface Management, Technical Risk Management, Configuration Management, Technical Data Management
6. Crosscutting technical management 3: Technical Assessment, Decision Analysis
   Technical Assessment, Decision Analysis
7. Crosscutting topics 1: Engineering with Contract etc.
   Engineering with Contracts, Selecting Engineering Design Tools
8. Crosscutting topics 2: Fault Management, Technical Margins
   Environmental, Nuclear Safety, and Planetary Protection Policy Compliance/ Systems Engineering on Multi-Level/Multi-Phase Programs, Fault Management, Technical Margins, Human Systems Integration (HSI) in the SE Process

How to conduct the lecture:
Lecture by aural presentation. Language is English only. Assignment for related subject shall be submitted before the next lecture. PDF file of presentation and text version of aural presentation will be uploaded. If situation allows, face to face presentation is base line of the lecture. Otherwise mp4 file will be uploaded. It is advised to read related handbook before and after the lecture.

3. Purpose

The lectures cover Space Systems Engineering Engine. Understanding of Process of System Design, Product realization and Technical Management of Systems Engineering activities are expected.

1. Understanding of System Design Process
2. Understanding of Product realization
3. Understanding of crosscutting technical management.

4. Method of evaluation

Attendance of lecture and Assignment

1. Watch presentation video in case of remote lecture. In remote lecture, attendance of class is measured by history of watch/Stream the video. If you does not watch or download the whole video, unwatched contents will be regarded unattended time of the lecture.
2. Submit Assignments.

5. Notification

The lecturer has been working as project manager for Space Project in Private Space Sector and Semi Private Space Foundation.

This lecture is provided in English. It is recommended to take "Introduction to Satellite Engineering" to understand technical issue of space system. It is strongly recommended to take "Space Systems Engineering II" after this subject. If situation allows, four lectures will be performed by face to face basis and four lectures will be performed on line.

6. Additional work

Download and study the lecture material before each lecture.

Students are expected to set aside 2 hours a week as time for class preparation. 2 hours for each assignment.

7. Text book and Reference book

Textbook

NASA/SP-2016-6105-SUPPL Expanded Guidance for NASA Systems Engineering volume 1

NASA/SP-2016-6105-SUPPL Expanded Guidance for NASA Systems Engineering volume 2

References

NASA Systems Engineering Handbook. NASA/SP-2016-6105 Rev 2.

8. Key words

Systems Engineering, Space Project, System Design Process, Product Realization, Technical Management, Technical Requirement Definition, Logical Decomposition, Interface Management, Product Verification, Product Validation, Configuration management, Decision Analysis

9. Email address

Mihara-Shoichiro*jspacesystems.or.jp, change*to@

Space Systems Engineering II（宇宙システム工学 II）

Subject code, Lecturer, Credit

26500951, MIHARA Shoichiro, Credit 1

1. **Course Description and Purpose**

Program and Project Management and Control for Space System will be covered based on NASA Handbooks. The lecture covers Functions of Project Planning and Control (PP&C) and Work Breakdown Structure (WBS). Schedule Management and Fault analysis. (FTA and FMECA) Functions of PP&C covers PP&C Integration, Resource Management, Scheduling, Cost Estimation/Assessment, Acquisition and Contract Management, Risk Management, Configuration and Data Management. The contents of this course are indispensable as a common language for those who are or will be working for space project, space industry, academia around the world.

Space Systems Engineering II is a subject for the Space Engineering International Course (SEIC). Space System Project Management will be lectured by Space Systems Engineering I (3rd semester) and Space Systems Engineering II (4th semester). In Space Systems Engineering I, lectures will be focused on Systems Engineering, and in Space Systems Engineering II, lectures will be focused on program and project planning and control (PP & C) and so on. Technical areas, such as satellite orbits, space environment, technical design for satellite components or satellites, are not covered in this course.

2. **Schedule**

1. Introduction to Project Management of Space Systems, Project Planning and Control (1/3)
   Course plan, Fundamentals of project planning and control, Functions
2. Project Planning and Control (2/3)
   Resource Management Function, Scheduling Function, Cost Estimation Function
3. Project Planning and Control (3/3)
   Acquisition and Contract Management Function, Risk Management Function, configuration and Data Management Function
4. WBS and Schedule Management 1
   Work Breakdown Structure
5. WBS and Schedule Management 2
   Schedule Management
6. Fault analysis for space systems 1
   Fault Tree Analysis (FTA)
7. Fault analysis for space systems 2
   Failure Modes, Effects and criticality analysis (FMECA)

How to conduct the lecture:

Lecture by aural presentation. Language is English only. Assignment for related subject shall be submitted before the next lecture. PDF file of presentation and text version of aural presentation will be uploaded. If situation allows, face to face presentation is base line of the lecture. Otherwise mp4 file will be uploaded. It is advised to read related handbook before and after the lecture.

3. **Purpose**

The lectures cover Project Planning and Control (PP&C). Understanding of functions of PP&C, Work Breakdown Structure, Schedule Management, and Fault analysis are expected.

1. Understanding contents of functions of Project Planning and Control.
2. Understanding how to make Work Breakdown Structure and development Schedule.
3. Understanding how to make Fault Analysis of Space Systems.

4. **Method of evaluation**

Attendance of lecture and Assignment

1. Watch presentation video in case of remote lecture. In remote lecture, attendance of class is measured by history of watch/Stream the video. If you does not watch or download the whole video, unwatched or undownloaded contents will be regarded unattended time of the lecture.
2. Submit Assignments.

5. Notification

The lecturer has been working as project manager for Space Project in Private Space Sector and Semi Private Space Foundation.
This lecture is provided in English. It is strongly recommended to take "Space Systems Engineering I" before this subject. It is recommended to take "Introduction to Satellite Engineering" to understand technical issue of space system. If situation allows, four lectures will be performed by face to face basis and three or four lectures will be performed on line.

6. Additional work

Download and study the lecture material before each lecture.
Students are expected to set aside 2 hours a week as time for class preparation. 2 hours a week for each assignment.

7. Textbook and Reference book

Textbook
Presentation Material and lecture note. And following materials.
#1, #2, #3, NASA Project Planning and Control Handbook NASA/SP-2016-3424
#4: NASA/SP-3404 Work Break Down Structure Handbook
#5:NASA/SP-2010-3403 Schedule Management Handbook Ver 2010
#6: Fault Tree Handbook with Aerospace Applications Ver1.1
#7: Failure Modes, Effects and criticality analysis (FMECA) for C4ISR

References
NASA Risk Management Handbook NASA/SP-2011-3422 Version 1.0
Failure Analysis: Case Study Challenger SRB Field Join
Failure mode and effect analysis on safety critical components of space travel
Electronic Reliability design hand book. MIL-HDBK-338B
Implementation of FMEA to improve the reliability of GEO satellite payload
NASA Systems Engineering Handbook. NASA/SP-2016-6105 Rev 2.
NASA Schedule Management (version 2020. Revision 1 total 403 pages. Deferent edition from the text, ver 2010)

8. Key words

Space Project Planning and Control, WBS, Schedule Management, Fault analysis, FTA, FMECA, Resource management, Risk Management.

9. Email address

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Spacecraft Environment Interaction Engineering（宇宙環境技術特論）

Subject code, Lecturers, Credit

26440801, CHO Mengu, AKAHOSHI Yasuhiro, TOYODA Kazuhiro, KIMOTO Yugo, KOGA Seiichi, Credit 2

1. Course Description and Purpose

A spacecraft must withstand the severe space environment which is widely different from the ground. The purpose of this class is to understand special characteristics of space environment, and to learn the basic knowledge needed to develop technologies against space environment.

2. Schedule

Syllabus outline:

1. Space environment
2. Spacecraft charging and discharge
3. Space debris
4. Spacecraft charging analysis
5. Lunar charging
6. Space environment measurement
7. Contamination on spacecraft

3. Method of evaluation

Report

4. Notification

Students should be well informed about space engineering.

5. Additional work

Lecture materials will be uploaded on Moodle page. It is recommended to read lecture materials before the class.

Students are expected to set aside 4 hours a week as time for class preparation.

6. Textbook and Reference book

(1) D. E. Hastings and H. Garret, Spacecraft Environment Interaction, Cambridge University Press

7. Key words

Space environment, spacecraft charging, space debris, contamination

8. Email address

toyoda(at)ele.kyutech.ac.jp

Energy Conversion and Plasma Physics（エネルギー工学特論）

Subject code, Lecturer，Credit

26490802, TOYODA Kazuhiro, Credit 2

1. Course Description and Purpose

   Fluid dynamics and plasma physics are introduced for understanding energy conversion from electric enegy to kinetic energy employed in electric propulsion.

2. Schedule

   1. Fluid dynamics1
   2. Fluid dynamics2
   3. Fluid dynamics3
   4. Fluid dynamics4
   5. Fluid dynamics5
   6. Plasma physics1
   7. Plasma physics2
   8. Plasma physics3
   9. Plasma physics4
   10. Plasma physics5
   11. Energy conversion from electric power to propulsion1
   12. Energy conversion from electric power to propulsion2
   13. Energy conversion from electric power to propulsion3
   14. Energy conversion from electric power to propulsion4
   15. Energy conversion from electric power to propulsion5

3. Purpose

To understand the application of energy convergion to new technology

4. Method of evaluation

Perticipation and weekly report

5. Notification

6. Additional work

Futher understanding is needed with reference books after the lecture.
Students are expected to set aside 4 hours a week as time for class preparation.

7. Textbook and Reference book

Reference book

(1) J. D. Anderson: Modern Compressible Flow. (McGraw-Hill)

(2) F. F. Chen: Introduction to Plasma Physics and Controlled Fusion. (PLENUM)

(3) 栗木、荒川: 電気推進ロケット入門（東京大学出版会）

8. Key words

Energy conversion

9. Email address

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Advanced Space Engineering Science（宇宙環境科学特論）

Subject code, Lecturer, Credit
26650002, KITAMURA Kentaro, Credit 2

1. Course Description and Purpose

Near-earth space environment is essentially described by an interaction between the solar plasma (solar wind) and the earth's magnetic fields. This interaction often generates large-scale electromagnetic disturbances (Space Weather), which is sometimes causes significant failure on the social infrastructures such as malfunction of the satellite. An objective of this lecture is to understand the overview of the space weather and to become able to consider an affection of the space weather on the social infrastructure.

This is Space Engineering International Course.
It is desirable to have completed rocket propulsion engineering, rocket/satellite system engineering, combustion engineering and thermo-fluid engineering related subjects in the faculty.

2. Schedule

1-5: Basis of solar wind, geomagnetic field, magnetosphere ionosphere, and radiation belt
6-7: Electromagnetic and particle environments in the magnetosphere.
8: Midterm student's presentation
9: Concept of the space weather
10-13: Impact of the space weather on the spacecraft systems and the social infrastructures
14: Task learning
15: Final presentation

How to conduct the lecture
This lecture is conducted as a combination of the lecture-style lesson and the group practice. Participants are sometimes required to submit reports and to give presentations.

3. Purpose

Purpose of this lecture is to understand the overview of the space environment in terms of the plasma physics and space electromagnetism, and to become able to discuss the affection of the space weather on the actual social infrastructures.

(1) Understanding of basis of the magnetosphere and the ionosphere
(2) Understanding of electromagnetic and particle disturbances in the magnetosphere and the ionosphere.
(3) Understanding of affections of the space weather on social infrastructures and spacecraft systems

3. Method of evaluation

Participants are evaluated by their report and presentation and passes with more than 60 %.

4. Notification

5. Additional work

Participants is required self-studies of 4 hours/week for preparations and reports of each lecture.

6. Textbook and Reference book

Textbook: None
Reference Book:
(1) Introduction to Space Physics, Kivelson and Russell, ISBN: 0521457149
(2) Space Weather, Singer et al., ISBN: 0875909841
(3) Fundamentals of Space Systems, Pisacane, ISBN: 0195162056
(4) Spacecraft-Environment Interactions, Hastings and Garret, ISBN: 0521607566
(5) The Space Environment, Alan C. Tribble, ISBN 0-691-10299-6

7. Key words
Space weather

8. Email address
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Advanced Rocket Propulsion Engineering（ロケット推進工学特論）

Subject code, Lecturer, Credit
26640001, KITAGAWA Koki, Credit 2

1. Course Description and Purpose

In order to develop a rocket, it is necessary to definitise the mission requiments, perform conceptual design and proceed with detiled design based on it. Setting the initial model by conceptual design is an important task because it affects the work efficiency. The purpose in this lecture is to acquire the ability to perform rocket sizing and rocket engine conceptual design for initial model setting.
This is Space Engineering International Course.
It is desirable to have completed rocket propulsion engineering, rocket/satellite system engineering, combustion engineering and thermo-fluid engineering related subjects in the faculty.

2. Schedule

1 Introduction
2 Rocket sizing 1
3 Rocket sizing 2
4 Rocket sizing 3
5 Rocket sizing 4
6 Rocket sizing 5
7 Intermediate presentation
8 Rocket engine conceptual design 1
9 rocket engine conceptual design 2
10 rocket engine conceptual design 3
11 rocket engine conceptual design 4
12 rocket engine conceptual design 5
13 rocket engine conceptual design 6
14 Final presentation
15 Feedback, Summary

3. Method of evaluation

Lecture and group exercises.
A total of 60% or more of evaluation of the report and the presentation.

4. Notification

5. Additional work

Read a paper listed as reference during each lecture.
Students are expected to set aside 4 hours a week as time for class preparation.

6. Textbook and Reference book

Textbook: None
Reference Book:
（1）NASA SP-125, Design of Liquid Propellant Rocket Engines(NASA)
（2）George P. Sutton, Rocket Propulsion Elements (WILEY)
（3）田辺英二：ロケットシステム（風虎通信）(in japanese)

7. Key words

Rocket, Sizing, Rocket engine

8. Email address

To be announced during the lecture