Space and Astronautical Science

Course Code	Course	Credit	Content of Subject
40SAS001**	Space Science	2	Reviews of the development of astrophysics and solar system sciences are given. Scientific issues are discussed and possible future plans are introduced. Methods of investigation using satellite, space probe and sounding rocket are also explained.
40SAS002**	Space Engineering	2	Technologies for space science, exploration, and utilization are overviewed. System design of launch vehicle and spacecraft, mission analysis of space systems, orbit control and determination, and project management are lectured by professional personnel in each field.
40SAS003**	Space and Astronautical Science	1	This online lecture (E-learning) provides an of overview of the researches conducted in the Space and Astronautical Science as an omnibus, which includes scientific subjects on astrophysics and solar system physics as well as engineering subjects on spacecrafts and rockets.
40SAS004**	Scientific writing 1	2	This class is to learn the scientific presentation and its practice in English mainly through exercises. This class starts with a short course in Japanese explicating "How to compose and write scientific articles". Lecture is given by a native English lecturer in addition to a Soken-dai Professor. (for students of English as a second language)
40SAS005**	Scientific writing 2	2	Learn the basics of writing academic papers in English mainly through exercises. Lecture is given by a native English lecturer in addition to a Soken-dai Professor. (for students of English as a second language)
40SAS006**	Introduction to Space Astronomy	2	This lecture gives an overview of the new view of the universe revealed by the observations in various wave bands. Observational technology is also reviewed with emphasis on that specific to the space missions. In the lecture, it is explained how various phenomena in the universe are understood based on the laws of physics, together with the telescope technology and the data analysis methods.
40SAS007**	Introduction to Exploring the Solar System	2	The lecture treats origin and evolution of the planetary bodies and thier environment on a basis of the scientific results of recent planetary explorations, observation techniques, and the scientific instruments onboard spacecraft, focusing on the science of solarsystem small bodies and astrobiology considering both extrasolar planets and solar system.

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40SAS008**	Introduction to Spacecraft Propulsion	2	The lecture describes theories and experimental methods on thermo-fluid engineering for space transportation system. It includes specific examples as well as basic technology.
40SAS009**	Introduction to Space Structures and Materials	2	The class focuses on the structure and the materials of spacecraft including flexible structure and deployable structure. The lecture describes their feature and provides the fundamental knowledge required in the design and development of spacecraft structure and materials.
40SAS010**	Introduction to electronics and information for space applications	2	As technologies to support the information society, the course includes wireless telecommunication technologies covering spacecraft systems and microdevices as their base technologies especially shedding light on MEMS (Micro Electro Mechanical Systems) . Both treat topics on fundamentals and applications.
40SAS011**	Introduction to Radiowave Engineering for Space Applications	2	Distance measurement systems based on radio waves and light are used in spacecraft systems. This lecture will cover the basic principles, hardware configuration, signal processing, and actual applications in space systems for RADARs and LIDARs.
40SAS012**	Computational engineering and science	2	Computational science based on the numerical simulation technologies stands with theory and experiments, being an important research and developping tool in the ace science field. This lecture introduces the leading edge technologies in numerical simulation, data assimilation, data visualization and high performance computing which support them and related technologies especially from the engineering perspective. Also the high performance computing and related topics, which support computational engineering and science are introduced.
40SAS013**	Space Observation Science	2	Fundamental methods of mission analysis and design for space-science experiments are lectured from the understanding of background physics and its methods.
40SAS014**	Space Systems Engineering 1	2	Basic theories, technologies and project management of the space system including the satellites and the scientific balloons will be lectured, and their applications, current subjects and future prospects will be discussed.

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40SAS015**	Space Systems Engineering 2	2	The rocket systems engineering associated with launch and reentry of space vehicles is thoroughly lectured. Flight dynamics, guidance and control, thermal protection, and recovery systems etc. are reviewed in some detail. The lecture is extended to entry systems for planetary missions. Special topics involving system design processes, applications and future prospects are also discussed.
40SAS016**	Space Systems Engineering 3	2	The orbit calculation and the orbit design/determination of solar system bodies and man-made space probes (artificial satellites and spacecraft) are lectured. Various dynamical features are known for solar system bodies. The origins of such features and the methods of analysis will be discussed. As for the man-made space probes, the basic knowledge and methods for the orbit planning/determination will be discussed.
40SAS017**	Space Systems Engineering 4	2	Space power systems and subsystems including power generation, storage, transmission, and management are lectured. The lecture covers basic and advanced power technologies, and future space energy systems for Solar Power Satellite and planetary exploration mission.
40SAS018**	Space Environment Physics	2	High-energy plasma phenomena in the solar corona, such as flares and coronal mass ejections (CMEs), affect the space environment of the solar system. The lecture reviews observational aspects and mechanisms of such high-energy phenomena in the solar atmosphere, and discusses their effects on the near-Earth space environment.
40SAS019**	Space Astronomy 1	2	Give a lecture on various high-energy phenomena revealed through X-ray and Gamma-ray observations from satellites, and study the background physics behind the phenomena. Also given is a lecture on the principle and the actual configuration of X-ray and Gamma-ray instruments and the analysis methods of their data.
40SAS020**	Space Astronomy 2	2	The lecture gives an overview of the recent picture of the Universe, especially the early Universe, the large scale structure, and formation and evolution of galaxies, stars, and planets, which have been revealed by infrared and submillimeter observations from space. Also gives brief descriptions of detection principle of infrared light from space, and the unique techniques used in the observational instrumentation and the data analysis.

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40SAS021**	Space Astronomy 3	2	The lecture gives an overview of science and technology of radio astronomy observations from space, especially that of space-VLBI (Very Long Baseline Interferometry) and CMB (Cosmic Microwave Background Radiation) observations. It also describes scientific backgrounds and outcomes, operation principles and examples of application of the observation technology.
40SAS022**	Science of Planetary Exploration	2	The lecture gives an introduction of the area of solid planetary science, Especially, we discuss the practical methods of investigation of the surface and the internal structure of the solid planets by the space exploration. The goal of this lecutre is to understand how the obtained data are related to the origin and evolution of the planets.
40SAS023**	Physics of Planetary Atmospheres	2	The lecture gives the basic physics of planetary atmospheres and the overview of atmospheric structures and physical processes observed so far. Unsolved problems to be addressed in future spacecraft missions will also be discussed.
40SAS024**	Solar System Plasma Physics	2	The solar system is a laboratory where dynamics of energetic plasma in the universe can be studied in situ by state-of- the-art instruments on board spacecraft. This lecture provides basic knowledge of physical processes occurring in the plasma environment of the solar system, including the solar wind, ionospheres, and magnetospheres around the planets. Scientific objectives of space missions both for magnetized and unmagnetized planets are described, with the reference to the innovative techniques for the plasma measurements in space.
40SAS025**	Spacecraft Propulsion	2	Starting from the basic concepts of both chemical and advanced propulsion systems, practical application of these concepts to space transportations and space probes are provided. Topics include state-of-the-art rocket motors, air breathing engines, propulsive method for orbital transfer vehicles, as well as in-space electric and other advanced propulsion systems.

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40SAS026**	Space Structures and Materials	2	The lecture gives patterns, design methods, component materials, and on-board mechanisms of structures for spacecraft and rockets.
40SAS027**	Space Applied Physical Chemistry	2	The purpose of the lecture is to deepen the knowledge of materials which have been used for the spacecraft from the aspect of chemistry. With the basic lecture of chemistry, the fuel cell, oxygen generator, CO2 removal/reduction, the film material, chemical propellant and other materials will be described from the view point of chemistry. The malfunctions of the spacecraft caused by the chemical reaction will also be discussed. Furthermore, the special material chemistry using the special space environment like microgravity conditions is also described as the future aspects of chemistry and material engineering. The background of the thermodynamics and thermochemistry will also be discussed.
40SAS028**	Electronics and information for space applications 1	2	The lecture gives basic circuit design and semiconductor device technologies with special emphasis on scientific foundations locating underneath the technologies. Further, RF circuits and small antennas for space communication are introduced. Special interest is put on characteristic measurement of high-power and low-noise circuits in a fur-disitance of deep space are discussed.
40SAS029**	Electronics and information for space applications 2	2	- The lecture gives the methods of attitude determination, attitude control, navigation and guidance of spacecraft, including sensors and actuators technologies. - This lecture also summarizes the technologies used in space exploration robots, and discusses how to design and build robots which explore the various surfaces of celestial bodies in the solar system. - Hands-on practice of software implementation of a simple system including sensor data processing, actuator commanding, and hardware control.

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40SAS030**	Space Life Science	2	In this lecture, we will focus on how humans can live in space, the technologies needed to do so, and the problems that need to be solved when operating in space, as well as the latest findings on these issues. The former describes the basic laws of the universe, space experiments using the space environment, the history of space exploration, space elevators, terraforming, space agriculture, exoplanets, and so on. The latter describes that we will discuss issues that need to be resolved and the latest findings regarding microbiology in manned space facilities (environmental microorganisms, human microbiota, microbiology of potable water on the International Space Station), muscle atrophy and bone loss similar to aging during long stays in space, risk management in human space activities, planetary protection (planetary quarantine), etc.
40SAS031**	Materials Engineering in Space	2	This program explains the materials science research under the microgravity offered by orbital space platforms where buoyancy convections are fully suppressed and containerless conditions (levitation-positioning) can be easily obtained. Previous experiments, including their research facilities and experimental techniques, are also described. For containerless processing, electrostatic levitation techniques and related studies that include thermophysical property measurements and synthesis of metastable materials will be discussed in details. In addition, the crystal growth mechanisms under microgravity and their applications are also discussed in detail.
40SAS032**	Field works	2	The credit of the field work is given to students for external studies which is planned voluntary and is carried over a total period longer than 2 weeks. The credit is given through examination based on the plan and resulting report by course committee members.
80SAS001**	Space science colloquium ＩA	2	Through the studies in semiregular colloquia, etc., students acquire basic knowledge of the space science related to their research fields.

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80SAS002**	Space science colloquium ⅠB	2	Through the studies in semiregular colloquia, etc., students acquire basic knowledge of the space science related to their research fields and start learning advanced papers related to their research.
80SAS003**	Space science colloquium ⅡA	2	Through the studies in semiregular colloquia, etc., students learn the advanced papers relevant to their research topics.
80SAS004**	Space science colloquium ⅡB	2	Through the studies in semiregular colloquia, etc., students learn the basis to describe the research results logically and theoritically, with the completion in "Thesis Progress Report I" in mind.
80SAS005**	Space science colloquium ⅢA	2	Through the studies in semiregular colloquia, etc., students set the discussion topic voluntarily and lead the discussion.
80SAS006**	Space science colloquium ⅢB	2	Through the studies in semiregular colloquia, etc., students set the discussion topic voluntarily and lead the discussion. Students also acquire the discussion tecnique aiming the presentation within/outside Japan.
80SAS007**	Space science colloquium ⅣA	2	Through the studies in semiregular colloquia, etc., students present research results related to their PhD thesis and explore the related literature.
80SAS008**	Space science colloquium ⅣB	2	Through the studies in semiregular seminars, etc., students present research results related to their PhD thesis and summarize the explored literature.
80SAS009**	Space science colloquium VA	2	Through the studies in semiregular colloquia, etc., students understand the academic significance of their research in the relevant fields and in the society. Students also participate in seminars, meetings and symposia in preparation for the external reviews of their thesis.
80SAS010**	Space science colloquium VB	2	Students conduct comprehensive studies through colloquia, which aim to overlook the academic background of the research and to clarify the significance of the research results, when they write the PhD thesis. Students also evaluate objectively the possibilities of their results or data to be related to general society and industry, and the merit of their results or data as intelectual property.

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80SAS011**	Thesis Progress Report 1	2	Students in the 2nd year of the 5-year course summarize their research conducted in the 1st and 2nd years in a paper, and make an oral presentation
80SAS012**	Thesis Progress Report 2	2	Students in the 4th year of the 5-year course and in the 2nd year of the 3-year course summarize an interim report on their research conducted for the PhD thesis, and make an oral presentation.