Polar Science

Course Code	Course	Credit	Content of Subject
40PLS001**	Introduction to Polar Multidisciplinary Science	1	In this class, we will give lectures from multiple perspectives on the history, present state, and future prospects of scientific observations that Japan is advancing in the Antarctic and Arctic regions, including scientific research, logistics aspects, environmental protection perspectives, and relationships with social life, and introduce the overall picture and attractiveness of multidisciplinary science conducted in the unique field of the polar region.
40PLS002**	Introduction to Advanced Earth Science 1	2	Topics from each research discipline are studied with special interest of international circumstances.
40PLS003**	Introduction to Advanced Earth Science 2	2	Topics from each research discipline are studied with special interest of international circumstances.
40PLS004**	Introduction to Earth's Metrology	2	To assess the natural environment of the polar regions, various means of geophysical observation are necessary, most notably remote sensing techniques using artificial satellites. It is also very useful to know how, over the long course of human history, people managed to measure such things as time, geographical location, distance on the Earth's surface, and how developed devices enabling these to be measured with enhanced precision. This subject explores the history of various kinds of geophysical measurement and discusses the current technological status and future developments.
40PLS005**	Polar Data Analysis	2	This course covers the basics of statistics, also known as the grammar of science, providing lectures and practical training about data acquisition and analysis using examples of measurements and analysis in polar regions.
40PLS006**	Marine Ecology	2	The world ocean covers approximately 70% of the earth's surface and has an average depth of about 3,800 m. The Ocean provide a vast living space for marine life. This subject explores various types of marine environmental systems, in particular through the biological processes associated with plankton community of the pelagic ecosystem. Sampling and observation of marine organisms at sea will be carried our as a field course.
40PLS007**	Introduction to the atmospheric and hydrospheric sciences	2	This subject is designed to provide a geophysical and geochemical outline of phenomena occurring in the atmosphere, cryosphere, and ocean of the Earth for the integrated understanding of the processes in the polar regions.
40PLS008**	Experimental Planetary Sciences	2	We systematically learn the experimental approaches and the obtained results for science on planetary materials to understand the characteristics of extraterrestrial materials and their formation and evolution, which will help us deeply understand the history of our solar system. The lectures will mainly treat the following topics: Basis of meteoritics, Antarctic meteorites, Antarctic micrometeorites, petrological and mineralogical method, crystallographic method, geochemical method, spectroscopic method, and mathematical method for examining the planetary materials. Based on these methods, we will study the primary evolution of planetary materials and metamorphism on the parent body.
40PLS009**	Behavioural Analysis of Marine Animals	2	This subject outlines the fundamentals of behavioural data analysis for marine animals. It overviews the behavioural measurement of marine animals, especially the biologging techniques, and basics of behavioural data analyses. Students also pursue practical exercises of using biologging techniques and analyzing the body acceleration and movement trajectories of marine animals.
40PLS010**	Physiological Ecology of polar photosynthetic organisms	2	This subject outlines the characteristics of polar environments in terms of biological adaptation to the environment, particularly physiological adaptation of aquatic microorganisms and flora. In addition, it provides practical training in the measurement of photosynthesis and other physiological activities and in techniques for outdoor research.

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40PLS011**	Data Analysis for Ocean Remote Sensing	2	This subject explains from fundamentals of satellite remote sensing to their applications, covering the technical aspects of onboard satellite sensors and sensor operation methods. Also outlined are how to acquire ocean remote sensing data collected by earth observing satellites for studying polar ocean sciences and how to process them with computer application packages through lectures and training. It will introduce application examples in marine biological researches in polar areas.
40PLS012**	Magnetospheric Physics	2	The Earth's magnetosphere is made up of regions with various characteristics, and it changes dynamically due to the effects of solar wind and the Earth's atmosphere.This subject is designed to provide general knowledge about the structure of the magnetosphere and the various phenomena that arise within it.
40PLS013**	Cosmic Electrodynamics	2	This lecture covers the electromagnetism of the cosmos, i.e. the large-scale magnetic fields that are transported bodily in the swirling plasma throughout the universe. The motion of charged partcles and some basic characteristics are also derived in some special magnetic field configurations such as dipole and shocks.
40PLS014**	Radar Aeronomy	2	This subject covers the principles of radar observation for surveying the middle atmosphere, thermosphere and ionosphere, as well as the physics of neutral and ionized atmospheres as revealed by such radar observations. IS radar, HF radar, MF radar, meteor radar and MST radar are specifically described.
40PLS015**	Auroral Physics	2	Aurora is a bright enough natural emission as captured by naked eyes, which is caused by massive electron precipitation into the polar atmosphere, as a result of the interaction between the solar wind and terrestrial magnetism. This lecture covers the fundamntal mechanism and the predictability of a compound system of the solar wind, magnetosphere, and ionosphere, which is manifested in the shape, motion, and colors of aurora.
40PLS016**	Polar Plasma Wave Theory	2	In the ionosphere and magnetosphere of the polar regions, as well as in the solar winds that blow through interplanetary space, plasma waves of various modes are dynamically and repeatedly formed, propagated and extinguished. These waves play an essential role in regulating the physical characteristics and mass balance of each of these regions. This subject covers the basic characteristics of magnetohydrodynamic waves, electrostatic plasma waves and electromagnetic waves, as observed in geospace (the region of space near Earth), as well as methods of observing these waves.
40PLS017**	Aeronomy	2	Our understanding of the structure and variation of the Earth's atmosphere as it extends from the surface of the earth to the outer reaches of the solar system has grown dramatically. Whereas observation was previously limited to geomagnetic observation at the Earth's surface and spectroscopic observation from the ground, advances in recent years have made possible remote sensing from spacecraft and from the ground, as well as direct and indirect measurements from satellites. This subject offers an overview of our current understanding of the structure of the Earth's atmosphere and various physical processes based on geoelectromagnetic phenomena.
40PLS018**	Ionospheric physics	2	Charged particles in the ionosphere are affected by numerous physical and chemical processes, including plasma instabilities, diffusion, and transportation via electric and magnetic fields. In this lecture, students learn the basic processes occurring in the ionosphere, and also generation mechanisms of several ionospheric phenomena.
40PLS019**	Fundamental physics on the upper-atmospheric waves	2	This subject systematically covers the fundamentals of aeronomic waves, along with atmospheric gravity waves, tidal waves and planetary waves, as well as the propagation, wave-mean flow interaction and observation of such waves.
40PLS020**	Introduction of upper atmosphere physics	2	The polar region is called the window of space, because the inflow, transport, accumulation, and consumption of solar wind energy are remarkably seen in the region, as typified by the aurora borealis. This lecture will give an overview of the various physical phenomena observed in this polar region from the viewpoint of the solar-terrestrial system.
40PLS021**	Introduction to Polar climate system	2	The formation of polar climates and their role in global climate is discussed on the basis of atmospheric dynamics, atmospheric thermodynamics, water phase change processes, and radiative processes. The mechanisms of global warming and ozone hole formation and the significant changes currently occurring in the polar regions will be discussed.

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40PLS022**	Ice-core paleoclimatology	2	The principles and methods of climatic reconstructions will be introduced. It also provides basics on the past climate and environmental changes such as glacial-interglacial cycles, abrupt climate changes, and the roles of polar regions.
40PLS023**	Circulation systems of water and materials in the polar atmosphere	2	This subject describes the circulation systems of water and materials and their impact on the energy budget in the polar/global atmsophere. It also covers the practical topics on atmospheric physics and chemistry including the methodology for observation and data analysis. Students will work in a group to read scientific papers in turn.
40PLS024**	Cryosphere Science	2	This subject aims at understanding the role played by the cryosphere in the Earth's system. Composed mainly of ice sheets, glaciers, snowcover, frozen ground and sea ice, the cryosphere is a key factor in the climate change system. In addition to understanding the glaciological sciences, this subject deals with their relationship to global environmental change. Students will also learn methods of field observation and laboratory analysis. Occasionally, students will read scientific papers in turn.
40PLS025**	Introduction to Polar Oceanography	2	Sea ice extent in both polar oceans covers about 10% area in total earth surface. This subject gives a lecture on geophysical phenomena in the Arctic and Southern oceans and relationship to the global climate system through sea ice variations. Also, water and ice, having unique characteristics, and basic interpretation on sea ice formation/melting processes will be lectured in accompanied with recent scientific topics and future studies on polar oceanography.
40PLS026**	An introduction of Glaciology	2	This subject features explanation and discussion of the physical processes of snow/ice formation in polar ice sheets, including fundamental principles, with presentation of actual research data and recent research topics. The order of study will be according to the flow shown on the class plan of item 8. In addition to the listed items, cutting-edge polar environmental research topics will be discussed, as required.
40PLS027**	Crustal Evolution	2	This subject deals with the evolution of continental crust that forms the surface layer of the Earth. For this purpose, it demonstrates the basic knowledge and analytical technique to understand the crustal evolution by lecture, practical training and reading published scientiic papers. Recent examples of geochmical discussion for crustal evolution will be demonstrated.
40PLS028**	Introduction to Marine Geophysics in the Antarctic Region	2	One of the greatest challenges in Earth sciences is understanding the mechanism of continental breakup. The seafloor of the Antarctic Ocean reveals a record of the spreading of the seafloor caused by the separation of Gondwana and of the evolution of the Antarctic plates, important clues to understanding the process of continental fragmentation. The seafloor spreading and plate tectonic evolution processes are deduced through geophysical observations such as seafloor topography, magnetic and gravity anomalies. This subject provides an outline of the features of the Antarctic plates in the context of the world's plate tectonics, through geophysical observations such as seafloor topography, magnetic and gravity anomalies. It also discusses ship-based observation equipment and data processing.
40PLS029**	Polar Seismology	2	Polar seismology covers the various kinds of phenomena in geosphere, as well as physical interaction between cryosphere, ocean and atmosphere involving global warming. This lecture deals with significant characteristics of seismic wave propagation, seismicity including glacial earthquakes, structure and dynamics of the crust and mantle, as well as the deep interior of the Earth. The observation technique in polar region, data management and international collaboration are demonstrated.
40PLS030**	Planetary material science	2	Meteorites are of many and various types, but they can be broadly classified as primitive or differentiated, according to the process by which they are formed. Since primitive meteorites are made of matter that was never melted, they are thought to embody information about the solid materials from which the solar system was created and the processes by which their materials were formed. On the other hand, differentiated meteorites are thought to have melted from their parent celestial bodies. In addition to explaining the classification of meteorites, this subject examines the parent bodies.

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40PLS031**	Paleo- & rock Magnetism	2	This subject discusses the Earth's magnetic field, and explains the mechanism by which rocks acquire natural remnant magnetism and the magnetic characteristics of magnetic minerals. In addition, it gives some ideas about the magnetic environment of volcanic rocks, and deep sea sediments. Furthermore, it introduces techniques and measurement methods for the paleomagnetism, and also Earth dynamics, plate tectonics theory, and magnetostratigraphy.
40PLS032**	Introduction to crustal materials and processes	2	This subject offers an outline of geological phenomena in continental crusts from petrological, mineralogical and geochemical view points. In addition to understanding techniques for interpreting the traces of past changes recorded in the rocks and minerals that make up the Earth's crust, students will learn how the continental crust originated and evolved in the course of the Earth's history.
40PLS033**	Introduction to Solid Earth Geophysics in the Antarctic Region	2	Local characteristics of the Antarctic plate reflect the history of the planet's evolution. Accordingly, to understand the evolution process of Antarctica and its current shape, it is necessary to compare and understand its local characteristics, such as crust and mantle structure, geoid, gravity anomalies and crustal magnetic anomalies, with those of the other areas. This subject describes features of Antarctica, as determined by a seismic velocity survey and/or regional tomography, crustal magnetic survey, and free-air and Bouguer gravity surveys. In addition, details about defromations of the solid Earth induced by the tidal potential, surface loadings and Earth's rotation are also presented.
40PLS034**	An introduction to Quaternary in the polar regions	2	The approximately 2.6 million years of the Quaternary period, the latest period in the Earth's historical evolution, has featured large-scale growth and decay in ice sheet conditions, marked variations in sea levels and dramatic change in the Earth's crust. These factors have enabled nature to take shape as we see it today and for humanity to evolve as it has. As a principal stage for these changes, the polar regions represent a key to understanding how they occurred. This subject begins by explaining the techniques and concepts used to elucidate and recognize the various changes in the evolution of nature during the Quaternary period. Next, the latest research trends are used to discuss the role of Quaternary research in understanding the system of the Earth, to assess the possibility of predicting forthcoming changes in the natural environment and human development. And fundamental numerical analysis dealing with paleoclimatological data will be performed.
40PLS035**	Animal Behaviour and Ecology in Polar Regions	2	This course aims to present an introduction to studies on behaviour and ecology of marine animals in polar region. Students are introduced to the basics of behavioural ecology, and to the ways of adaptations shown by marine animals to the dynamic polar environment. Then, various topics in recent behavioural and ecological studies of marine top predators in polar region will be explored via reading sessions of journal articles.
40PLS036**	Primary production in polar oceans	2	In marine ecosystem primary production is principally the production process of organic matter due to photosynthesis, which is understood to be the starting point of the complex food chains and food webs of the sea. While solar radiation is indispensable for photosynthesis, available sunlight is far more seasonal in the polar oceans than in middle-latitude regions. Whilst summer offers 24 hours of solar radiation and features a midnight sun, winter is the exact opposite. This subject examines the process of primary production in the polar seas in light of these exceptional solar environmental conditions.
40PLS037**	Polar Limnology and Ecology	2	This subject explores the characteristics of lake environments in polar regions, particularly those along the Antarctic coast, from an ecological perspective. It explains the fundamentals of limnology and the ecological discoveries made through limnology. Also covered are field observation and experiment methods used to study the lake ecosystems around the Showa Station where NIPR began observations in recent years.
40PLS038**	Analysis of terrestrial ecosystem in polar regions	2	The objective of this subject is to deepen understanding of the various approaches to research and observation and the methods used to study polar terrestrial ecosystems. Students will be exposed to actual observation activities in polar regions, based on experience in the field.

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40PLS039**	Biological oceanography in polar seas	2	Our knowledge on the polar marine environments is essential for understanding the global environmental issues. The unique marine ecosystems of polar regions are closely associated with sea ice formation, and the marine biological production processes centered on these ecosystems strongly influence marine environments. This subject aims to develop a deeper understanding of how this structure relates to the dynamics of marine organisms. In particular, the role of zooplankotn in the polar marine ecosystem is outlined. Field work on sea ice will be carried out.
40PLS040**	An exercise for experimental methods on snow and ice studies 1	2	I will teach basic experimental methods and experimental skills to study nature and properties of snow and ice in polar regions. I start from introduction of instruments and basic skills such as error handling. I will teach laboratory skills and field skills. In addition, we learn computer aided control of measurements and computer aided data acquisition. In this 1st semester, I teach basic subjects including: (i) preparations of thick sections and thin sections, (ii) density measurements, (iii) measurment on dielectric permittivity and electrical conductivity, (iv) optical properties and (v) temperature measurmennts.
40PLS041**	An exercise for experimental methods on snow and ice studies 2	2	I will teach basic experimental methods and experimental skills to study nature and properties of snow and ice in polar regions. I start from introduction of instruments and basic skills such as error handling. I will teach laboratory skills and field skills. In addition, we learn computer aided control of measurements and computer aided data acquisition. In this 2nd semester, I teach advanced subjects including: (i) preparations of thick sections and thin sections, (ii) measurements of grain size, shape and grain boundaries, (iii) measurment on crystal orientation fabrics, (iv) air permeability, (v) measurements on dielectric permittivity tensor, and (vi) mechanical properties.
40PLS042**	Advanced metrology on polar science	2	Scientific data acquisition and analysis, or measurement in general, have a common basis in statistics. Essentially, measurement is an inverse problem, and appropriate data acquisition procedures and analysis techniques must be adopted based on understanding the statistical characteristics of target phenomena and measurement systems. This course covers advanced measurement and analysis techniques with practical examples in polar sciences. The course provides lectures as well as exercises on computers.
80PLS001**	Special Exercise for Dissertation Ⅰ A	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.
80PLS002**	Special Exercise for Dissertation Ⅰ B	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.
80PLS003**	Special Exercise for Dissertation Ⅱ A	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.
80PLS004**	Special Exercise for Dissertation Ⅱ B	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.
80PLS005**	Special Exercise for Dissertation Ⅲ A	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.
80PLS006**	Special Exercise for Dissertation Ⅲ B	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.

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80PLS007**	Special Exercise for Dissertation ⅣA	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.
80PLS008**	Special Exercise for DissertationⅣB	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.
80PLS009**	Special Exercise for Dissertation ⅤA	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.
80PLS010**	Special Exercise for DissertationⅤB	2	Seminar-style practical exercises are conducted for each of the fields of polar science in which research guidance is provided.
20DPS027**	Biodiversity in polar regions	2	Registration possible only by the students enrolled in SOKENDAI in/before AY2022
20DPS035**	Introduction to Terrestrial Ecology in Polar Region	2	Registration possible only by the students enrolled in SOKENDAI in/before AY2022