Sub-course: Diverse Fields and Key Ideas of Natural Science

Course title	[Code]	(Credits)
Undergraduate students: Summer Program in English III	[25N3051]	(2)
Graduate students: Special Lectures in Humanities and Sciences III	[25S0153]	(2)

1. Description

Nowadays, natural sciences cover a wide range of fields, making it difficult to understand other fields. However, a comprehensive knowledge of these fields will help you deepen your own specialty, even if the understanding is shallow. This course offers a variety of lectures from five fields of natural science, namely, mathematics, physics, chemistry, biology, and information, as an introduction to the wide range of natural science. These lectures will be arranged to explain key ideas of natural science in plainer language by professors of our university who are on the cutting edge of their own field of natural science. We hope that these lectures will contribute your future development.

Day **Topic/Contents** Place Time Lecturer July 22 6:10pm-Room A Prof. Dr. Mitsuhiko MIYAZAKI **Course Orientation** Tue 6:40pm 2F, Plaza July 23 9:30am-Computer Graphics and Room A Prof. Dr. Takayuki ITOH Wed 12:40pm Information Visualization 2F, Plaza July 24 9:30am-Room A Prof. Dr. Akira CHIKAMATSU Crystal structure in solids Thu 12:40pm 2F, Plaza July 25 9:30am-Molecules, light, and colors. The Room A Prof. Dr. Mitsuhiko MIYAZAKI Fri 12:40pm quantum chemical foundations 2F, Plaza How to make your brain smarter Prof. Dr. Hiromu MONAI & July 28 9:30am-Room A & **Ecosystem Services and Nature** 2F, Plaza Mon 12:40pm Prof. Dr. Takaya IWASAKI Positive - How Biodiversity Supports Our Sustainable Life July 30 1:30pm-Field trip (The Tokyo waterworks Hongo, Prof. Dr. Mitsuhiko MIYAZAKI Wed 4:00pm historical museum) Bunkyo-ku July 31 9:30am-Cosmology: Its History and Room A Prof. Dr. Tomohiro FUJITA Wed 2F, Plaza 12:40pm Cutting-Edge Research Aug 1 9:30am-Room A Prof. Dr. Sin Yi TSANG Mathematics and magic tricks Fri 12:40pm 2F, Plaza

2. Teaching Day and Time

3. Class Contents:

Topic 1: Computer Graphics and Information Visualization

Prof. Dr. Takayuki ITOH

The lecturer focuses on computer-based visual technologies. The former part of this class introduces fundamental computer graphics techniques that are used in various industries including engineering design and entertainment.

The latter part introduces information visualization that makes visual representations of daily information. Also, applications of information visualization to the analysis of music and arts are introduced.

Topic 2: Crystal structure in solids

Prof. Dr. Akira CHIKAMATSU

In solids, the arrangement of atoms, ions, or molecules forms a crystal structure. This refers to the ordered and repeating pattern in which these particles are arranged in a solid. The structure is defined by the unit cell, which is the smallest repeating unit that retains the symmetry and properties of the entire crystal. Solids exhibit a variety of properties depending on the combination of elements and differences in crystal structure. In this lecture, we will learn about various crystal structures in solids while assembling crystal structure models.

Topic 3: Molecules, light, and colors. The quantum chemical foundations

Prof. Dr. Mitsuhiko MIYAZAKI

The appearance of a substance that we see originates from interaction between light and molecules composing the substance, and is finally recognized by our brain through neural action. To understand this phenomenon, it is required to know both molecules and light based on quantum chemistry. In this lecture, I would like to explain fundamentals of what is the color of matter and what happens to the energy of light, based on quantum chemistry of molecules and light.

Topic 4-1: <u>A brief history of brain science research and development of the tool of neuroscience</u> Prof. Dr. Hiromu MONAI

In this lecture, we will review the fundamental discoveries of the brain and how our understanding of the brain and mind has evolved. We will also explore the technological advancements developed to monitor brain activity, as the functioning of the living brain is not visible to the naked eye. Researchers have faced significant challenges in observing this "invisible brain function", but their curiosity and passion have led to recent breakthroughs in neuroscience.

Topic 4-2: How to make your brain smarter

Prof. Dr. Hiromu MONAI

Astrocytes are a kind of brain cell. We thought they were supporting cells for neurons for a long time, such as maintenance of the extracellular environment and energy supply to neurons. But now we know they are doing more than that. Our lab has developed a system to observe neuronal and astrocytic activities using calcium fluorescence imaging in living mice. When we electrically stimulate the brain with

a weak direct current, calcium levels in astrocytes go up, making the transmission between neurons more efficient and enhancing the mice's sensory functions. But detectable neuronal activities didn't show any apparent changes during stimulations. Also, animals with more developed intelligence and cognitive functions, like cats or humans, have more astrocytes per neuron. That is why we think astrocytes are essential for brain functions.

Topic 4-3: <u>Ecosystem Services and Nature Positive – How Biodiversity Supports Our Sustainable</u> Life

Prof. Dr. Takaya IWASAKI

Recent computer graphics techniques archived realistic and fine representations. It has the power to convert data into visual messages. The former part of this class introduces fundamental computer graphics techniques that are used in various industries including engineering design and entertainment. The latter part introduces information visualization techniques that make visual representations of daily information.

Topic 5: Cosmology: Its History and Cutting-Edge Research

Prof. Dr. Tomohiro FUJITA

Astronomy is one of the oldest fields of science. Originally developed for astrology and navigation, it has evolved alongside modern science, greatly enhancing our understanding of the universe that we live in. Today, cosmology presents astonishing insights into the origins of the universe and its fundamental components. In the first part of this lecture, I will provide an introductory review of the history of astronomy and key discoveries in modern cosmology. The second half will focus on recent research exploring the possibility that the universe may have a preferred handedness, suggesting a violation of left-right symmetry (parity symmetry).

Topic 6: Mathematics and magic tricks

Prof. Dr. Sin Yi TSANG

In this lecture, we will introduce some magic tricks that are based on mathematical concepts, such as representation of numbers, modular arithmetics, and symmetries. We will explain the ideas behind the magic tricks and discuss some important applications of the mathematical concepts that are involved, such as in cryptography and check digit algorithm.

4. Evaluation

The final grade for the course will be determined by the evaluation of Reaction papers. Each participant must submit one paper per lecture, i.e., seven papers in total.