

Model Core Curriculum

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National Institute of Technology (KOSEN)

An Incorporated Administrative Agency of Japan

This English translation has been prepared as a reference for the Model Core Curriculum (MCC) Guidelines, originally issued in Japanese on April 28, 2023. In case of any discrepancies, the Japanese version shall take precedence.

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Preface to the revised Model Core Curriculum

April 2023

National Institute of Technology (KOSEN) Japan

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Key features of KOSEN education and significance of the Model Core Curriculum

The National Institute of Technology (hereinafter referred to as “KOSEN”) fosters highly skilled “*human capital*” – a term used instead of “*human resources*” to emphasize that people are valuable assets to society – who can apply, develop and innovate science and technology to contribute to the well-being of people and society.

A distinctive feature of KOSEN education is its five-year integrated, experience-oriented education, which begins at the highly receptive age of 15. This enables students to acquire the fundamentals of their specialization, while also motivating them to contribute to society. Through a combination of “Thinking” experiences from lectures and exercises, and “Hands-on” experiences acquired through laboratory experiments and hands-on practices, students develop a deep understanding that enables them to confidently apply their specialized knowledge in real-world situations. In COOP (Cooperative) education and PBL (Problem/Project Based learning) focused on regional or community-based challenges, students work in teams with their peers to tackle real-world issues. Through this, they experience the process of social implementation, which includes identifying issues, creating solutions and translating feedback from those on the frontlines into improvements. Through these activities, students develop competencies such as communication, teamwork, problem identification and resolution, as well as creativity and design skills crucial for society. In addition, students cultivate flexible thinking and a rich sense of humanity through diverse learning experiences, including contest such as robotics and programming, international exchanges, school dormitory life and club activities, all tailored to their individual interests. Furthermore, in addition to daily support and guidance in school life provided by homeroom teachers and student support organizations, KOSEN offers education from various perspectives beyond academics, helping students shape their understanding of work and life perspective through career education. KOSEN education has consistently been highly recognized by various sectors both in Japan and internationally.

The *Model Core Curriculum* (hereinafter referred to as “MCC”), which outlines the achievement goals that all students must attain by graduation, serves two key purposes in KOSEN education. The first is to visualize the features and strengths of KOSEN education and to show them both internally and externally. In recent years, the global trend in higher education has shifted towards learner-centered education, focusing not on “*what is taught*”, but on “*what students can do*”. By clearly defining “*what students who study at a KOSEN can do*”, we can foster correct understanding of Japan’s unique KOSEN system among stakeholders, such as industry and local communities, as well as on a global scale. This, in turn, enhances the presence of KOSEN education.

Another important aspect is that it serves as a foundation for maintaining and improving the quality assurance of education at all KOSENs with MCC-compliant curricula. Each KOSEN will set a Diploma Policy incorporating the MCC, design a curriculum that ensure learning opportunities for students to achieve the MCC, implement education, assess learning outcomes, and continuously evaluate and improve through a series of PDCA cycles. These efforts collectively ensure the quality of education and contribute to the realization of distinctive educational program.

Background and purpose of the revision the Model Core Curriculum

Since the introduction of the *Deregulation of University Establishment Standards* in 1991, KOSEN curricula have diversified in learning content and achievement goals, driven by the creative efforts and continuous improvements of each KOSEN. From the perspective of international quality assurance in higher education, efforts have been made to establish learning achievement goals, particularly in the training of highly specialized professionals. In Japan, model core curriculum has been developed for university programs in fields such as medicine, dentistry and veterinary science. Similarly, KOSEN also required common guidelines for learning content and achievement goals across all KOSENs.

With this background, The *National Institute of Technology, an Incorporated Administrative Agency of Japan* that organizes 51 national KOSEN colleges across the country (hereinafter referred to as “NIT”) started developing MCC in 2008. The MCC carefully selects the essential knowledge and skills that all students should acquire upon graduation from KOSEN and defines learning contents and expected achievement levels. Since then, after repeated discussions by the review committee members from both within and outside the NIT, a draft of the MCC was developed and released in March 2012. The MCC for KOSEN consists of a “*core*” component, which defines the minimum standard for specific learning content, and a “*model*” component, which outlines the qualities and abilities to be developed and assessed throughout the curriculum, such as competencies required in society. Another feature is that it defined KOSEN as a transit point in students’ career development and clearly outlines the learning content and achievement goals that students should attain by graduation.

Subsequently, the MCC 2017 was released in March 2017, reflecting trends such as the progress of globalization and the upgrading of educational content, including reorganization to introduce new *Multidisciplinary Departments*. All KOSEN implemented the curriculum based on the MCC 2017 starting in the academic year 2018. Subsequently, in March 2020, the Economics/Business field (field-specific competencies) was added, and in April 2021, “Information Literacy”, one of the fundamental engineering subjects, was revised.

In recent years, a shift in social and industrial structures has become essential to address global challenges such as the declining birthrate, aging population, digital innovation and decarbonization. As a result, expectations for KOSEN to develop human capital capable of creating new values, visions, and solutions to social issues are growing. Furthermore, international trends in engineering education are shifting from a focus on knowledge to an emphasis on competencies such as independence, autonomy, teamwork, problem identification and problem-solving skills, and the motivation to contribute to society. Furthermore, the *Ministry of Education, Culture, Sports, Science and Technology* (MEXT) has called for organized and systematic curriculum management in higher education institutions through its “*Guidelines for Educational Management*” (January 2020). In a survey conducted in June 2021 on “Issues related to the MCC 2009” across all KOSENs, several concerns regarding curriculum management were raised. As the result, there is a growing need for the further clarification of the concept of curriculum management based on the MCC.

Therefore, in the newly “Revised MCC”, revisions were made to its “overall design” and “field-specific (achievement goals)”. First, the revisions related to the overall design include: (i) Further clarification of the position and purpose of the MCC in KOSEN education; (ii) Addition of an explanation of curriculum management based on the MCC; (iii) Organization of the overall structure of the qualities and abilities to be acquired; (iv) reorganization of “*Cross-disciplinary Competencies*” in MCC 2009 as “*MCC (model)*”; (v) Establishment of *MCC Plus* as a reference standard for advancing and specializing the educational content of each KOSEN. In addition, the revisions related to achievement goals by field include: (vi) Careful selection on achievement goals to be attained over the five-year KOSEN main course, considering new social needs, (vii) Adjustment and refinement of the level of abstraction in the descriptions of

achievement goals for specialized competence by field and for the engineering fundamentals; (viii) Further review of considerations for *Multidisciplinary Departments or Courses*.

Each KOSEN will develop a curriculum aligned with the revised MCC and implement it for students enrolling in the 2024 academic year, following the standard academic progression. Additionally, in areas where the Revised MCC can be applied ahead of schedule through syllabus adjustments, the latest content is expected to be promptly incorporated into the education of current students without waiting for the annual progression. Each KOSEN will autonomously organize its course subjects, grade distribution, and educational methods to ensure both educational quality assurance and distinctive education. Additionally, the Revised MCC is expected to accelerate curriculum management at each KOSEN by integrating various initiatives, such as the development of highly effective teaching materials, improvements to the educational environment, and Faculty Development (FD). Furthermore, by sharing these efforts within KOSENs, the Revised MCC will significantly contribute to the overall quality assurance of education while promoting the advancement and distinction of KOSEN education.

In recent years, international interest in KOSEN education has been growing, leading to the establishment of KOSEN institutions in Thailand, Mongolia and Vietnam. Furthermore, in collaboration with JABEE, the *KOSEN Education International Standard (KIS)* has also been launched, and three KOSENs in Japan were accredited in the academic year 2022. The introduction of the MCC will not only enhance quality assurance in higher education for fostering outstanding engineers but also facilitate the development of curricula tailored to the specific needs of each country. We are confident that Japan's KOSEN education will play a vital role in cultivating highly skilled engineering capital and making a significant global contribution as an *Internationally Recognized "KOSEN"* model.

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Part 1:

Ensuring quality assurance of KOSEN education through
the Model Core Curriculum

Chapter 1: KOSEN education and the Model Core Curriculum

1-1 Expected role of KOSEN

In 1962, *National Institute of Technology* (hereinafter referred to as “KOSEN”) was established as a higher education institution with the aim of fostering practical engineers to meet industry needs, “with the purpose of teaching specialized knowledge in depth and developing the competencies required for occupations” (Article 115, Paragraph 1 of the *School Education Act*). In 1967, specialized fields of KOSEN education, initially limited to engineering, were expanded to include merchant marine studies. Furthermore, in 1991, the restriction to engineering and merchant marine fields was removed, allowing KOSEN to adapt to a broad range of social needs.

The expected profile of human capital fostered at KOSEN has evolved over time. In the industrial field of engineering, when KOSEN was first established, Japan was emerging from the challenges of the post-war period and undergoing rapid economic growth. At that time, KOSEN was expected to foster *mid-level engineers* to support society and industry. As science and technology advanced, the type of engineers that KOSEN aim to foster has changed over time, shifting from “*mid-level engineers*” to “*practical engineers with a wealth of ideas*”^[1], “*practical and creative engineers with strong application skills*”^[2], “*diverse, practical and innovative engineers active in a wide range of fields*”^[3] and “*professionals with advanced practical skills and the potential for lifelong growth*”^[4].

However, while KOSEN was originally expected to foster mid-level engineers, its education system has actually nurtured outstanding professionals, including core engineers, managers, executives (entrepreneurs) and researchers. Moreover, as highlighted in the *OECD Higher Education Policy Review*^[5], KOSEN education has gained international recognition.

In recent years, declining birthrates, an ageing population, rapid technological innovation – particularly in digital technology – and the growing demand for global solutions to social challenges such as decarbonization have made shifts in social and industrial structures essential. Developing human capital capable of responding to these changes has become an urgent priority, requiring individuals with “*the qualities to improve society*”^[6] and “*the ability to create new values and visions while solving social issues*”^[7]. In Japan, where a drastic transformation of industrial structure is needed, there is an urgent demand for human capital development – particularly in digital and green industries, as well as in fields that drive the growth and strengthening of diverse industries contributing to both domestic and global social development. Additionally, revitalizing regional economies through industries such as robotics, semiconductors, batteries, agriculture and tourism has become a key priority. As a result, expectations for KOSEN as institutions of higher education are rising.

1-2 Distinctive features of KOSEN education

KOSEN education is Japan’s unique higher education system, introduced as an addition to the traditional 6-3-3-4 system that has been in place since 1947, by incorporating a 6-3-5 system. KOSEN accepts students at the age of 15 after they graduate from lower secondary school (junior high school), providing an environment where they can develop flexible thinking and creativity. Through an uninterrupted five-year integrated curriculum, free from university entrance examination constraints, KOSEN has fostered human capital with strong specialized knowledge, practical technical skills, and the creativity needed to support society, drive industrial progress and lead transformative change.

The distinctive features and strengths of KOSEN education that make this possible can be seen in the following aspects: (1) Acquiring academic fundamentals through lectures and exercises from early years, developing technical skills by integrating theory and practice through laboratory experiments and hands-on practices, and engaging in creative learning in practical fields through industry collaborations, social cooperation activities and competitions; (2) Education through diverse learning experiences, both within and beyond the classroom, is a key feature of KOSEN education. This includes the development of human skills through shared dormitory life and extracurricular activities

with students of different ages and cultural backgrounds, including international students (Table 1). Since the establishment of the *National Institute of Technology, an Incorporated Administrative Agency of Japan*, that organizes 51 national KOSEN colleges across the country (hereinafter referred to as “NIT”) in 2004, key features and strengths of KOSEN education include; (3) Initiatives to enhance education and improve quality by leveraging the economies of scale across all 51 national KOSENs throughout Japan.

Table 1: Characteristic elements included in KOSEN education

KOSEN education	Regular curriculum	Lecture		
		Exercises		
		Laboratory experiments and hand-on practices		
		Other		
		Independent learning, Cooperative learning	Group work	
			PBL for social implementation	
			Co-operative education	
			Graduation research	
			Global education	
			Other	
	Extracurricular activities	School life	Special activities (including HR)	
			Career counseling	
			School events	
			Student associations and committee activities	
			Club and association activities	
			Competitions	
			International exchange	
			Volunteer	
			Friendship	
			Other	
Dormitory life		Boarding and committee activities		
		Friendship		
		Other		

Practical and creative education integrating theory and practice

KOSEN education integrates a strong academic foundation with practical technical skills by dedicating more than 30% of the curriculum to laboratory experiments and hands-on practices, in addition to lectures and exercises from the early grades. The importance of STEM and STEAM education has been widely recognized in recent years, but KOSEN has been implementing this approach since its establishment. Based on combination of lectures, exercises, experiments and hands-on practices, KOSEN has introduced PBL and COOP education in collaboration with local communities and industry. These learning activities are designed to tackle specific social issues, promoting education that focuses on problem solving and social contribution through the application of specialized knowledge and technology. In competitions such as Robotics, Programming, Design, and Deep Learning, creativity is nurtured through the essential learning process of repeated trial and error. Students collaborate in teams to achieve their goals under given conditions, fostering critical problem-solving and innovative skills.

The graduation research project, conducted in the final year of study – the fifth year, serves as a capstone opportunity in which students apply their acquired knowledge and skills to navigate the entire process, from problem identification to solution, tailored to their individual interests. Another key strength of KOSEN education is that students who continue to the *KOSEN Advanced Course* after graduating five-year main course can dedicate even more time to research activities, further building on their graduation research.

Developing human skills through diverse learning opportunities

KOSEN education supports and fosters students' growth through various activities beyond the regular curriculum. For example, all KOSEN in Japan have student dormitories that create an environment where students of different ages live together, fostering the development of essential human skills such as communication and self-management abilities. International students also live in the student dormitories, providing a foundation for international collaboration by allowing students from diverse cultural and historical backgrounds to live and learn together. In recent years, KOSEN has also emphasized the development of global leadership, including the construction of new international dormitories. Additionally, efforts to cultivate teamwork and leadership are being made through extracurricular activities such as participation in clubs and volunteer work. In addition, KOSEN is fostering social cooperation skills through community engagement activities, such as supporting science education and digital education with local communities. Alongside daily support and guidance for student life provided by homeroom teachers and student support organizations, KOSEN seeks to cultivate a broad perspective on work and life through career education, offering a comprehensive educational experience that goes beyond academics.

Improving educational quality by leveraging the economies of scale at national KOSEN

Recent educational reforms have shifted from the education provider's perspective of "*what was taught*" to the learner-centered perspective of "*what have you learnt to do*", with an emphasis on learning outcomes. From this perspective, various educational methods, such as active learning and methods and portfolio education, have been introduced.

KOSEN has developed the MCC, positioned it as the foundation for quality assurance in KOSEN education, and has promoted various initiatives to enhance the quality of education in cooperation with 51 national KOSENs across Japan. For example, the MCC has promoted class design and instruction based on instructional design, active learning, the introduction of portfolio education, and the establishment of a peer support system. Additionally, by sharing outstanding examples of advanced educational practices, improvements are being made to enhance the educational functionality of KOSEN.

Furthermore, as society is going through major change, NIT is advancing and enriching education by leveraging the economies of scale across 51 national KOSENs. This includes introducing social infrastructure technology for realizing Society 5.0 into the curriculum, promoting social implementation education through advanced research activities aimed at solving social challenges, and encouraging credit transfer among KOSENs. KOSEN is driving these initiatives to enhance education by making full use of the advantages offered by the scale of the 51 national KOSENs.

1-3 Background on the development of the MCC

NIT began developing the MCC in 2008 and published a draft in 2012 (hereinafter referred to as the "MCC Draft"). Following its release, a revision study was conducted to social reflect changes, leading to the publication of the first official version in 2017 (hereinafter referred to as the "MCC 2017"). The development of the MCC was driven by challenges in Japan's higher education system and global trends in higher education reform.

Challenges the Japanese education system was facing

Japan's education system, which played a crucial role in post-war economic recovery and development, began encountering demands for reform in the 1980s. Based on the recommendations for higher education reform presented in the *Second Report of the Provisional Education Council* in April 1986, the *School Education Law and Standards for the Establishment of Higher Education* were revised in 1991. These revisions led to efforts to enhance, individualize, and diversify higher education. While the individualization and diversification of higher education were encouraged to keep pace with social changes and advancements in science and technology, ensuring the quality of higher

education also became a concern. In December 2008, the *Central Council for Education* released a report titled “*Towards the Design of Bachelor’s Degree Education*”^[8], which highlighted the need to guarantee and enhance the quality of higher education in Japan. The report emphasized the importance of aligning with international educational reforms that focus on learning outcomes. In addition, the January 2011 Central Council for Education Report “*Future Directions for Career and Vocational Education in Schools*”^[9] emphasized the importance of clearly defining the abilities to be developed through school education, with a focus on the continuity between school education and social and professional life.

As mentioned above, against the backdrop of social changes, shifts in industrial structure, and advancements in science and technology, the expectations for human resource development at KOSEN, particularly with regard to engineers, have evolved. The image of engineers now includes “*practical engineers with a wealth of ideas*”, “*practical and creative engineers with extensive application skills*” and “*diverse practical and innovative engineers who are more advanced and active in a wide range of fields*”. As can be seen from this transition, there are now expectations for KOSEN to develop human capital capable of contributing to society as practical and creative engineers with advanced knowledge in science and technology, rather than producing “mid-level engineers” that the KOSEN system was originally designed to develop.

Trends in international education reform

While Japan’s education system has been diversifying and individualizing higher education to meet society’s diverse needs, ensuring its quality in accordance with international trends had also been a key significant challenge. One international framework for quality assurance in engineering education is the *Washington Accord*, of which the *Japan Accreditation Board for Engineering Education* (JABEE) is a member. However, this framework primarily focuses on the quality assurance of university undergraduate programs, while at KOSEN, only its Advanced Course has been addressed. Since its establishment, KOSEN has provided practical and creative engineering education, along with specialized knowledge and theory equivalent to or exceeding a university bachelor’s degree, through a unique five-year higher education course that differs from traditional post-secondary education. Therefore, it had been a challenge for NIT to support and promote the autonomy and diversity of each KOSEN, while also establishing a system to guarantee the quality of KOSEN education, in line with international trends in engineering education.

1-4 The MCC of KOSEN and Model Core Curriculum in universities

Development of Model Core Curricula in other fields

While universities and other higher education institutions are expected to offer autonomous and diverse education that meets various social needs, there had also been a movement in the fields such as medicine, dentistry, pharmacy and law to develop a model core curriculum aimed at educating professionals, in order to address the demand for quality assurance in education. In most cases, these fields have clear human resource development objectives and are closely related to national licensing examinations, as well as the qualities and abilities required by society. The model core curricula in these fields organize and present core educational contents as models, based on a shared understanding of the issues and objectives among the various educational institutions within these subject disciplines.

Model core curricula in other fields have been developed as guidelines for essential and mandatory content, focusing on integrated knowledge, skills and attitudes to address common issues across various institutions. While these curricula offer a framework, institutions are not necessarily bound by them, as many have been designed in connection with national licensing examinations, which ultimately ensure the quality of the learners.

Study on the setting of achievement goals in the field of engineering

In June 2010, a report was presented by the *Collaborators' Conference on Practical Engineering Education at Universities* (hereinafter referred to as the "Collaborators' Conference Report")^[10]. In response to this, in April 2012, a report titled "*Research and Study on the Setting of Achievement Goals by Field of Engineering Education*" (hereinafter referred to as the "Research and Study Report") was published. This report, initiated by MEXT to promote leading university reform in 2010 and 2011, was primarily prepared by Chiba University^[11]. Furthermore, the *Science Council of Japan* had also studied and published reference standards for organizing curricula in various fields to contribute to field-specific quality assurance in university education^[12]. However, unlike the organization of core curricula in fields closely related to national licensing examinations, engineering practice in Japan is not directly related to national qualifications. As a result, while these achievement goals serve as guidelines, the learning and educational objectives, as well as the educational content, are defined voluntarily and autonomously by universities and other higher education institutions, allowing for the originality and diversity of these institutions to be reflected.

Developing a Model Core Curriculum for KOSEN

The circumstances under which KOSEN develops a model core curriculum differ from those of universities and other fields.

The "Collaborators' Conference Report" and the "Research and Study Report" offer recommendations on engineering education at universities and should be used as references when considering the role of engineers, as well as the qualities, abilities and attitudes required. However, directly applying these recommendations is not suitable for defining the uniqueness and characteristics of KOSEN education, as it is a higher education system distinct from universities.

The international framework represented by the Washington Accord for Professional Engineers, who use science and technology to solve society's issues and achieve their goals, classified them into engineers, technologists and technicians, based on the scope of their responsibilities, in line with the complexity of the problems they address. One of the requirements for this classification is a period of post-secondary education at a higher education institution. For engineers, this typically involves four to five years of study, which generally corresponds to a university bachelor's degree. However, since KOSEN is a unique educational system in Japan, following a 6-3-5 structure rather than the more common 6-3-3-4 system, individuals trained through the KOSEN system would not be considered engineers based on this requirement.

The KOSEN system is a unique educational system in Japan that accepts students at age of 15 and provides them with five years of higher education to develop the skills and qualities needed to become practical and creative engineers. The educational system has produced excellent human capital since its establishment and is internationally recognized. Given that KOSEN is a unique higher education system in Japan, and considering that its graduates should not be unfairly evaluated on international frameworks, it is the responsibility of the NIT, the institution that manages all national KOSENs, to clearly define the knowledge and abilities acquired through KOSEN education and to promote the high quality of this education both in Japan and internationally. The MCC is seen as an essential educational foundation for those involved in KOSEN education, while also meeting social demands for quality assurance in education.

The MCC, developed by the NIT, the agency responsible for national KOSEN, serves as the foundation for ensuring educational quality at KOSEN. It is positioned as a set of requirements to be met when organizing the curriculum of each KOSEN. However, the MCC is not intended to standardize education across all national KOSENs. There is no doubt that the philosophy, since the introduction of the *Deregulation of University Establishment Standards* has been that, in order to meet quality assurance requirements and address the diverse needs of society, each KOSEN should leverage its own characteristics to provide diverse and autonomous education. It is also challenging to uniformly define the qualities and abilities expected of "practical and creative engineers" and "individuals who create

new values, visions and solve social issues“. Various approaches are being explored and tested to develop these qualities and abilities. Therefore, it is essential for the MCC to be structured in a way that defines the minimum competency standards to be achieved through each KOSEN’s education and includes guidelines for the various educational practices at each KOSEN aimed at developing creative and practical engineers. Therefore, unlike the model core curriculum in other fields, the MCC established by NIT is not simply a “*Model of a Core Curriculum*“. Instead, it functions as *both a “Core Curriculum”, representing the minimum standards, and a “Model Curriculum”, which serves as a guideline for the diverse and autonomous educational structures at each KOSEN.*

1-5 Significance and objectives of MCC

The MCC plays a crucial in highlighting both within Japan and internationally the unique features and strengths of KOSEN education, which responds to social needs and develops human capital to support society and industry. It also serves as a foundation for quality assurance, enabling all KOSENs to develop autonomous and diverse curricula while cultivating human capital aligned with the MCC, leveraging their distinctive features and strengths. The significance and objectives of the MCC can be understood as follows.

Visualizing the features and strengths of KOSEN education

Since its establishment, KOSEN education has responded to social demands by cultivating and producing human capital who contribute to society and industry. In recent years, educational reforms have increasingly emphasized learning outcomes over educational content, adopting a learner-centered approach. This shift is reflected in the idea that “*It is not what the educator has taught, but what the learner has learnt and become capable of*“. Clearly defining “*What students who study at a KOSEN will be able to do*” helps stakeholders gain a deeper understanding of, and share, the distinctive features and strengths of KOSEN education. In this way, the MCC plays a crucial role in fostering a proper understanding of Japan’s unique KOSEN system and promoting awareness of its effectiveness.

Clearly stating the learning outcomes also highlight the unique features and strengths of KOSEN education, both within Japan and internationally. KOSEN has achieved success by leveraging its distinct characteristics, such as five-year higher education program starting at the age of 15, specialized education that integrates theory and hands-on practices to foster creativity, and the development of essential interpersonal skills through dormitory life and extracurricular activities. In KOSEN, certain educational aspects may be taken for granted. However, it is important to actively highlights these elements both within Japan and internationally to enhance the presence and recognition of KOSEN education.

Providing a foundation for sustaining and enhancing quality assurance in KOSEN education

The MCC defines the learning objectives that all students are required to achieve. Each KOSEN must provide students with necessary learning opportunities to meet these objectives and ensure that they have achieved them by graduation. However, the MCC does not restrict the entire curriculum of each KOSEN. Instead, it establishes a foundation for quality assurance by defining minimum standards, while supporting diverse and autonomous education that utilizes the distinctive features and strengths of each KOSEN. After establishing a Diploma Policy that incorporates the MCC, each KOSEN designs its curriculum to achieve this policy, assess and evaluate the outcomes, and continuously enhances its education. The MCC serves as a foundation for these efforts, supporting each KOSEN in building and strengthening its quality assurance system.

Each KOSEN implements diverse and distinctive education by leveraging its regional characteristics, areas of specialization, and unique strengths. NIT supports the development of a quality assurance system for education based on the MCC, facilitates the sharing of best practices among KOSEN, and strives to continuously enhance the overall quality of KOSEN education.

1-6 Review and revision of the MCC 2017

1-6.1 Background of the MCC revision

NIT developed and released the MCC Draft in March 2014. Subsequently, in 2015, revisions to the MCC began, reflecting advancements in educational content, including globalization and the reorganization into new Multidisciplinary Departments. In March 2017, the updated MCC was released. In March 2020, the MCC for Economics and Business (field-specific competencies) was released, and in April 2021, a revised version of “Information Literacy”, one of the fundamental engineering subject, was released. Since the 2018 academic year, each KOSEN has been implementing the curriculum in compliance with the MCC 2017.

In 2021, the following points were raised from feedback collected from each KOSEN regarding issues related to the MCC:

- The detailed setting of achievement goals, particularly in specialized fields, has led to limitations in curriculum design.
- In the Multidisciplinary Department or Course, the approach has primarily focused on meeting the minimum standards for all subject fields that the department of course covers. However, this has made it difficult to achieve the original goals of fostering a broad perspective and developing the ability to collaborate with individuals from different field.
- It is challenging to implement the distinctive curriculum of each KOSEN while ensuring the quality assurance of KOSEN education based on the MCC.

Various other opinions were expressed regarding the achievement goals in each field. The MCC serves as the foundation for quality assurance in KOSEN education and plays a key role in clarifying its features and strengths. It is important to encourage autonomous and diverse education that leverages the unique characteristics of each KOSEN. Therefore, it was considered necessary to review the MCC 2017 and explore revisions to strengthen this role and function.

In addition, since the release of the MCC 2009, expectations for human capital development at KOSEN have become more sophisticated and diversified. This shift reflects the evolving needs of industry, driven by factors such as the aging population, the rapid progress of digitalization, and the need to tackle global challenges like decarbonization. Of particular importance is Japan’s need to advance science, technology and innovation to realize Society 5.0 and transform its social and industrial structures, making the development of human capital to support this transformation an urgent priority. The international movement for educational reform has gained momentum, making it crucial to reassess the profile of human capital to be fostered and the knowledge and skills to be acquired at KOSEN, taking into account the revision in global engineer education standards such as ABET, IEA and CDIO^{[13][14][15]}.

Furthermore, in January 2020, the *Central Council for Education’s University Subcommittee* published the “*Guidelines for Educational Management*”^[16]. The report emphasized the need for more efficient, organized, learner-oriented education and the assurance of educational quality. From this perspective, it also became a challenge to reorganize the concept of educational quality assurance based on the KOSEN MCC.

Based on these changes in social conditions and trends in educational reforms since the release of the MCC 2009, NIT began studying the revision of the MCC in 2021, guided by the following policy.

- The review policy for the MCC as a whole is to organize its overall design and operational methods, focusing on teaching and learning management.
- To consider new social needs and trends in academic development, while refining the achievement goals based on KOSEN’s five-year study period.

- Review the considerations for Multidisciplinary Departments/Courses to better align with the evolving needs of society and industry.
- The relationship with various KOSEN initiatives for the advancing KOSEN education, such as COMPASS 5.0 and GEAR 5.0, will be structured to support the development of each KOSEN's curriculum.
- Regarding the basic competencies common to all fields, the *Courses of Study Guidelines for Upper Secondary Schools in Japan* (notified in 2008), which were considered when developing the MCC 2017, will be fully applied. Additionally, the achievement goals will be further refined, considering the background and significance of Japan's secondary education reforms.
- Regarding the field-specific professional competencies, the achievement goals will be refined to ensure the quality of professional education while also promoting the unique educational characteristics of each KOSEN.

1-6.2 Main revisions in the MCC 2023

The main revisions made to the MCC 2023 are listed below. (The MCC 2023 will hereafter be referred to simply as the MCC, unless otherwise specified.)

Revisions relating to the overall structure

- Positioning of the MCC and organization of its objectives
The significance and purpose of the NIT's formulation of the MCC, along with the role of the MCC in KOSEN education, have been reorganized and clearly presented.
- Organization of Curriculum guidelines, lesson design guidelines, etc., based on the MCC
With reference to the "Guidelines for Educational Management", the role of the MCC, along with related systems and tools, in the quality assurance PDCA cycle at each KOSEN, has been organized and presented.
- Organization of achievement goals as minimum standards: MCC (core) and MCC (model)
The MCC sets the minimum standards that all KOSEN students must achieve by graduation, while also providing guidelines to support the design of diverse and autonomous education at each KOSEN. The achievement goals in the MCC, as minimum standards, are divided into two categories. The first category includes of achievement goals that are considered core component of the fundamental educational objectives to be achieved in specific fields, such as mathematics, natural science, humanities, and specialized subjects within each KOSEN's curriculum. The second category consists of achievement goals that are not limited to specific subjects but are expected to be achieved through various educational methods and activities, such as career design skills, communication skills and engineering design skills. These roles in curriculum organization and lesson design have been clarified, with the first category reworded as *MCC (core)* and the second as *MCC (model)*.
- Changes to the overall structure of "Cross-Disciplinary Competencies"
The structure of the MCC (model) – "*Cross-Disciplinary Competencies*" in the MCC 2017 – was reviewed and restructured into two categories; "*MCC (model) : Fundamental Qualities and Competencies*", and "*MCC (model) : Creativity and Design Competencies*". This reorganization provides clear guidelines for curriculum development and lesson design.
- Organization of Achievement levels based on the characteristics of KOSEN education
The concept of achievement levels in the MCC was reviewed and restructured by examining the achievement levels based on the revised *Bloom's Taxonomy* adopted in the MCC 2017, along with a confirmation of the features and strengths of KOSEN education. Additionally, the concept of achievement levels in the MCC (model) ("*Cross-Disciplinary Competencies*" in the MCC 2017)

was revised, where it was challenging to align with the achievement levels in the cognitive learning domain.

- Presentation of a framework to promote the extension and deepening of the unique characteristics of each KOSEN.

The MCC sets the achievement goals as the minimum standards for KOSEN education and provides guidelines for curriculum organization. However, KOSEN education goes beyond the MCC by utilizing each KOSEN’s unique characteristics and strengths to create and implement its curriculum. The concept of *MCC Plus* was introduced to allow each KOSEN to establish and present achievement goals for fields not included in the MCC, which address society needs and require more advanced educational approaches.

Revisions relating to the achievement goals in each area

- The objectives were carefully selected to be achievable within five years of study at KOSEN, while also responding to trends in academic progress and the needs of society.
- As mentioned above, to address the challenge of restrictions on curriculum organization in fields with detailed achievement goals, the structure of the achievement goals in the MCC 2017 was analyzed, focusing on the basic competence “Engineering Fundamentals” common to all fields and the specialized competence for each field. The achievement goals were expressed in a more abstract way. Additionally, a “Reference Learning Items” was included as a reference to ensure that important items are not overlooked.
- Considerations for Multidisciplinary Departments/Courses were reviewed.

The issues and main revisions in the above revisions are listed in Table 2. The details of the revised achievement goals for each field are described in “Part 2: Achievement Goals as Minimum Standards in KOSEN Education”

Table 2: Issues and main revisions in the MCC revision

Issues for MCC revision	Main revisions to the draft revised MCC	Handling Issues
<ul style="list-style-type: none"> ■ Issues Raised by each KOSEN a. Issues related to curriculum management <ul style="list-style-type: none"> • Curricular constraints that arise in specializations with detailed achievement goals. • Difficulties in balancing “quality assurance of education” and “advancement and distinction of education” through MCC. • Consideration regarding minimum standards in multidisciplinary departments/courses. 	Revisions to the Overall Design	
	• Reorganize the positioning and objectives of the MCC	a, b, c, d
	• Clarify the role and position of the MCC in curriculum management	a, d
	• Structure the overall framework of the qualities and competencies to be acquired	c
	• Revise the overall “Cross-Disciplinary Competencies”	c
	• Organizing the level of achievement goals	a, c
• Establish “MCC Plus” as a reference standard for advancing and specializing education in each KOSEN	b, c	
<ul style="list-style-type: none"> ■ Responding to Social Needs and Educational Reforms b. Need for education that addresses transformations in social and industrial structures c. Review of educational content (for engineers) in alignment with trends in education reform d. Requests for systematic and structured curriculum management as outlined in the “Guidelines for Teaching and Learning Management” 	Revision by Field (Achievement Goal)	
	• Responding to social needs and carefully selecting the achievement goals that can be achievable within the limited five-year KOSEN main course.	a, b
	• Refining both field-specific professional competencies and engineering fundamentals while ensuring consistency in the level of abstraction, based on an analysis of the current MCC achievement goals.	a
	• Reviewing considerations for Multidisciplinary Departments/Courses	a

Chapter 2: Approach to quality assurance of KOSEN education based on the MCC

2-1 The profile of human capital fostered by KOSEN

The “Collaborators’ Conference Report”^[17] defines an engineer as “a professional who applies knowledge of mathematics and the natural sciences while considering public health, safety, cultural, social, and environmental factors to engage in design, development, innovation or problem-solving for the benefit of humanity”. As previously mentioned, this report primarily address engineering education at universities and does not directly cover KOSEN education. However, since KOSEN provides professional education comparable to university undergraduate program by offering early higher education, it is appropriate to highlight the uniqueness and characteristics of KOSEN education in relation to the engineer’s role as defined in the “Collaborators’ Conference Report”.

KOSEN, while focusing on engineering education, also develops human capital across diverse fields. Based on the engineer model, KOSEN defines the ideal human capital to be fostered as “Specialized Human Capital”[※] who contribute to society and people’s well-being by utilizing, applying and advancing science and technology“.^[18] These individuals have the ability to create a healthy and sustainable society by developing innovative technologies and ideas, building upon the knowledge, skills and expertise acquired at KOSEN.

Such human capital has the following profile:

1. A desire for the well-being of both individuals and society as a whole, along with an awareness of the responsibility to act, considering the impact of their professional activities.
2. Understanding the real-world frontlines of manufacturing and service innovation (*Mono-zukuri* and *Koto-zukuri*), in a broad sense, by acquiring the essential knowledge and skills in their specialized area of expertise, enabling them to utilize technology for social implementation.
3. Acquiring knowledge and skills in their specialized area, with an understanding of fundamental principles, and developing the ability to apply specialized knowledge (technical skills as an engineer) required for the real-world frontlines of manufacturing and service innovation.
4. Having multifaceted communication skills that bridge the gap not only between the frontlines of manufacturing and development but also with society.
5. The ability to enhance existing values or create new value by utilizing the power of technology; in other words, the ability to engage in a wide range of activities, from planning and development to production and social deployment, for effective social implementation.
6. Having the ability to take initiative and a spirit of challenges to improve existing value or create new value.
7. Having a mindset of continuous learning from a broad perspective to keep one’s knowledge up-to-date and integrate new insights.

※ KOSEN refers to the human resources it fosters as “Human Capital”. These “Human Capital” are professionals who have deepened their expertise in their respective fields and demonstrate the capability to drive social change. In engineering fields, they are recognized as “Engineers”, while in the merchant marine field, they are referred to as “Maritime Engineers”. In the business fields, they are recognized as “Human Capital for Economic and Business Sectors” – individuals who can evaluate and promote social development from an economic and business perspective.

This kind of human capital development is made possible by KOSEN education (Fig.1), which incorporates the features described above (Chapter 1: 1-2). In particular, KOSEN education has been designed to cultivate the ability and mindset to apply knowledge and technology to social issues. This is achieved through learning activities that involve identifying and solving problems by addressing specific issues and integrating insights through repeated trial-and-error processes.

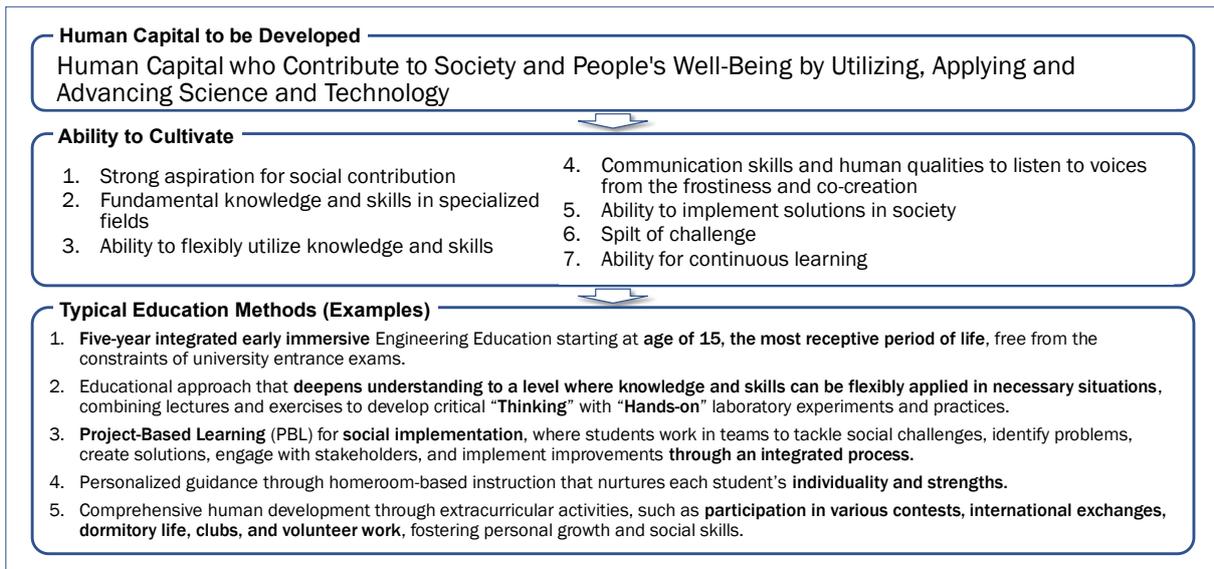


Fig.1: Human capital profiles and competencies developed by KOSEN, and representing educational methods

2-2 Components of engineering education and MCC achievement goals

Engineers, who are responsible for solving various social issues and responding to diverse needs, must not only acquire general knowledge and specialized skills but also develop common skills applicable across fields (generic skills) and cultivate the attitudes and mindsets that form the foundation for their learning and activities. Furthermore, through learning activities aimed at solving specific problems, it is necessary to cultivate the qualities and abilities required for problem-solving and achieving goals. The MCC takes as its model the profile of engineer presented in the "Collaborators' Conference Report" mentioned before and organizes achievement goals that correspond to the components of education required to foster this profile, taking in account the five-year KOSEN main course (Fig.2).

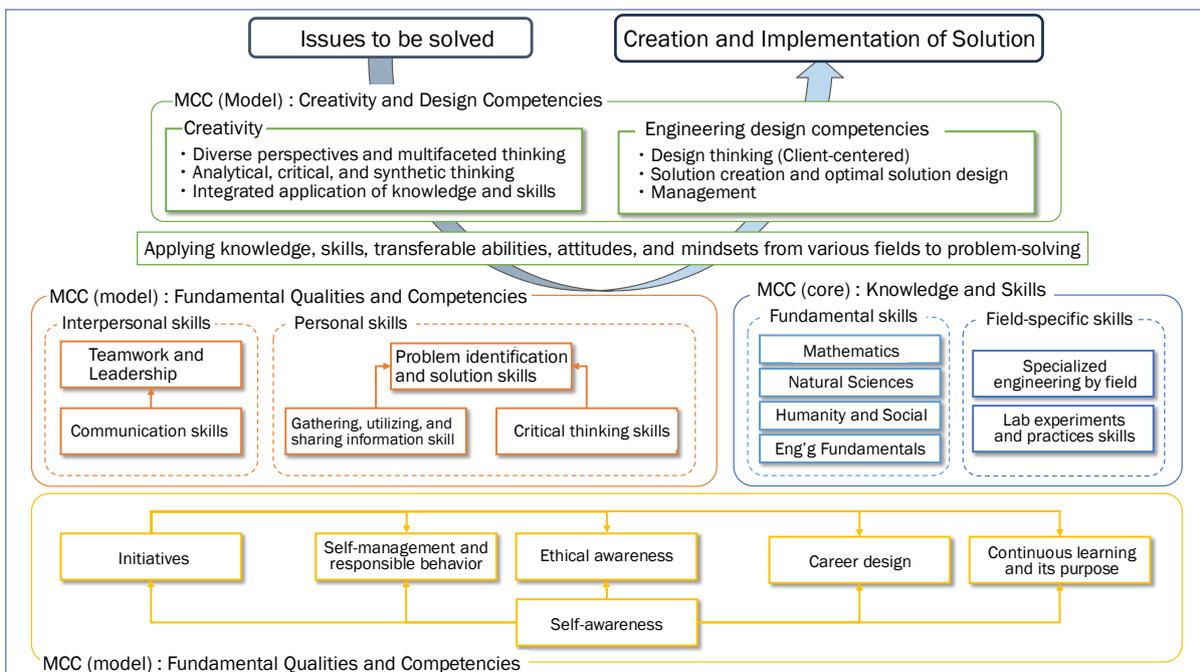


Figure 2: Overall structure of MCC achievement goals

(Organized with reference to the "Conference of collaborators on the state of practical engineer education at universities" (June 2010), "Research and study on the setting of achievement goals by field regarding engineer education" (April 2012), etc.).

2-3 Fundamental framework of MCC achievement goals

The minimum achievement goals to be acquired by graduates of KOSEN outlined in the MCC consist of MCC (core) and MCC (model). (Figure 3)

2-3.1 MCC (core)

The MCC (core) outline the general achievement goals to be achieved in education in specific fields, including both general and specialized subjects. It primarily sets the minimum standards of achievement goals for knowledge and skills, consisting of discipline-common basic competencies and field-specific specialized competencies. The discipline-common basic competencies include mathematics, natural sciences, humanities and social sciences, and engineering fundamentals. Subject-specific specialized competencies include experimental and practical skills in the fields of mechanics, materials, electrical and electronics, information technology, chemistry and biology, construction, architecture, merchant marine (navigation) and merchant marine (engines). When organizing the curriculum for each KOSEN, all departments are required to include basic competencies common across disciplines, and each department or course must also incorporate field-specific specialized competencies relevant to the fields.

2-3.2 MCC (model)

The MCC (model) consists of two components; “MCC (model) : Fundamental Qualities and Competencies” and “MCC (model) : Creativity and Design Competencies”. Since it is difficult to directly link the MCC (model) to specific subjects, it serves as a collection of the achievement goals to be attained throughout the entire curriculum of each KOSEN. Regarding how to define the achievement goals included in the MCC (model) in the graduation certification policy (hereinafter referred to as the “Diploma Policy”) and the curriculum designed to achieve these goals, as well as how to foster and evaluate them, each KOSEN can design its approach according to its own unique characteristics. Therefore, the MCC (model) is intended to serve as a guideline for setting the Diploma Policy and designing the curriculum at each KOSEN. This enables each KOSEN to structure its curriculum based on the MCC (model), ensuring that the achievement goals contained in the MCC (model) are effectively included.

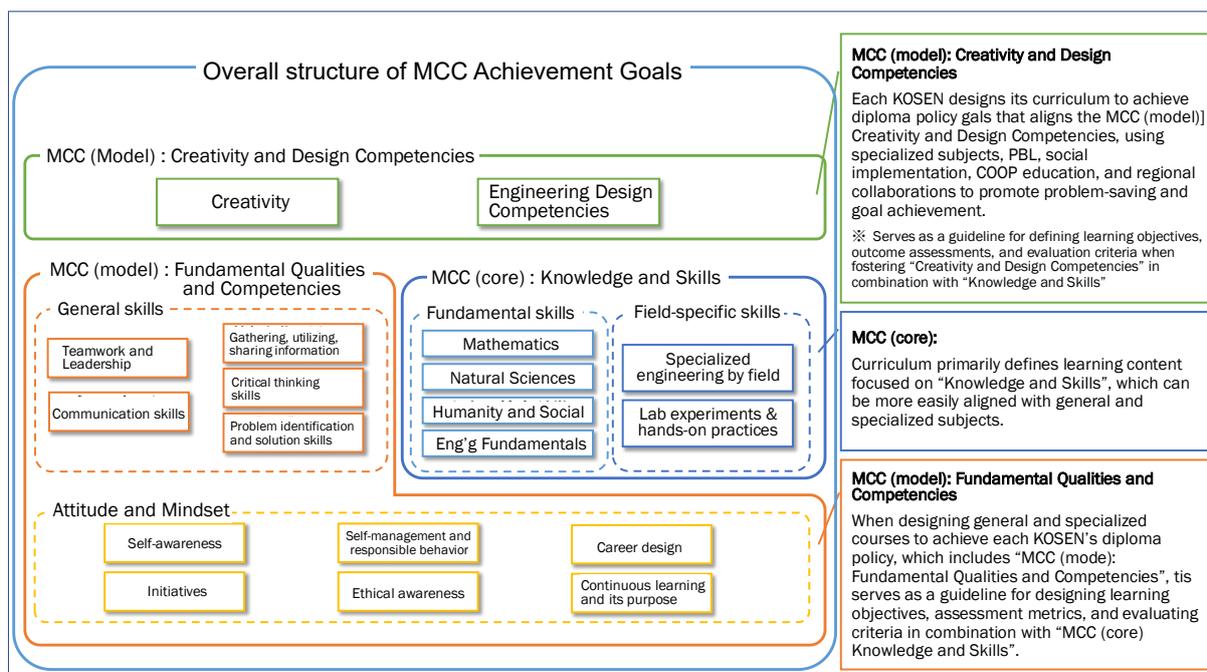


Figure 3: MCC (core) and MCC (model)

2-4 Competencies required to be developed in KOSEN education

The MCC has defined achievement goals for the following areas (Table 3). Specific achievement goals are described in Part 2. Note that while the profile of human capital to be fostered through KOSEN education also includes human capitals for economic and business sectors, but the achievement goals for these areas are defined separately.

Table 3: Competencies to be acquired in KOSEN education

MCC (core)	
Basic Competencies that Engineers should have in Common	Field-specific Competencies that Engineers should have
I Mathematics	V Specialist engineering by discipline
II Natural sciences II-A Physics II-B Physics experiment II-C Chemistry. II-D Chemistry experiments II-E Life Sciences and Earth Sciences	V-A Mechanical fields V-B Materials fields V-C Electrical and electronic fields V-D Information systems fields V-E Chemical and biological fields V-F Construction fields V-G Architectural fields V-H Merchant marine fields (navigation) V-I Merchant marine fields (engines)
III Humanities and social sciences III-A Japanese III-B English. III-C Society.	VI Field-specific skills for engineering laboratory experiments and hands-on practices
IV Engineering fundamentals IV-A Engineering experimental technologies (various measurement methods, data processing and discussion methods) IV-B Technology ethics IV-C Information literacy IV-D Globalization and intercultural multicultural understanding	VI-A Mechanical engineering fields VI-B Materials systems fields VI-C Electrical and electronics fields VI-D Electrical and electronic fields VI-E Chemical and biological fields VI-F Construction-related fields VI-G Architectural fields VI-H Merchant marine fields (navigation) VI-I Merchant marine fields (engines)
MCC (model)	
MCC (model) : Fundamental Qualities and Competencies	MCC (model) : Creativity and Design Competencies
VII Versatile skills VII-A Communication skills VII-B Teamwork and leadership VII-C Information gathering, utilization and dissemination skills VII-D Thinking skills VII-E Problem-finding and problem-solving skills	IX Creativity and design competencies IX-A Creativity. IX-B Engineering design competencies
VIII Attitudes and mindsets VIII-A Self-understanding VIII-B Initiative VIII-C Self-management and responsible behavior VIII-D Ethics VIII-E Career design VIII-F Continuous learning and learning objectives	

2-5 The concept of achievement level in the MCC

Based on the profile of the ideal engineer required by society, the MCC establishes the standards to be achieved in each of the competence areas listed in Table 1 during the five-year main course at KOSEN. As in the MCC 2009, the achievement goals are set with reference to the revised Bloom's Taxonomy. The concept of achievement goals for the MCC (model) is described below.

2-5.1 The concept of achievement level for the MCC (core)

The concept of achievement goals for the learning content included in the MCC (core) is shown in Figure 4.

Learning at KOSEN goes beyond simply accumulating knowledge. Through a wedge-shaped education approach, students begin studying specialized fields early on and deepen their understanding to the point where they can freely apply their knowledge. This is achieved through learning activities in which students apply what they have learned in lectures to specific cases, as well as through experiences in laboratory experiments and hands-on practices. This level of achievement is set at Level 3 (application). In addition, at each KOSEN, students collaborate in teams to address real-world issues, analyze and understand the essence of these issues, and develop solutions to complex and unfamiliar challenges. They achieve this by fully utilizing scientific knowledge, specialized knowledge and technology through social implementation-type PBL and other learning activities. The standards reached through these activities, which are the true essence of KOSEN education, include Level 4 (Analyze), Level 5 (Evaluate) and Level 6 (Create) of the revised Bloom's Taxonomy. Therefore, for the field-specific professional competencies in the MCC (core), the level students should achieve by graduation is defined as level 4 (Practice), which includes levels 4 to 6 of the revised Bloom's Taxonomy. Based on this concept of achievement levels, the learning outcomes for the five-year of the course are set to achieve up to level 3 for basic professional competencies common to the disciplines and up to level 4 for field-specific professional competencies.

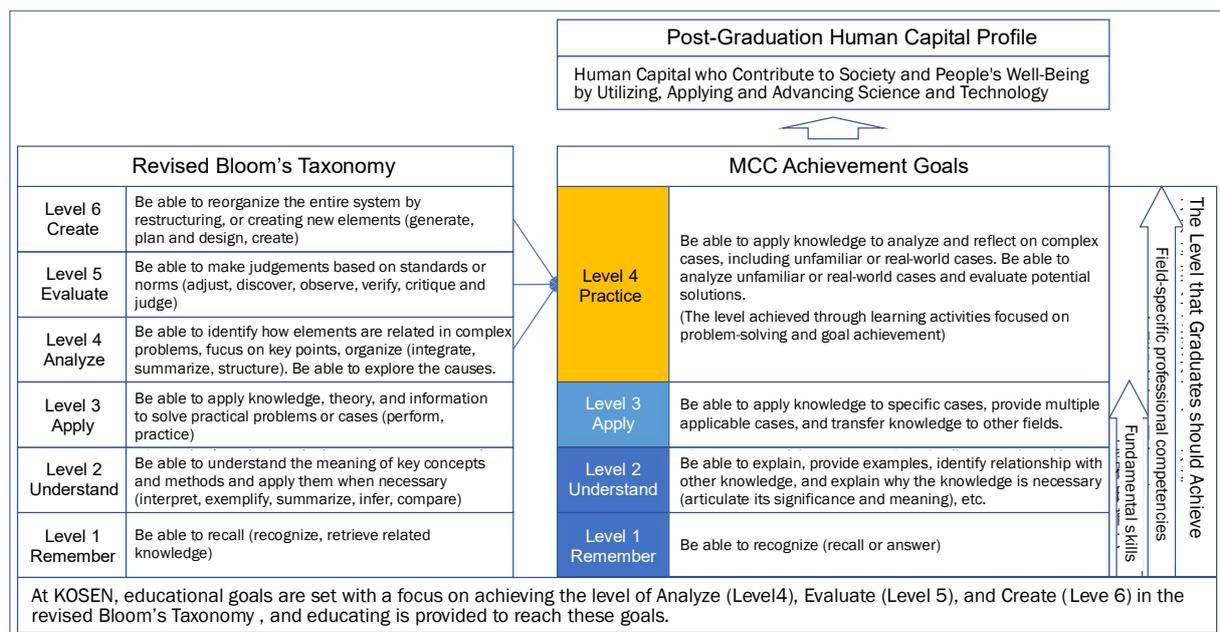


Figure 4: The concept of achievement levels in MCC (core)

When designing the specific curriculum at each KOSEN, it is not always necessary to build up achievement levels sequentially, starting from Level 1 (Remember). For example, if the achievement levels related to a particular learning objectives are developed progressively as courses are linked or as students advance through academic years, the progression from Level 1 (Remember) to Level 3 (Apply) should be assessed step by step. On the other hand, if, a subject or activity is designed to achieve Level 3 (Apply) for a particular learning objective, then the lower levels (Level 1 and Level 2) can be considered achieved once Level 3 (Apply) is confirmed (Table 4). Based on this approach, each KOSEN must review syllabus, course content, and other materials to ensure alignment between learning objectives and their intended achievement levels.

Table 4: Examples of achievement levels and curriculum design concepts

Achievement Level 1	Achievement Level 2	Achievement Level 3	Note
○	○	○	When a subject is designed to progressively build up the level of achievement toward a specific learning objective.
→	→	○	If only subjects at achievement Level 3 designated for a specific learning objective, achieving Level 3 can be considered as also achieving Level 1 and Level 2.

Additional information on the achievement levels of the MCC (core)

The achievement levels of the MCC (core) are not intended to indicate levels of difficulty. While it is true that learning activities become more complex as student progress from acquiring knowledge to understanding, application, and practice, the higher levels naturally encompass the lower levels. This progression may, in some cases, be perceived as an increase in difficulty. However, what these graded levels reflect is an increase in the types of learning activities based on knowledge acquisition and the additional learning outcomes that are sought. Therefore, the higher standards are never set in the sense that only the most academically able students can reach them. Although there may naturally be a difference in performance among students who reach the achievement level, students who are allowed to graduate have met the set achievement level.※

※ Although this may not be the most fitting example of the level of achievement in the cognitive learning domain, we can use the skills required for sport as an analogy. For instance, basketball involves various skills such as running, throwing, receiving, dribbling shooting, defensive techniques, and executing set plays, all of which are learned progressively until the final game is played. When applied to the MCC (core) achievement level model, it can be expressed as follows:

- Level 1: Can perform basic footwork, receive passes, and dribble.
- Level 2: Can pass to team players while running, dribble while avoiding defense.
- Level 3: Can demonstrate acquired skills and play as a team in a match format.
- Level 4: Can play as a team in a real game, making decisions according based on their own strategy.

Although higher levels involve more complex learning activities and outcomes compared to the lower levels, this does not imply that only exceptional learners can reach Level 4. While there may be differences in performance among learners at each level, it does not mean that they are incapable of engaging in activities at the Level 4 standard of “Playing as a team in a real game, making their own decisions according to their own strategy”. In KOSEN education, all students can participate in learning activities focused on problem-solving and task achievement, which are set at Level 4. It is considered achievable for all students to meet the required standard at this level.

2-5.2 The concept of achievement level for the MCC (model)

The learning content in the MCC (model) includes certain content topics that are not suitable for being organized in a step-by-step progression of knowledge acquisition, understanding, application, and practice within the cognitive learning domain. For example, the attitude and mindset in the “MCC (model) : Fundamental Qualities and Competencies” are not solely developed through the acquisition of knowledge; they also form the foundation for learners’ thinking and behavior. These qualities are considered to be transformed not only through the learning process of acquiring and applying knowledge, but also through intentional learning activities where the learner actively practice the required behavior. This involves drawing on diverse perspectives, awareness of different ideas and values, and recognizing the attitudes, ideas and characteristics that underlie thinking and behavior. General-purpose skills in the “MCC (model) : Fundamental Qualities and Competencies” are not only acquired and understood through the acquisition of knowledge, but are also developed by

demonstrating each skill through action and practice. In other words, “MCC (model) : Fundamental Qualities and Competencies” are developed through practical learning activities due to their nature, and it is important to measure and evaluate the outcomes of these activities. Therefore, it is appropriate for the “MCC (model) : Fundamental Qualities and Competencies” to be set as the standards that KOSEN students should acquire by graduation, rather than treating it as development process progressing step by step through knowledge, understanding, application, and analysis, as outlined in the revised Bloom’s Taxonomy cognitive learning domain model.

Furthermore, the “MCC (model) : Creativity and Design Competencies” must be developed through learning activities focus on solving specific problems and achieving tasks. As such, “MCC (model) : Creativity and Design Competencies” are cultivated through learning experiences corresponding to Level 4 (Practice) in the model, which defines the achievement level set for KOSEN education based on the revised Bloom’s Taxonomy for cognitive learning domains. Therefore, the “MCC (model) : Creativity and Design Competencies” represent only the level that students are expected to achieve upon graduation from KOSEN.

The MCC (model) is established as an achievement level to be attained over the five-year KOSEN education, differing from the achievement levels (Levels 1 to 4) applied to the MCC (core), which are structured based on increasing complexity in the application of knowledge. In other words, the progressive leveling from Level 1 to Level 3 (or 4) is not applied. Instead, the indicators presented in the achievement goals in the MCC (model) serve as guidelines, defining the learning and educational objectives that each KOSEN student should attain by graduation.

In the curriculum designed by each KOSEN to fulfill its Diploma Policy, as mentioned above, the fundamental skills included in the MCC (core) should be achieved at Level 3 or above, while specialized skills in each field should be attained at Level 4 or above. In particular, achieving Level 4 in the field-specific specialized competencies requires designing curricula that incorporate learning activities such as PBL and social implementation. Additionally, for the MCC (model), each KOSEN must define specific achievement levels, design the curriculum and classes to achieve those levels by referring to provided materials such as the standard rubric, and ensure learning opportunities while measuring and evaluating learning outcomes (Figure 5).

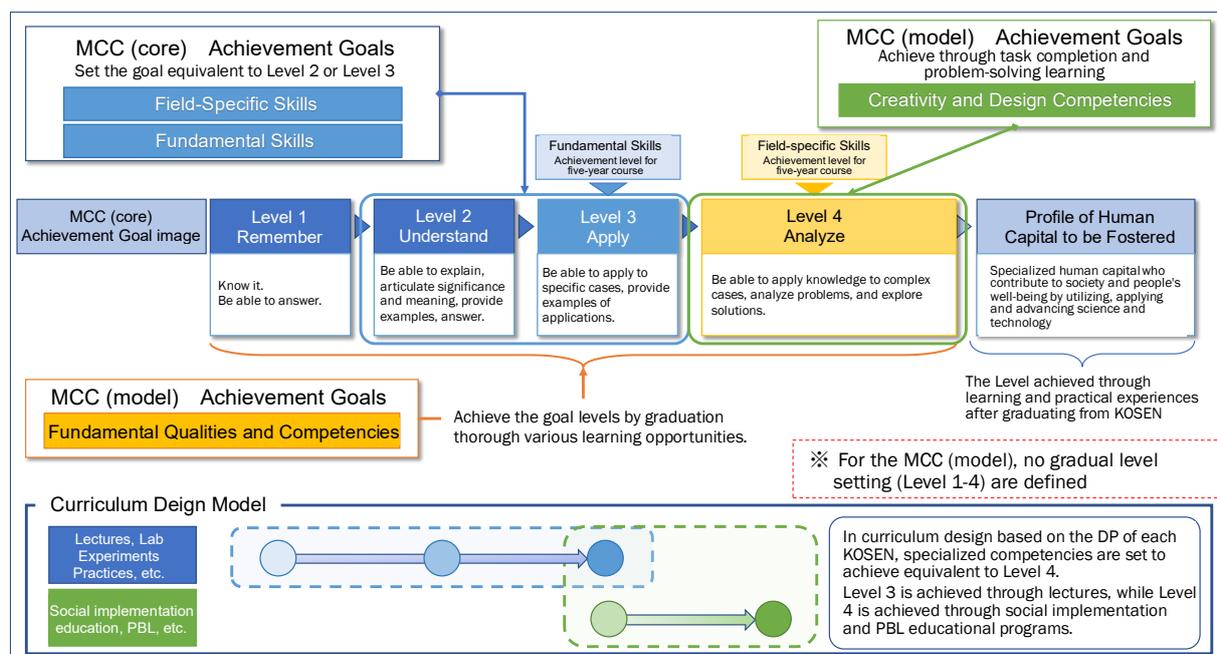


Figure 5: Relationship between achievement levels and curriculum design in MCC

Chapter 3: Curriculum management and the MCC in each KOSEN

3-1 Quality assurance initiatives and the MCC in each KOSEN

The achievement goals of the MCC represent a minimum standard for the competencies that all KOSEN students should acquire. Each KOSEN has its own Diploma Policy and curriculum designed to achieve the learning and educational objective that further specify the Diploma Policy (hereafter, unless otherwise specified, the “Diploma Policy” will collectively refer to both the Diploma Policy and the learning and educational objectives). The MCC is integrated into this framework. The quality assurance of education required of each KOSEN ensure that the Diploma Policy, which encompasses the MCC achievement goals, has been achieved, and that the curriculum, organized based on the curriculum design policy (hereinafter referred to as the “Curriculum Policy”) for achieving the Diploma Policy, is implemented. The curriculum, designed based on the MCC achievement goals, is put in practice, and the PDCA cycle, based on the results of measuring and evaluating the outcomes, is functioning as the foundation for systematic improvement.

To support and promote activities based on the PDCA cycle for quality assurance in each KOSEN, NIT provides MCC and related systems and tools, and implements various initiatives (Figure 6).

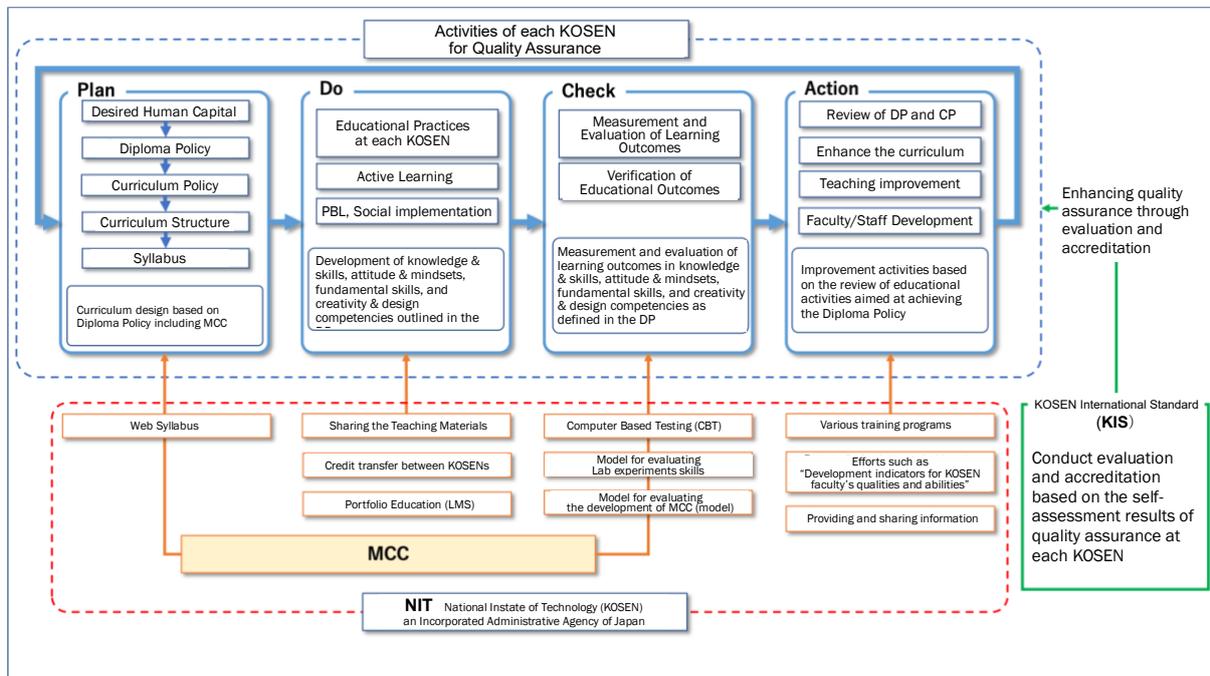


Figure 6: Quality assurance PDCA cycles for each KOSEN, MCC, and Initiatives by NIT

Plan - Each KOSEN is responsible for defining a Diploma Policy that includes the achievement goals outlined in the MCC. This is done after defining the profile of human capital to be fostered, which reflects the unique characteristics and features of each KOSEN. Curriculum Policies are then established to achieve these goals, and the curriculum is designed accordingly. Individual teachers are responsible for preparing syllabuses by defining achievement goals and learning content for their subjects, based on their understanding of how the KOSEN’s Diploma Policy relates to the subjects they teach.

A web syllabus system is provided as a tool to review this design. The web syllabus allows departments and each KOSEN as a whole to verify that the curricula align with the Diploma Policy and include the achievement goals outlined in the MCC. It also enables users to check how the learning objectives (and content) of each subject correspond to the achievement goals of the MCC.

Do - Each KOSEN is to implement education based on the curriculum designed to achieve the Diploma Policy. KOSENs are required to introduce and promote effective educational methods to meet various achievement goals, while also improve the learning environment. This includes the introduction and use of systems such as Learning Management Systems (LMS). Each teacher should select and apply effective educational methods to support and encourage students' learning activities toward achieving the set goals. In particular, in response to the recent educational reform trends that emphasizes students' active role in "learning" rather than simply being "taught", methods such as active learning should be adopted and practiced .

The NIT has actively promoted active learning and has developed and shared teaching materials. It also supports KOSEN educational activities through initiatives such as the sharing teaching materials and facilitating credit transfers among KOSENs. The vision for the human capital fostered by KOSEN is to develop "*professional individuals who contribute to society and people's well-being through the use, application, and development of science and technology*". For graduates of KOSEN to actively contribute to society, they must develop creativity and design competencies through hands-on learning activities that focus on solving specific issues and accomplishing tasks. This process allows them to apply and demonstrate the knowledge, skills and fundamental competencies that they have acquired during their studies. By sharing advanced practical examples of learning and educational activities that promote problem-solving and goal achievement – such as socially implemented PBL and COOP education in collaboration with industries – the project supports the improvement of educational practices at each KOSEN. Additionally, the initiative promotes the sharing of educational content that integrates *Next-Generation Core Technologies* into the curriculum.

Check - Each KOSEN is required to establish an assessment plan to ensure that students achieve the Diploma Policy, verify and improve educational activities, and visualize, measure, and evaluate learning outcomes and educational effectiveness based on this plan. In addition to strictly grading each subject, each KOSEN must make the achievement status of the Diploma Policy transparent and accessible for review. Teachers are responsible for assessing individual students' learning outcomes using appropriate methods and standards to measure the attainment of course-specific achievement goals. Furthermore, improvements should be made not only based on performance data but also by incorporating student satisfaction feedback and the results of class evaluation questionnaires.

NIT supports the evaluation and improvement of curriculum structured and educational practices at each KOSEN by conducting computer-based testing (CBT) and analyzing the results. Additionally, NIT has developed and released a model for cultivating and assessing "skills for engineering laboratory and practices" and "cross-disciplinary competencies". The achievement goals of the MCC extend beyond subject-specific knowledge and include competencies such as skill development through experiments and hands-on practices, a key characteristic of KOSEN education. They also encompass general skills, attitudes and mindsets common to all fields, as well as creativity and design competencies. The MCC's achievement goals are structured as guidelines for developing these competencies, measuring learning outcomes, and implementing evaluation methods.

Action - Each KOSEN is required to analyze the results visualize and understood through the assessment plan and use them to drive educational improvements. These improvements may include reviewing the Diploma Policy and corresponding Curriculum Policy, revising the curriculum, enhancing classes, and refining the learning support system. Additionally, each teacher is responsible for improving their classes by referring to various data sources, such as student grades, class evaluation results, and students' learning progress.

Capacity development for faculty members and staff (FD - Faculty Development / SD - Staff Development) is also essential. Various initiatives aimed at human resource development are being implemented at each KOSEN. NIT has also developed and published an FD Map, which outlines the qualities and abilities required of faculty members at KOSEN and provides a framework for fostering these qualities and abilities.

Furthermore, the *KOSEN Education International Standard (KIS)* has been introduced as a framework for conducting accreditation evaluations of the overall educational activities of each KOSEN, based on a Diploma Policy that aligns with the MCC.^[19]

The basic concept of how the MCC is integrated into the management system for curriculum organization, implementation, and evaluation at each KOSEN is outlined below. The activities of curriculum organization, implementation, evaluation and improvement, which form the core of educational management, are collectively referred to as “Curriculum Management”.

3-2 Diploma Policy development at each KOSEN and its MCC alignment

Each KOSEN is required to establish a clear and specific Diploma Policy that defines the type of human capital it aims to develop. The “Teaching and Learning Management Guidelines”^[20] outline the following.

The policy should emphasize on “what students will be able to do” and clearly define the specific learning outcomes required for graduation and degree conferral. In doing so, it is recommended to follow the “*Bachelor’s Competencies Developed through Each Major Field of Study - Reference Guidelines for Bachelor’s Curriculum Common Learning Outcomes*” presented in the Bachelor’s Curriculum Report should be followed, and the “*Reference Standards on Curriculum Development for Field-specific Quality Assurance in University Education*” (hereinafter referred to as “Field-specific Reference Standards”) of the Science Council of Japan should also be used as reference.

(Guidelines for Educational Management, p.12)

When formulating the “*Graduation Accreditation and Degree Awarding Policy*”, it is essential to ensure consistency with the university’s overall educational philosophy. Furthermore, based on the previously referenced “*Bachelor’s Competencies Developed through Each Major Field of Study - Reference Guidelines for Bachelor’s Curriculum Common Learning Outcomes*”, the policy is also expected to consider the development of broad range of competencies that extend beyond individual specialized fields.

(Teaching and Learning Management Guidelines, pp.13-14)

At NIT, the MCC serves as the foundation for establishing the Diploma Policy of each KOSEN. The MCC (core) defines the essential knowledge and skills to be acquired, while the MCC (model) encompasses a broader range of qualities and abilities that extended beyond the individual specializations that is outlined in the “*Bachelor’s Degree Competency Report*” and “*Field Specific Reference Standards*” that universities are expected to follow under the “*Academic Guidelines*”. By adopting a Diploma Policy that integrates the MCC, each KOSEN ensure that students attain the minimum required competencies. (Fig.7)

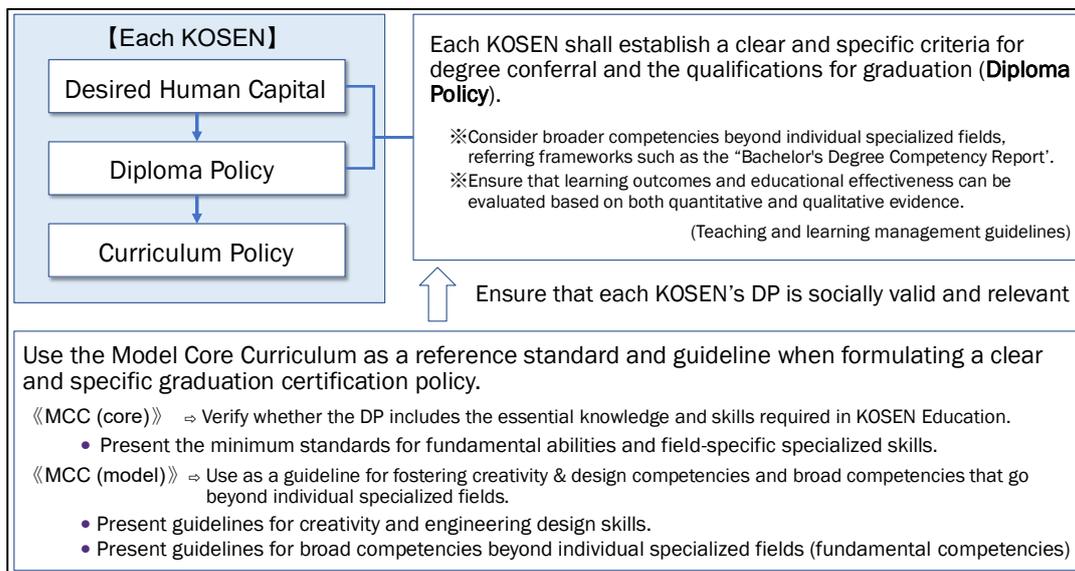


Figure 7: Relationship between the Diploma Policy of each KOSEN and the MCC

In March 2020, to support and promote the review of diploma policies at each KOSEN in accordance with the “Academic Management Guidelines“, NIT introduced the “Concept of KOSEN DP (Diploma Policy) “ as a reference for all KOSEN. Each KOSEN is required to integrate the “Concept of KOSEN DP” into its Diploma Policy while reflecting its unique characteristics . The “Concept of KOSEN DP” is based on the MCC, ensuring that diploma policies integrating this concept also encompass the MCC. (Fig. 8).

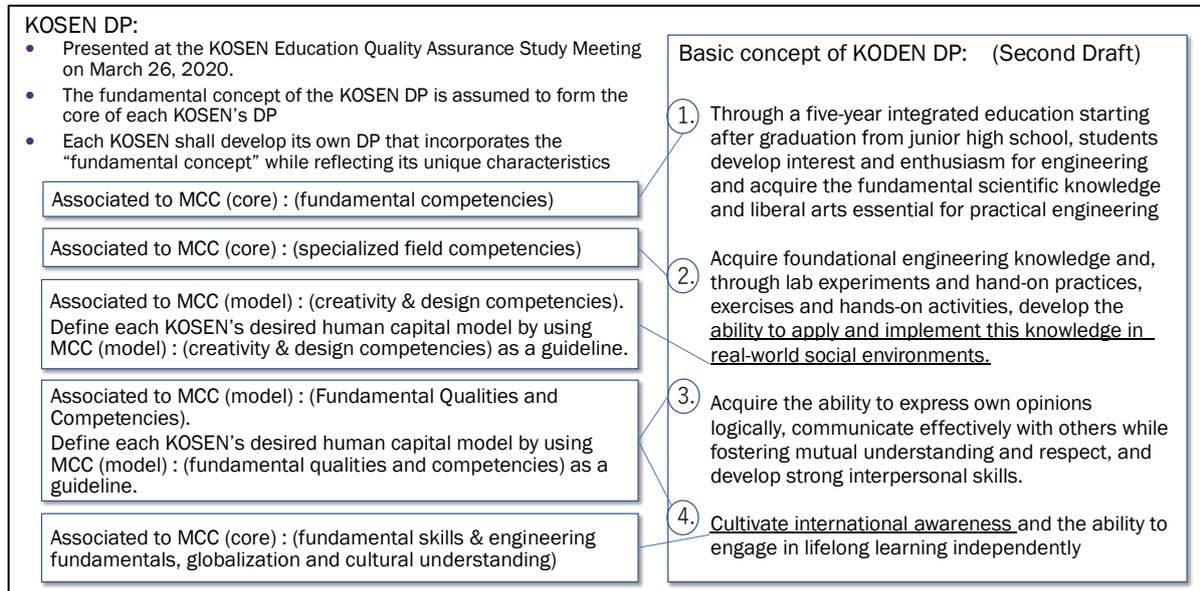


Figure 8: Basic concept of the KOSEN DP and its correspondence with the MCC

Additionally, each KOSEN defines its own Diploma Policy based on its regional characteristics, history, and areas of specialization, defining the desired qualities of its graduates and specifying them to meet the diverse needs of society. As a result, the Diploma Policy of each KOSEN will encompass the MCC while also reflecting its unique characteristics. Furthermore, it is desirable to consider advancement in KOSEN education as a whole, particularly in fields necessary for driving social and industrial transformation. This should take into account the outcomes of various NIT initiatives, such as COMPASS 5.0 and GEAR 5.0. (Note: The achievement goals of these initiatives, which serve as a part of their deliverables, are discussed in Part 3 as MCC Plus[※]).

※About MCC Plus

The Model Core Curriculum (MCC) defines the minimum standards in KOSEN education. However, KOSEN education is not limited to the MCC alone; each KOSEN is encouraged to leverage its unique strengths and advance its educational programs in response to social needs. The MCC Plus serves as a set of achievement goals that guide the enhancement of KOSEN education, fostering both the development and deepening of each KOSEN's distinctive features.

3-3 Curriculum structure at each KOSEN and its relationship with the MCC

Each KOSEN shall define a Curriculum Policy to achieve its Diploma Policy and design its curriculum accordingly. The designed curriculum is required to provide the necessary learning opportunities to achieve the Diploma Policy, including the achievement goals indicated in the MCC. Whether the necessary learning opportunities are guaranteed for the curriculum as a whole can be designed and confirmed by the web syllabus provided by NIT.

3-3.1 Ensuring learning opportunities to achieve MCC goals in the curriculum of each KOSEN

The following points should be considered when designing the curriculum to ensure learning opportunities that align with the MCC achievement goals outlined in each KOSEN's Diploma Policy: The MCC (core) consists of fundamental competencies shared across all fields and the specialized competencies. The field-specific fundamental competencies primarily align with the achievement goals of learning areas covered in general subjects, while the field-specific specialized competencies are mainly associated with the achievement goals of specialized subjects. However, these alignments are not strictly fixed, as the MCC (core) achievement goals are intended to be met throughout the entire curriculum of each KOSEN. Consequently, the curriculum can be designed in a way that allows achievement goals from the common basic competencies to be addressed within specialized subjects, and conversely, achievement from the field-specific specialized competencies to be met through general subjects.

Since establishing a one-to-one correspondence between the MCC (model) and general subjects is challenging, it is assumed that competencies will be cultivated and learning outcomes assessed across the entire curriculum and various subjects. Each KOSEN (or department) is required to define a Diploma Policy that incorporates the achievement goals outlined in the MCC (model). Accordingly, each KOSEN (or department) must systematically develop learning opportunities to fulfill its Diploma Policy, ensuring the attainment of the MCC (model) achievement goals. To achieve these objectives, it is essential for each KOSEN to carefully design the curriculum by determining the appropriate sequence of subjects, as well as the timing, methods, and criteria for assessing learning outcomes. Additionally, the generic skills, attitudes, and mindsets included in the "MCC (Model) : Fundamental Qualities and Competencies" are significantly influenced by experiences beyond the classroom, such as extracurricular activities and dormitory life. Therefore, it is also important to explore ways to effectively incorporate these experiences into the curriculum.

In addition, the "MCC (model) : Creativity and Design Competencies" is developed through problem-solving and task achievement activities, such as PBL, which are key features and strengths of KOSEN education. It is expected that the ability in the field of study, as defined by each KOSEN, will reach Level 4 (Practice) through these learning activities. Therefore, in organizing the curriculum, it is essential for each KOSEN to ensure learning opportunities that enable students to solve problems and accomplish tasks through trial and error, while demonstrating acquired knowledge and skills, general skills that apply across fields, and the attitude and mindset that support various activities. For example, it is essential to ensure learning opportunities that focus on developing creativity and engineering design skills, such as PBL for solving real-world challenges in collaboration with local communities, as well as the incorporation of COOP education in partnership with industries.

The relationship between curriculum organization based on Curriculum Policy and MCC at each KOSEN is shown in Figure 9. Regarding curriculum organization and subject design, which include the achievement goals of the MCC (model), reference materials, including practical examples from each KOSEN, are described in Part 4. By referring to these documents, it is necessary to organize the curriculum and design the lessons of each subject to achieve the Diploma Policy of each KOSEN.

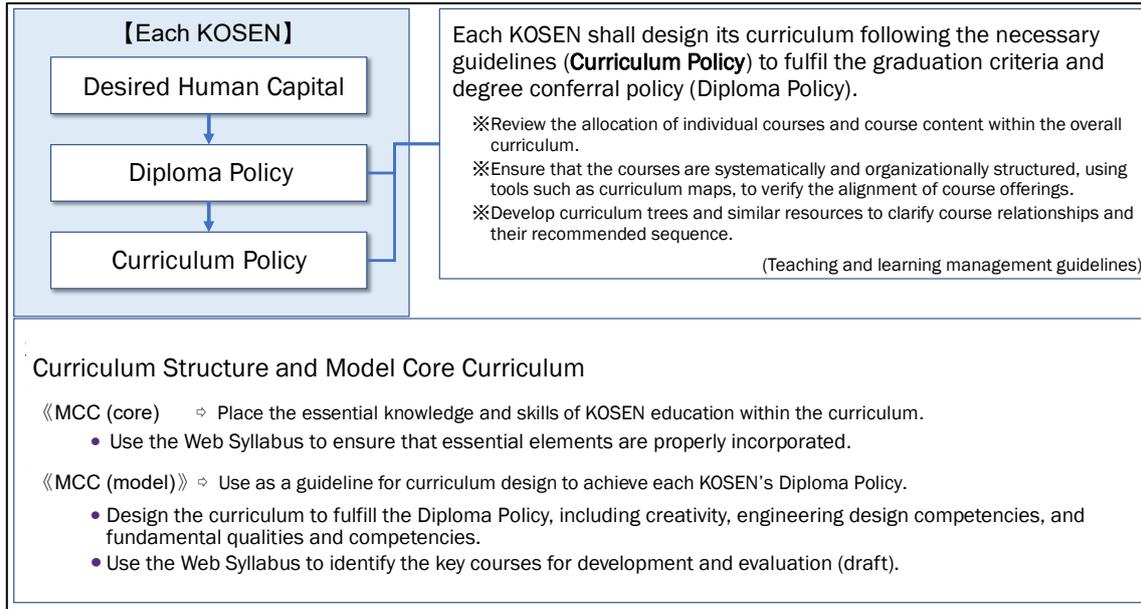


Figure 9: Relationship between MCC and the Curriculum Policy and Curriculum Structure of each KOSEN

3-3.2 The Concept of each KOSEN's unique approach to curriculum design

The achievement goals of the MCC are structured as minimum standards of KOSEN education. However, KOSEN education goes beyond the MCC, offering broader curriculum and more advanced levels of learning. Therefore, it is expected the proportion of MCC in the total curriculum of each KOSEN will be approximately 60-70%. The specific implementation will reflect the unique characteristics and circumstances of each KOSEN, as evidenced by the Diploma Policy developed using the MCC (model) as a guideline, and the curriculum design tailored accordingly.

The following cases can be considered for the unique parts of the curriculum of each KOSEN:

(1) Features related to the content (scope) of study

Check the alignment between the achievement goals of the MCC (core) – including basic competencies common to all fields and field-specific competencies – and the teaching frameworks of each subject. The parts of curriculum that extend beyond the MCC (core) content is considered the unique features of that KOSEN.

(2) Features on achievement levels

If the learning content in the MCC (core) – including both common basic competencies and field-specific competencies – is covered, but the level of achievement beyond the minimum standard is specified in the Diploma Policy and the assessment plan, it is considered a unique part of the KOSEN.

(3) Other ideas of special features

It is expected that each KOSEN will define its unique characteristics through the inclusion of the MCC (model) achievement objectives in its Diploma Policy, the organization of the curriculum to achieve these objectives, and the learning opportunities it provides. Each KOSEN is also expected to adopt its own unique approach to socially implemented PBL, collaboration with industries, and the methods used to put these into practice.

The curriculum of each KOSEN encompasses learning opportunities to achieve the achievement goals of the MCC, but it goes beyond that by including a variety of learning activities designed to fulfill the Diploma Policy, reflecting the unique characteristics of each KOSEN.

3-3.3 Approach to applying MCC to Single-Discipline Departments and Multidisciplinary Departments

To foster engineers who can address various social challenges, some KOSEN have Diploma Policies that focus on acquiring knowledge and skills across multiple specializations, and the number of such KOSEN is expected to increase. Therefore, guidelines have been established for applying MCC to both departments or courses that consist of a single specialization (hereinafter referred to as “Single-Discipline Department/Course”) and those consist of several specializations (hereinafter referred to as “Multidisciplinary Department/Course”).

Single-Discipline Department/Course

For Single-discipline department/course, the curriculum must include all the achievement goals specified in the relevant MCC (core), including the field-specific professional competencies.

Multidisciplinary Department/Course

The “*Considerations for Multidisciplinary Departments/Courses*” have been developed based on the “*Application Guidelines for Multidisciplinary Department/Course*” outlined below. In the case of a multidisciplinary department/course, the curriculum must include the achievement goals for the field that comprises that department/course, as outlined in “*Considerations for Multidisciplinary Department/Course*”.

Application guideline for Multidisciplinary Department/Course

(1) Basic policy

To achieve the human capital development goals outlined in each KOSEN’s Diploma Policy while ensuring effective teaching and learning management, it is essential to design an integrated multidisciplinary curriculum that cultivates comprehensive problem-solving abilities beyond the boundaries of specific fields. To achieve this, the content and scope of essential elements in each field will be carefully refined to ensure that the curriculum does not become just an accumulation of MCC (core) components from individual specializations. These refined elements will be defined as “*Considerations for Multidisciplinary Departments/Courses*”.

When evaluating whether a Multidisciplinary Department/Course meets the MCC (core), it should be assessed based on the integration of two disciplines. If the curriculum covers more than three disciplines, it must fulfill the MCC (core) requirements for at least two of the core disciplines. The remaining fields are not required to meet the MCC (core) criteria and can instead be considered part of the “unique features of each KOSEN”.

(2) Concept of considerations for the Multidisciplinary Department/Course

Consider a case where a multidisciplinary department/course consists of two specialized engineering fields, A and B. Let N_A and N_B represent the total number of items in each achievement objective group, with n_A being the number of items selected from the achievement objective group of professional engineering A, and n_B being the number of items selected from the achievement objective group of professional engineering B. In this case, the set Diploma Policy set by each KOSEN for the Multidisciplinary Department/Course should ensure that:

The key point here is that, even in a Multidisciplinary Department/Course, it is possible to achieve the equivalent core learning outcomes of a single-disciplinary department while also acquiring cross-disciplinary engineering skills, such as a broad perspective and problem-solving abilities, simultaneously.

Based on this approach, the considerations for Multidisciplinary Department/Course have been organized (see Part 2: Achievement Goals as the Minimum Standards in KOSEN Education).

The relationship between the Diploma Policy of each KOSEN, the Curriculum Policy, and the curriculum to achieve these policies, which have been discussed so far, and the MCC, is shown once again below (Figure 10).

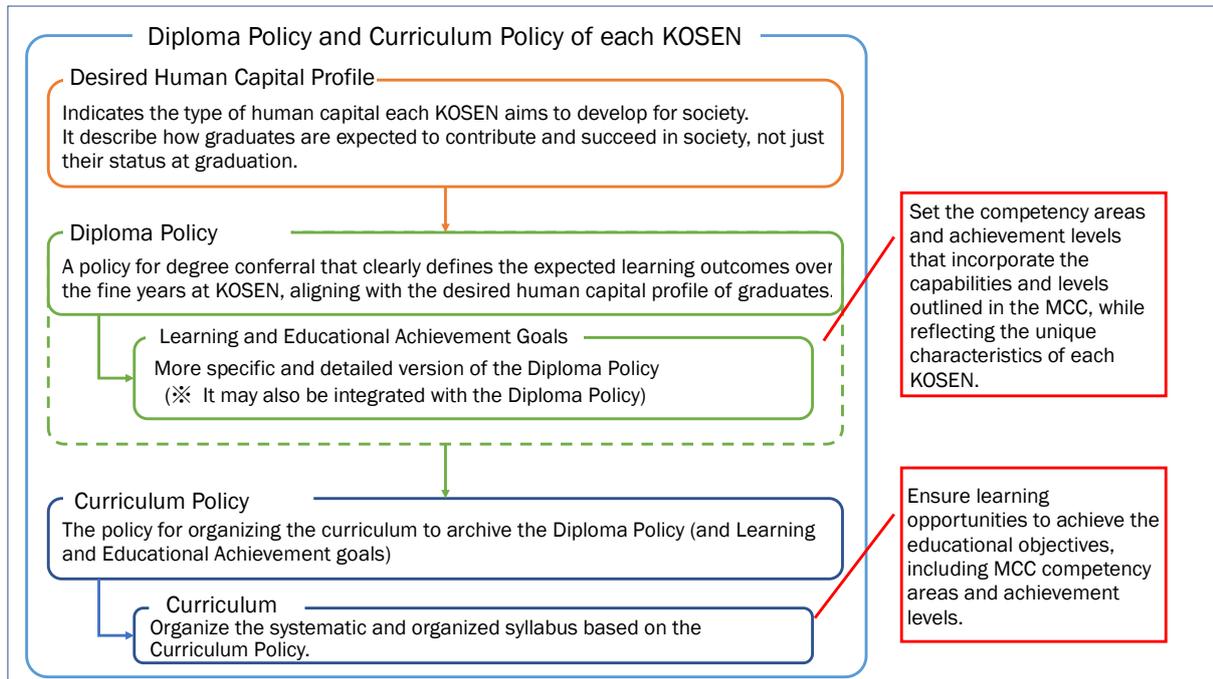


Figure 10: Relationship between MCC and each KOSEN's Diploma Policy, Curriculum Policy and curriculum

3-4 MCC-based approach to lesson design

As stated in the “Collaborators’ Conference Report”^[21] and the “Research and Study Report”^[22], practical engineers need to learn basic knowledge and skills in each field of study. They also need to develop general skills applicable to all fields and cultivate the right attitudes and mindset for learning and professional activities. Furthermore, practical engineers must foster the creativity to solve various problems or complete tasks using these learning outcomes, as well as the design skills required to develop specific solutions. In response to these components of engineering education, the MCC organizes the learning content into three main categories; “MCC (core)” for knowledge and skills, “MCC (model) : Fundamental Qualities and Competencies” for attitudes, mindsets and generic skills, and “MCC (model) : Creativity and Design Competencies” for creativity and design competencies. (This section focuses on “Engineers” in the engineering field, but the same principles apply to human capital in the merchant marine, economic and business fields).

The achievement goals presented in the MCC are organized as minimum standards in KOSEN education and consist of MCC (core) and MCC (model). As mentioned above, MCC (core) is organized as a set of achievement goals that have a relatively straightforward, one-to-one relationship with specific subjects in both generic and specialized areas. On the other hand, the MCC (model) is organized as a set of achievement goals that do not directly correspond to specific subjects. However, these goals must be achieved throughout the curriculum, and their outcomes must be understood. Therefore, the achievement goals in MCC (model) are considered to be achieved through learning activities across various subjects. In other words, when designing lessons in each subject area, it is necessary to integrate the MCC (core), which includes knowledge and skills directly related to the subject, with the MCC (model), which, although not directly related to the subject, is developed through learning activities across a variety of subjects.

3-4.1 Concept of lesson design combining MCC (core) and MCC (model), such as Lecture-based courses

General and specialized subjects primarily set learning objectives and class designs that include the achievement goals outlined in the common basic competencies and field-specific specialized competencies of MCC (core). However, it is important to note that these achievement goals primarily focus on knowledge and skills. The abilities to be developed in each subject are not limited to specific knowledge and skills of the respective fields; they also aim to cultivate general skills, qualities, and abilities related to attitude and mindset. Therefore, when preparing the syllabus for each subject, learning objectives that combine MCC (core) and MCC (model) are established. Additionally, the necessary learning activities and educational strategies to development these abilities are considered, along with the criteria and methods for measuring and evaluating learning outcomes (Fig.11). The MCC assumes that the curriculum as a whole, through lectures and other subjects, will reach Level 3 (Apply) in terms of common basic competencies and field-specific professional competencies. Level 4 (Practice) for field-specific professional competencies is discussed in the next section.

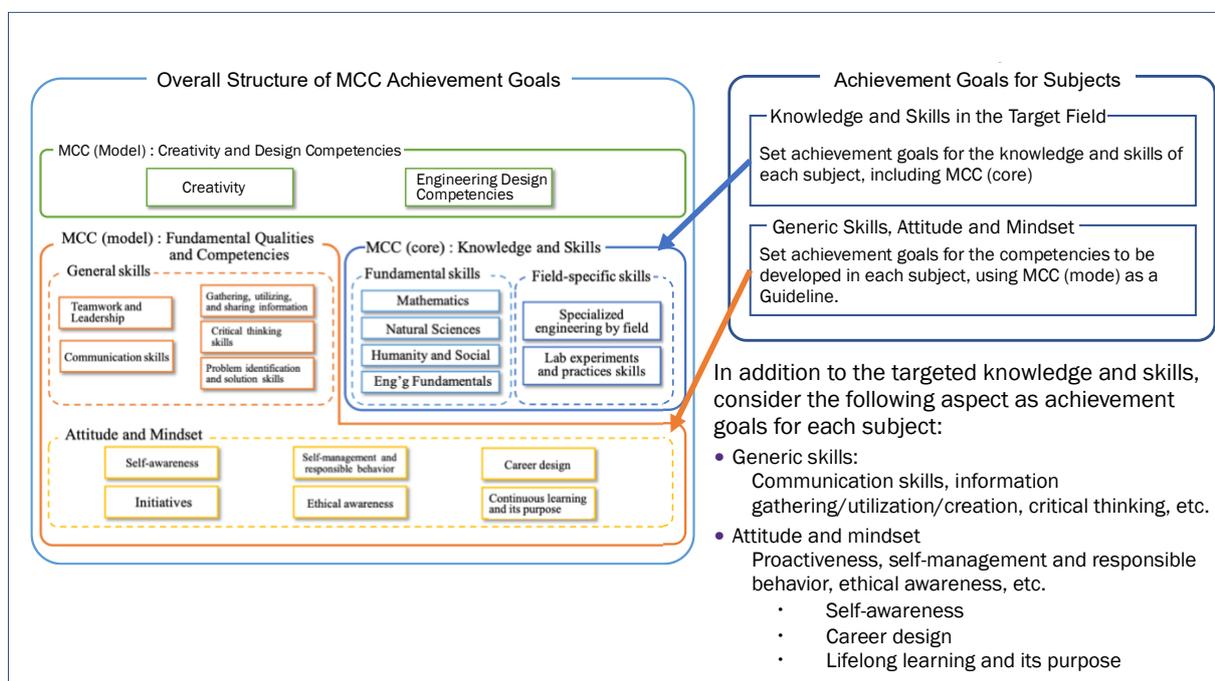


Figure 11: Relationship between lesson design, MCC (core), and MCC (model) for Lecture-based courses in general and specialized subjects

[Note]

“The Courses of Study for Upper Secondary Schools (Notified Version, 2008)” [23] also emphasizes curriculum and lesson design that integrates the three elements of academic ability, as described below. Although KOSEN education does not directly correspond to upper secondary school education, it is still useful to refer to this guideline since KOSEN has a five-year curriculum, which includes the upper secondary education.

These guidelines have been fully implemented since 2022. Therefore, it is important for KOSEN to consider the lesson design for each subject, considering the content of Comprehensive Inquiry, Geography Comprehensive, History Comprehensive, Geography Inquiry, Japanese History Inquiry, World History Inquiry, Classics Inquiry, Basic Science and Mathematics Inquiry, Science and Mathematics Inquiry, and Comprehensive Inquiry. Thoughtful lesson planning in each subject area is crucial at KOSEN.

The Courses of Study Guideline for Upper Secondary Schools (Notified Edition, 2008), Chapter 1: General Provisions, Section 1 (extract).

3The school shall enhance its educational activities by clearly defining the qualities and abilities it aims to develop through overall school education and within each subject or subject area. In doing so, it must ensure that the following goals are achieved without bias, while considering the developmental stages and characteristics of the students.

- (1) Ensure the acquisition of knowledge and skills.
- (2) Foster the development of think, judgement, expression, and more.
- (3) Cultivate the ability to learn for personal growth, human development, and more.

3-4.2 Concept of lesson design combining MCC (core) and MCC (model), such as PBL, social implementation education

The MCC assumes that students will reach Level 4 (Practice), particularly in terms of professional competence, through learning activities where they apply the knowledge, skills, generic competencies, attitudes and mindsets acquired in both general and specialized subjects to solve specific problems and complete tasks. The “MCC (model) : Creativity and Design Competencies” serves as a guideline for setting the achievement goals to be attained through these learning activities.

The development of broad range of competencies – such as the ability to analyze complex situations, identify problems or set challenges, design solutions while considering stakeholders, and plan and manage the implementation of solutions – is expected to be achieved through PBL and social implementation education. The strength of KOSEN education lies in its integration of knowledge and practice. The curriculum should be holistically designed to foster the development of creativity and design competencies essential for practical engineers. This should be accomplished through learning activities centered on solving real-world issues and completing tasks, while demonstrating acquired knowledge, skills, general competencies, attitudes and mindsets. Curriculum organization and lesson design should fully leverage the unique characteristics of each KOSEN (Fig.12).

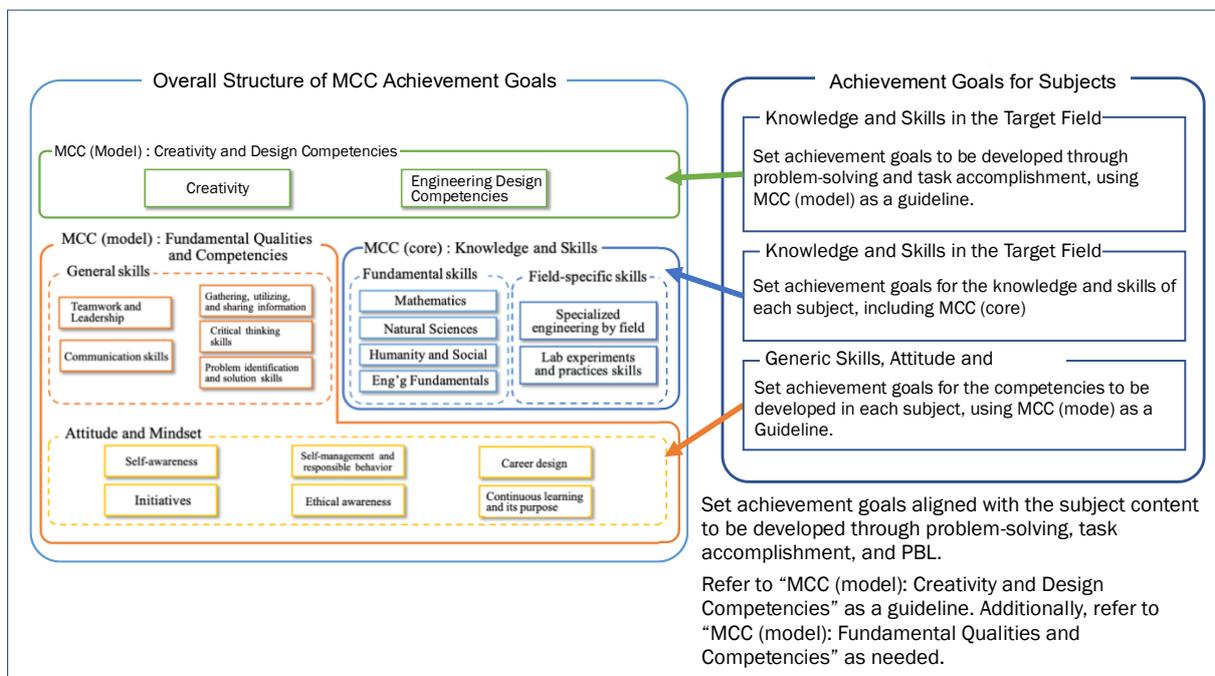


Figure 12: Relationship between MCC (core) and MCC (model) in lesson design for problem solving and task achievement

[Concept of educational approaches to fostering creativity]

There are many perspectives on how to foster creativity in education explored and implemented across different KOSENs. Recognizing and understanding social and human challenges, solving problems and developing solutions cannot be achieved through formulaic approaches alone.

Therefore, fostering creativity in education is not simply about acquiring knowledge or understanding and applying structured thinking methods. Creativity is believed to emerge through a process of trial and error, where insights and ideas develop from taking on challenges and learning from mistakes. When designing curricula and classes at each KOSEN, it is essential to offer opportunities for students to engage with real-world issues, set their own challenges, and continuously refine their ideas using the knowledge and skills they have acquired. This approach, which emphasizes wisdom gained through experience, can be described as “Wisdom Education“ (Fig.13).^[24]

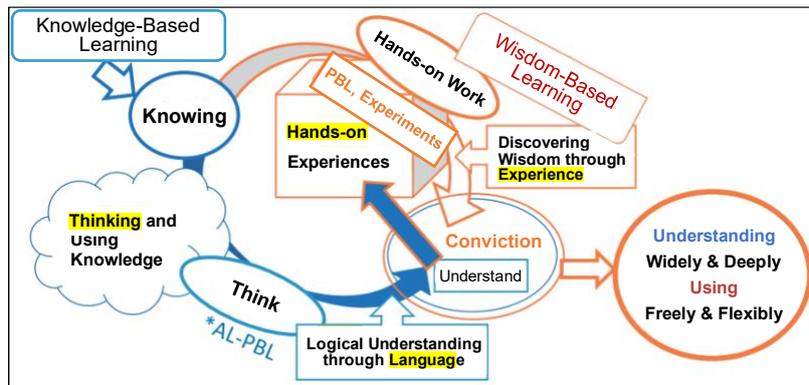


Figure 13: Knowledge and wisdom education
 (quoted in T. Yotsunayanagi, Wisdom Education for Using Science, J. of JSEE, 70-3 (2022))

This approach to education had been practiced in KOSEN education. In PBL, which focus on solving problems and achieving tasks, socially implemented PBL aimed at addressing specific social issues, and education in collaboration with industries (COOP education), students deepen their learning through hands-on experiences. These experiences reflect the real work that engineers do to solve issues and accomplish tasks. By applying the knowledge and skills they have acquired, students realize that they cannot tackle these challenges alone. They then learn to utilize the insights gained through trial and error, combined with the knowledge and information they have gathered and analyzed, to solve problems and achieve tasks (Fig. 14).^[25]

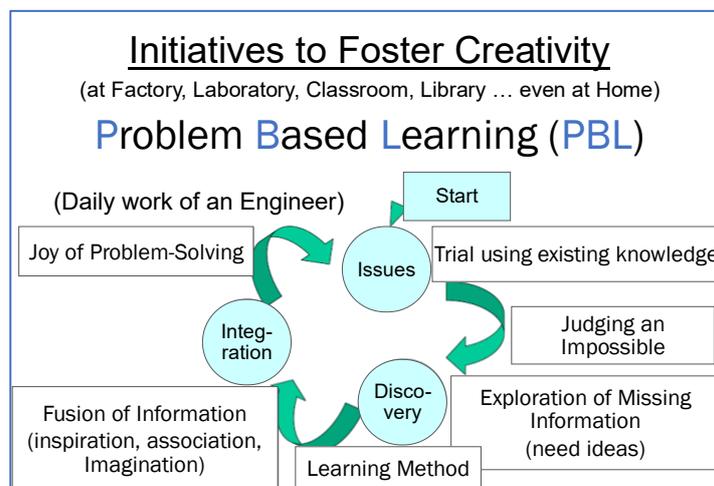


Figure 14: Initiatives for cultivating creativity
 (T. Yotsutsuyanagi, quoted in Central Council for Education, University Subcommittee, Institutional Subcommittee data, 2004.6.17.)

Along with achieving the goals outlined in the MCC (model), it is encouraged that each KOSEN consider curriculum organization and lesson design that foster creativity and design competencies, drawing inspiration from these concepts.

3-5 Educational activities: Support and promotion of learning activities

Each KOSEN conducts educational activities based on a curriculum designed to meet the Diploma Policy. To achieve the Diploma Policy and specific learning objectives of each subject, it is essential for each KOSEN to offer tailored learning guidance and support for individual students by utilizing systems and tools such as LMS. Additionally, KOSEN should enhance the learning environment to foster collaborative learning. Moreover, each KOSEN is encouraged to expand its understanding of educational methods that support independent students learning and improved learning outcomes, such as portfolio-based education and active learning, and to proactively integrate these methods into their teaching.

Each teacher is responsible for selecting and applying appropriate educational methods to support and enhance students' learning activities, ensuring that the learning objectives of each subject are met. This approach shifts the focus from "*what to teach*" to a learner-centered approach of "*what have you become able to do*", which has been emphasized in recent educational reforms. Teachers should focus on supporting and encouraging students' independent learning to help them achieve the desired learning outcomes.

NIT has undertaken activities to designate KOSENs that promote the active introduction of active learning and has provided support for its implementation at each KOSEN. Additionally, efforts have been made to support the acquisition of instructor qualifications at each KOSEN to introduce and promote lesson design and teaching methods based on instructional design.

Currently, NIT continues to support the enhancement and improvement of the educational activities at each KOSEN through initiatives such as sharing teaching materials, promoting credit transfer among KOSENs, introducing a unified LMS, encouraging portfolio education, and establishing a peer support system. It is expected that each KOSEN and its faculty members will actively utilize these initiatives.

3-6 Visualizing, measuring and assessing learning outcomes

Each KOSEN must measure and evaluate the achievement of students in relation to the Diploma Policy it has set. To do this, it is essential to visualize and assess the learning outcomes. Each KOSEN is required to establish clear grading standards and implement rigorous evaluation procedures. Furthermore, it is necessary to ensure that the grading for, designed to achieve the Diploma Policy, is carried out appropriately. Additionally, it should be clearly communicated how the learning outcomes from these subject contribute to the overall achievement of the Diploma Policy. Moreover, it is important to enable students to monitor and understand their progress toward achieving each component of the Diploma Policy.

The results that each KOSEN should track go beyond the grades in individual subject. They should also include the outcomes of external examinations and qualifications, awards and prizes, as well as survey results on students' sense of growth and satisfaction. Additionally, it is essential to evaluate the effectiveness of educational activities, including through the use of class questionnaires and student satisfaction surveys, to ensure that the educational approach is meeting its goal.

To effectively utilize this wide range of data for educational improvement, an assessment plan must be developed in advance. Ongoing inspection and evaluation based on the assessment plan should then be carried out to enhance the quality assurance system, leveraging this comprehensive data.

Each teacher is responsible for selecting appropriate methods and criteria for measuring and evaluating the achievement objectives of individual subjects, based on the perspective of "*what can be learnt and acquired*" in relation to the Diploma Policy. Teachers should evaluate grades based on quantitative or qualitative evidence accordingly. Additionally, in each subject, it is important to review

achievement goal levels, learning content, and teaching methods, using the evaluation results from class questionnaires.

NIT is supporting each KOSEN in visualizing and assessing learning outcomes, as well as exploring methods for measuring and evaluating them. For example, Computer-Based-Testing (CBT) has been introduced to help students assess their own learning progress and to enable each KOSEN to monitor students' achievement levels and implement improvements in teaching and education. Additionally, guidelines are being developed and shared among KOSEN to measure learning outcomes beyond knowledge acquisition and understanding – such as skills for engineering laboratory and practices, generic skills, attitude and mindset, creativity, and design competencies – which are more challenging to evaluate quantitatively.

3-6.1 Understanding learning outcomes through CBT

The NIT has been conducting CBT to measure students' progress towards the MCC achievement targets since 2015, building on the Learning Achievement Test (in mathematics and physics) that it had been conducting since 2005. A CBT trial was conducted in 2015, and full-scale operation began in 2018. As of 1992, CBT is implemented in general subjects such as mathematics, physics and chemistry, as well as in specialized subjects including mechanical, materials, electrical, information, chemistry and biology, construction, and architecture.

The objective of implementing CBT is to; (1) Verify the learning effectiveness of students (enabling each students to identify their own weaknesses and reinforcing those area autonomously), (2) Provide guidelines for improving classes and curricula (understanding trends in strengths and weaknesses within each grade/class based on MCC achievement targets and using this data as a guide for curriculum and class improvements).

3-6.2 Development and evaluation of field-specific laboratory experiments and hands-on skills

In March 2008, a project led by Asahikawa KOSEN focused on the “Development of Evaluation Indicators for Field-Specific Laboratory Experiments and Hands-on Practices Competence”, resulted in the creating of a set of measurement and evaluation indicators for the competencies to be developed through experiments and hands-on practices. This initiative also developed and published a model experimental guide (hereinafter referred to as the “Guidelines for Model Laboratory Experiments”.

The Guidelines for Model Laboratory Experiments serves as a standard model, with the understanding that each KOSEN may modify and adopt it accordingly to its own curriculum structure and specific conditions. The key point is that each KOSEN should clearly define the skills and competencies to be developed through laboratory experiments and hands-on practices, communicate these expectations to students, and then visualize, measure and evaluate the learning outcomes.

This model was developed based on the 2009 MCC, but the core content remains consistent with the MCC 2023. Therefore, it should be used by each KOSEN as a reference when specifying the competencies to be developed through experiments and hands-on practices, as well as for measuring and evaluating learning outcomes.

3-6.3 Updating and evaluating MCC (models)

The achievement goals expressed as “*Cross-Disciplinary Competence*” in the 2009 MCC was developed through the project aimed at constructing a “*Cross-Disciplinary Competence Assessment Model*” with Kumamoto KOSEN as the base college. This project resulted in the creation and publication of a cross-disciplinary competence assessment indicator, a standard rubric, and simple test. Additionally, a collection of practical examples from the participating KOSENs was published alongside these tools.

In the MCC 2023, the overall structure was reviewed, leading to the reorganization of the “*Cross-Disciplinary Competencies*” into two categories; “*MCC (model) : Fundamental Qualities and Competencies*” and “*MCC (model) : Creativity and Design Competencies*”. Similar to the previous

“Cross-Disciplinary Competencies”, the achievement goals included in the MCC (model) are difficult to directly associate with specific subjects and must be developed throughout the entire curriculum. These competencies also recognize the impact of students’ extra-curricular activities, such as club activities, student association roles, dormitory life, and other off-campus activities. Each KOSEN’s curriculum should consider how the outcomes of these extra-curricular activities can be integrated, demonstrated, and further nurtured through regular learning activities.

To develop the qualities and abilities included in the MCC (model), it is essential to establish specific measurement and evaluation indicators and share them with students. “Part 4: Reference Materials” contains supplementary explanatory materials on the MCC (model), including a standardized rubric. This rubric is intended to serve as a reference for each KOSEN and can be adjusted according to the characteristics of their curricula and individual subjects.

3-7 Efforts of the NIT to improve the education of each KOSEN

The “Guidelines for Educational Management” require each KOSEN to visualize and understand learning outcomes and other key educational data, implementing continuous improvements based on its assessment plans. Additionally, each KOSEN is responsible for defining the required qualities and competencies of their faculty and staff in alignment with its Diploma Policy. This includes implementing appropriate and optimal Faculty Development (FD) and Staff Development (SD) programs, systemically organized according to the position, experience. Furthermore, the promotion of educational Institutional Research (IR) as a key element to support educational management is also considered essential.

NIT has outlined the qualities and abilities required of teachers in charge of education at KOSEN and developed the “*Index for the Development of Qualities and Abilities of Teachers in KOSEN Education*” and the “*FD Map*”. Based on this, the relationship between the various FD/SD programs implemented at each KOSEN and those organized by NIT is being assessed and organized to ensure systematic and coordinated planning and implementation of FD/SD across all KOSENS .

3-8 Initiatives to support and promote curriculum management at each KOSEN

The MCC serves as the foundation for quality assurance in education at KOSEN and supports NIT’s various efforts to enhance and refine the unique educational offering of each KOSEN. NIT is implementing a range of initiatives to help each KOSEN respond to diverse social demands, develop educational activities that leverage their unique characteristics, and showcase the quality of their education both within Japan and internationally.

For example, to establish and strengthen the educational management system – a focus that primarily been emphasized by universities in recent years – NIT launched a project to promote educational management in 2020. Since 2022 academic year, initiatives to establish and enhance the educational management system have been actively promoted across all KOSEN in Japan.

In addition, the KOSEN Education International Standard (KIS) was introduced to assess and certify that the quality management of education at each KOSEN has been properly implemented. Trials runs began in 2021, and since 2022, the KIS accreditation and evaluation has been rolled out in stages across all KOSEN.

The MCC clearly defines the minimum standards for KOSEN education and ensures the quality of education at each KOSEN by organizing and implementing curricula based on these standards. However, KOSEN education is not limited to the MCC alone. Each KOSEN is encouraged to incorporate educational content that highlights its unique characteristics into its curriculum, striving for more advanced education. In response to the needs of local communities and industries, each KOSEN is required to define the type of human capital it aims to develop, leverage its educational and research strengths, establish a Diploma Policy that embodies this vision, and autonomously organize its curriculum to achieve this goal.

Leveraging the economies of scale of the 51 national KOSENs, NIT is collaborating on to advance and expand KOSEN education, aiming to develop highly skilled human capital for the next-generation society. To foster the creation of distinctive curricula that address diverse needs beyond the MCC framework, a set of achievement goals derived from the collaborative projects among 51 KOSENs is presented as MCC Plus. MCC Plus encompasses a wide range of fields, with COMPASS 5.0 and GEAR 5.0 – both implemented as part of the “KOSEN-Originated! ‘Society 5.0-Aligned Future Technological Human Capital’ Development Project” – serving a key example. For more details on MCC Plus, please refer to Part 3.

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Part 2:

Achievement goals as the minimum standard
for KOSEN education

Chapter 1: Notation of achievement goals

The achievement goals stipulated in the Model Core Curriculum are organized in three different forms. Form 1 is used for "common basic abilities common to all fields that engineers should possess" except for "IV Fundamentals of Engineering", Form 2 for "IV Fundamentals of Engineering" and "specialized abilities by field that engineers should possess", and Form 3 for "MCC (model): fundamental qualities and abilities" and "MCC (model): creativity and design abilities".

1-1 Form 1: MCC (core) – Basic competencies common to all engineering fields (Excluding IV. Fundamentals of engineering)

The following format is used to organize the achievement goals for the basic competencies common to the disciplines, with the exception of engineering fundamentals (Figure 1).

<p>2-1.1 Mathematics.</p> <p>[Goals to be achieved in the educational area].</p> <p>1. Achievement goals</p> <p>To acquire the mathematical knowledge, computational techniques and applied skills necessary to solve basic engineering problems, and to develop the ability to use this knowledge, techniques, etc. in relation to phenomena in engineering.</p> <p>2. Handling of learning contents</p> <p>The following items shall be taken into consideration when handling learning contents.</p> <p>(1) The results of learning in junior high schools are utilized, and teaching plans are prepared so that the curriculum develops smoothly in close cooperation with the mathematics, physics and specialized subjects of the major.</p> <p>(2) The grades in which students take the study contents are not specified, but are flexibly applied in accordance with the unique curriculum design of each KOSEN.</p> <p>(3) Teachers are allowed to teach the contents listed below in specialized classes.</p> <p>(4) Teachers may also teach study contents not listed below.</p>		<p>Provides an overview of the achievement goals for each area and an explanation of the handling of learning contents.</p>											
<table border="1"> <thead> <tr> <th>Learning Contents</th> <th>achievement goals</th> </tr> </thead> <tbody> <tr> <td>Computing</td> <td>Be able to calculate four arithmetic operation of polynomials and perform simple factorization using factor theorems, etc.</td> </tr> <tr> <td>Numbers and Expressions</td> <td>Be able to calculate four arithmetic operations of fractional expressions.</td> </tr> <tr> <td></td> <td>Understand and be able to be able to calculate the absolute value of real numbers.</td> </tr> <tr> <td></td> <td>Be able to calculate square roots, including rationalization of denominators.</td> </tr> <tr> <td></td> <td>Understand the equality of complex numbers and be able to calculate four arithmetic operations and absolute values.</td> </tr> </tbody> </table>	Learning Contents		achievement goals	Computing	Be able to calculate four arithmetic operation of polynomials and perform simple factorization using factor theorems, etc.	Numbers and Expressions	Be able to calculate four arithmetic operations of fractional expressions.		Understand and be able to be able to calculate the absolute value of real numbers.		Be able to calculate square roots, including rationalization of denominators.		Understand the equality of complex numbers and be able to calculate four arithmetic operations and absolute values.
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Figure 1: Form 1 for basic competencies common to MCC (core) areas

1-2 Form 2: MCC (core) – Field-specific competencies and engineering fundamentals

The achievement goals for basic engineering and discipline-specific professional competencies are organized using Form 2 (Figure 2).

<p>3-1.1 V-A Mechanical engineering fields</p> <p>V-A-1 Design and drafting</p> <p>[Goals to be achieved in the educational area].</p> <p>1 Goals</p> <p>The design and drawing area aims to provide students with a basic knowledge of mechanical drawing standards, drawing methods and the content of drawings.</p> <p>(1) Understand the standards for mechanical drawing and be able to accurately create production drawings of machine components etc.</p> <p>(2) Be able to design the main components of various machines and equipment based on their specifications and create the production drawings.</p> <p>2 General subject title</p> <p>Mechanical drawing, Mechanical design drawing</p>		<p>Provides an overview of the achievement goals for each area and an explanation of the handling of learning contents.</p>														
<table border="1"> <thead> <tr> <th>Learning Contents</th> <th>achievement goals</th> <th>Guideline items for study</th> </tr> </thead> <tbody> <tr> <td>Mechanical drawing</td> <td>Understand and use the role of drawings, the types and uses of lines, how to draw projections of objects and the tools used to produce drawings.</td> <td>Mechanical drawing, drawings, drawing tools, line types, projection methods, CAD.</td> </tr> <tr> <td></td> <td>Understand how to represent shapes, specify dimensions, tolerances and surface texture, and sketch parts to create production drawings.</td> <td>Representation of shapes, cross-section diagrams, dimensional tolerances, fits, geometric tolerances, surface textures, sketches, production drawings.</td> </tr> <tr> <td></td> <td>Understand the drawing standards for machine elements and be able to create drawings.</td> <td>Drawing of machine elements</td> </tr> <tr> <td>Design and drafting of machinery</td> <td>Understand how to design major elemental components and be able to create production drawings.</td> <td>Design and drawing of main parts of machinery and equipment</td> </tr> </tbody> </table>	Learning Contents		achievement goals	Guideline items for study	Mechanical drawing	Understand and use the role of drawings, the types and uses of lines, how to draw projections of objects and the tools used to produce drawings.	Mechanical drawing, drawings, drawing tools, line types, projection methods, CAD.		Understand how to represent shapes, specify dimensions, tolerances and surface texture, and sketch parts to create production drawings.	Representation of shapes, cross-section diagrams, dimensional tolerances, fits, geometric tolerances, surface textures, sketches, production drawings.		Understand the drawing standards for machine elements and be able to create drawings.	Drawing of machine elements	Design and drafting of machinery	Understand how to design major elemental components and be able to create production drawings.	Design and drawing of main parts of machinery and equipment
Learning Contents	achievement goals	Guideline items for study														
Mechanical drawing	Understand and use the role of drawings, the types and uses of lines, how to draw projections of objects and the tools used to produce drawings.	Mechanical drawing, drawings, drawing tools, line types, projection methods, CAD.														
	Understand how to represent shapes, specify dimensions, tolerances and surface texture, and sketch parts to create production drawings.	Representation of shapes, cross-section diagrams, dimensional tolerances, fits, geometric tolerances, surface textures, sketches, production drawings.														
	Understand the drawing standards for machine elements and be able to create drawings.	Drawing of machine elements														
Design and drafting of machinery	Understand how to design major elemental components and be able to create production drawings.	Design and drawing of main parts of machinery and equipment														
		<p>Check whether the curriculum of each KOSEN satisfies the Model Core Curriculum and whether it is designed to achieve the 'achievement goals'.</p>														

Figure 2: Form 2 MCC (core) for professional competence and engineering fundamentals by discipline

The "items that serve as learning guidelines" in Form 2 were added when the 2023 edition of the MCC

was examined. In the revision study conducted from 2021 to 2022, the structure of the achievement goals of the 2017 MCC was analyzed and organized in order to solve the problem of reduced autonomy in curriculum organization in fields where detailed achievement goals had been set, and the achievement goals in the 2023 MCC were set at a higher level of abstraction. On the other hand, to ensure that important items are not missing and to maintain consistency with the previous CBT question-writing policy, "items that serve as learning guidelines" are appended.

While each technical college is required to confirm the correspondence with the MCC achievement goals when organizing its curriculum, it is envisaged that the 'learning guideline items' will be used as a reference guideline when considering specific lesson plans.

1-3 Form 3: MCC (model)

The MCC (model) uses Form 3 to organize the achievement objectives (Figure 3). As in the case of the fundamentals of engineering and the competencies in specific field, the achievement goals of the 2023 version of the MCC are organized based on an analysis of the structure of the achievement goals of the 2017 version of the MCC. However, the qualities and competencies included in the MCC (model) are organized from various perspectives and their structure differs from one discussion to another. Therefore, unlike the 'guideline items for learning' that are listed alongside the achievement goals for engineering fundamentals and competencies in specific field, 'key words' are listed. "Key words" include key words that are mentioned in discussions on the relevant achievement goals (or the learning content they include). When organizing curricula or designing classes at each technical college, it is not necessary to include these keywords, but they should be used as a reference.

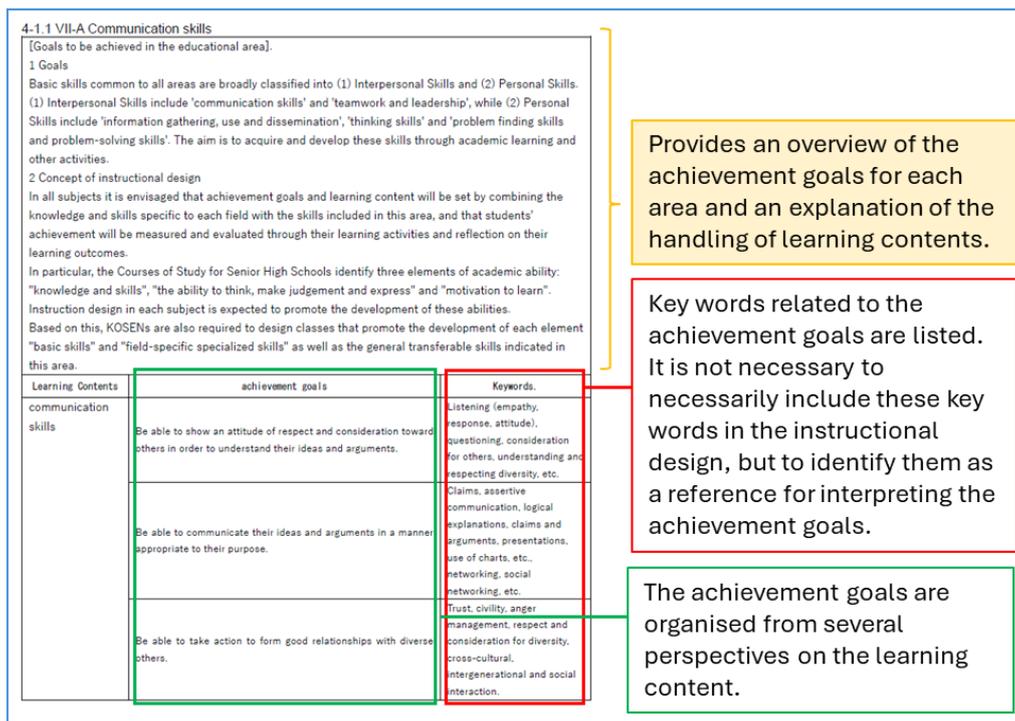


Figure 3: Form 3 for MCC (model)

Chapter 2: Achievement goals for fundamental competencies common to all engineering fields

2-1 | Mathematics

2-1.1 | Mathematics

[Learning achievement goals]	
1 Goals To acquire the mathematical knowledge, computational techniques and applied skills necessary to solve basic engineering problems, and to develop the ability to use this knowledge, techniques, etc. in relation to phenomena in engineering.	
2 Approach to learning contents The following items shall be taken into consideration when handling learning contents.	
(1) The results of learning in junior high schools are utilized, and teaching plans are prepared so that the curriculum develops smoothly in close cooperation with the mathematics, physics and specialized subjects of the major.	
(2) The grades in which students take the study contents are not specified, but are flexibly applied in accordance with the unique curriculum design of each KOSEN.	
(3) Teachers are allowed to teach the contents listed below in specialized classes.	
(4) Teachers may also teach study contents not listed below.	
Learning contents	Achievement goals
Computing Numbers and Expressions	Be able to calculate four arithmetic operation of polynomials and perform simple factorization using factor theorems, etc.
	Be able to calculate four arithmetic operations of fractional expressions.
	Understand and be able to be able to calculate the absolute value of real numbers.
	Be able to calculate square roots, including rationalization of denominators.
	Understand the equality of complex numbers and be able to calculate four arithmetic operations and absolute values.
equation inequality	Be able to solve quadratic equations using the solution formula etc.
	Be able to solve higher-order equations using factor theorems etc.
	Be able to solve simple simultaneous equations.
	Be able to solve irrational and fractional equations.
	Be able to solve linear and quadratic inequalities.
	Be able to utilize the concept of the identity equation.
Functions and graphs	Understand the properties and graphs of quadratic functions and be able to find the maximum and minimum values.
	Understand the properties and graphs of fractional and irrational functions and apply them to rational inequalities and irrational inequalities.
	Be able to find the inverse function of a given function and explain its properties.
Exponential function Logarithmic function	Be able to perform calculations using power roots and exponential laws.
	Understand the properties and graphs of exponential functions and be able to solve equations and inequalities involving exponential functions.
	Understand the properties of logarithms and be able to calculate logarithms.
	Understand the properties and graphs of logarithmic functions and solve equations and inequalities involving logarithmic functions.
trigonometric function	Be able to express angles by the circular measure.
	Be able to find the values of trigonometric ratios of acute angles and trigonometric functions of general angles.
	Understand the properties and graphs of trigonometric functions and be able to solve trigonometric equations and inequalities.
	Be able to apply additive theorems.
figures and expressions	Be able to find distance and an internal division point from two given points.
	Be able to find the equations of lines and circles.

	For quadratic curves, explain the relationship between the equation and the shape of the graph.
	Be able to illustrate the area represented by the inequalities.
number of cases	Be able to count events for simple cases using the laws of product and the law of sums.
	Understand the product and sum laws and be able to calculate permutations and combinations.
sequence	Find the general terms of arithmetic and geometric sequences and their sums.
	Be able to represent the sum of a number sequence using sigma and find the sum.
	Find the limit of a sequence.
	Be able to estimate the convergence of geometric series and find their sum.
vector	Be able to calculate vector sums, differences and scalar product and find magnitudes.
	Be able to calculate using the component representation of vectors.
	Be able to find the inner product of vectors.
	Be able to determine if two vectors are parallel or perpendicular.
	Be able to find equations for lines, planes and spheres in space.
matrix	Be able to calculate matrix sums, differences, scalar multiples and products.
	Be able to determine the regularity of a matrix and find its inverse.
	Understand the properties of determinant and be able to calculate the value of determinant.
	Solve simultaneous linear equations using matrices.
Applications of matrices	Understand that a matrix represents a linear transformation and be able to find the coordinates of the image of a point by linear transformation.
	Be able to find the matrices representing the composite or inverse transformations.
	Understand that symmetric translations and rotations in the plane are linear transformations and be able to find the matrix representing the linear transformation.
	Be able to find eigenvalues and eigenvectors of matrices.
differentiation	Be able to find the limit of a function.
	Understand the meaning of derivatives and be able to find the derivative of power functions.
	Be able to find derivatives of products and quotients of two functions.
	Be able to find the derivatives of various functions using the derivative method of composite functions.
	Be able to find derivatives of functions including trigonometric, exponential, logarithmic and inverse trigonometric functions.
Applications of differential calculus	Be able to use derivatives to get a general idea of the shape of a graph and to find the extremes, maximum and minimum values of a function.
	Be able to find the equation of the tangent.
	Be able to use the second derivative to determine the concavity and convexity of a graph.
	Be able to find the derivatives of functions expressed by a parameter.
integration	Be able to use derivative formulae to find indefinite integrals.
	Understand the fundamental theorem of calculus and be able to use indefinite integrals to obtain definite integrals.
	Be able to use integral by substitution and integral by parts to find indefinite or definite integrals.
	Be able to calculate indefinite or definite integrals of functions, including trigonometric, exponential, logarithmic, fractional and irrational functions.
Applications of the integral method	Be able to find areas using definite integrals.
	Be able to find the length of a curve using definite integrals.
	Be able to find volumes using definite integrals.
Series	Be able to find Taylor expansions of single variable functions.
	Be able to apply Euler's formula.

partial differentiation	Be able to find the second order partial derivatives using partial differentiation of composite functions, etc.
	Be able to find the extreme values of a 2-variable function.
multiple integral	Be able to calculate double integrals by iterated integration.
	Be able to calculate double integrals using polar coordinate transformations.
	Be able to find volumes using double integrals.
differential equation	Be able to solve differential equations in separation of variables form.
	Be able to solve first-order linear differential equations.
	Be able to solve constant coefficient second-order homogeneous linear differential equations.
probability	Understand the additive theorem of probability, the exclusive events and the complementary event, and be able to calculate their probabilities.
	Understand conditional probability, the multiplication theorem for probability and independent events, and be able to calculate probabilities using them.
	Understand random variables and probability distributions and be able to explain the properties and characteristics of binomial distribution and normal distribution.
statistics	Be able to organize one-dimensional data and determine the mean, variance and standard deviation.
	Be able to organize two-dimensional data to create scatter plots and obtain correlation coefficients and regression lines.

2-2 II Natural sciences

2-2.1 II-A Physics

[Learning achievement goals]	
1 Goals Acquire basic knowledge of physics and be able to apply it to their own engineering field. Furthermore, in the process, they cultivate the ability to think about natural phenomena systematically and logically, and acquire a physical view and way of thinking to scientifically elucidate various phenomena of nature in a wide range of fields. (1) Be able to perform basic calculations on the motion and energy of objects. (2) Be able to relate various phenomena with heat, waves, and electricity to the laws of physics.	
2 Approach to learning contents (1) Create an instructional plan to ensure the smooth development of the curriculum by closely coordinating with mathematics and specialized subjects, and by giving due consideration to the grade and order of each study content. (2) Respond to advances in science and technology and devise ways to acquire the basic knowledge necessary to understand them. (3) Consider cultivating the ability to understand and analyze physical phenomena through experimentation and observation.	
3 Common course titles Physics, Applied physics	
Learning contents	Achievement goals
Motion of bodies (field of mechanics)	Be able to explain the concepts of velocity and acceleration.
	Be able to perform calculations on average velocity and average acceleration.
	In linear and planar motion, be able to treat velocities as vectors and perform calculations on the synthesis and decomposition of velocities and relative velocities.
	Be able to perform calculations on the displacement, time, and velocity of an object using the formula for uniformly accelerated linear motion.
	Be able to treat the motion of a mass point moving in the plane as a change in the position vector.
	Be able to perform calculations on the displacement, velocity, and acceleration of an object mutually using differentiation and integration.
Motion of falling bodies (field of mechanics)	Be able to perform calculations on the displacement, velocity, and time of free-fall and vertically projectile objects.
	Be able to perform calculations on the displacement, velocity, and time of horizontally and obliquely projectile objects.
Various forces (field of mechanics)	Be able to illustrate the forces acting on an object.
	Be able to synthesize and decompose forces.
	Be able to perform calculations on the balance of forces acting on a mass point.
	Be able to understand the concepts of gravity, elastic force, drag force, and tension; and be able to perform calculations related to each of these forces.
	Be able to explain pressure and buoyancy.
Laws of motion (field of mechanics)	Be able to explain the three laws of motion.
	Be able to perform calculations on the acceleration and forces acting on the object by using the equations of motion.
	Be able to set up equations of motion in the form of differential equations for simple motions and solve them as initial value problems.
Frictional forces (field of mechanics)	Be able to explain the balance of forces acting on static frictional forces.
	Be able to perform calculations on maximum frictional forces.
	Be able to perform calculations on dynamic frictional forces.
Mechanical energy (field of mechanics)	Be able to perform calculations on work and power.
	Be able to perform calculations on the kinetic energy of objects.
	Be able to perform calculations on potential energy acting on gravity.
	Be able to perform calculations on potential energy acting on elastic forces.
	Be able to explain the law of conservation of mechanical energy and use the law to determine the velocity and displacement of objects.

Momentum (field of dynamics)	Be able to determine the momentum of objects by using their mass and velocity.
	Be able to determine the magnitude of the impulse, the change in velocity, and the average force applied to objects by using the change in momentum of the objects are equal to the impulse.
	Be able to explain the law of conservation of momentum and perform calculations on changes in velocity or other physical quantities related to collisions, splitting, and merging of objects by using the law or the coefficient of repulsion.
Circular motion and single oscillations (field of mechanics)	Be able to perform calculations on the velocity, angular velocity, period, acceleration, and centripetal force of an object in uniform circular motion.
	Be able to explain the relationship between displacement, velocity, acceleration, and restoring force in simple harmonic motion (SHM).
	Be able to perform calculations on various physical quantities that characterize SHM, such as period and frequency.
Universal gravitation (field of mechanics)	Be able to find the universal force of attraction acting between objects by using the law of universal gravitation.
	Be able to perform calculations on potential energy acting on universal gravitation.
	Be able to perform calculations on the motion of objects acting on universal gravitation.
Rigid bodies (field of mechanics)	Be able to perform calculations on moments of force.
	Be able to perform calculations on the balance of force and moments acting on a rigid body.
	Be able to perform calculations on the center of gravity.
Temperature and heat (field of thermodynamics)	Be able to explain the relationship between the thermal motion of atoms and molecules and absolute temperature.
	Be able to explain that heat transfer leads to thermal equilibrium over time.
	Be able to perform calculations on the heat capacity and specific heat of objects.
	Be able to perform calculations on the heat capacity, specific heat, and temperature of objects after thermal equilibrium by using the law of conservation of heat.
Work and heat (field of thermodynamics)	Be able to determine the pressure, temperature, and volume of a gas using Boyle-Charles' law and the equation of state of an ideal gas.
	Be able to explain the relationship between the kinetic energy and internal energy of molecules in an ideal gas.
	Be able to perform calculations on changes in the state of gases by using the first law of thermodynamics (in the case of constant volume change, constant pressure change, isothermal change, and adiabatic change).
Energy (field of thermodynamics)	Be able to explain with specific examples that energy exists in many forms and can be converted into each other.
	Be able to explain irreversible changes with specific examples.
	Be able to perform calculations on the thermal efficiency of heat engines.
Wave propagation and types (field of waves).	Be able to perform calculations on the amplitude, wavelength, period, frequency, and speed of waves.
	Be able to explain the propagation of transverse and longitudinal waves.
	Be able to express the displacement of the medium with respect to time and position by using a sinusoidal wave function.
Principle of superposition and wave interference (field of waves).	Be able to explain the principle of wave superposition.
	Be able to explain the independence of waves.
	Be able to explain the conditions under which two waves reinforce or weaken each other when they interfere.
	Be able to explain the characteristics of stationary waves (e.g. how they oscillate at nodes and antinode).
Reflection, refraction, and diffraction of waves (field of waves)	Be able to explain Huygens' principle.
	Be able to explain the laws of reflection, refraction, and diffraction of waves.
Sound waves and sounding bodies	Be able to perform calculations on the natural frequencies of the string by using the length of the string and the speed of the waves traveling along the string.

(field of waves)	Be able to perform calculations on the natural frequencies of open and closed tubes by using the length of the air column and the sound velocity. (Opening end correction is not considered.)
	Be able to explain buzzing and resonance and resonance phenomena with specific examples.
	Be able to perform calculations on the change in sound frequency due to the Doppler effect in the case of a motion on a straight line.
Light waves (field of waves)	Be able to explain the difference between natural light and polarized light.
	Be able to perform calculations on the angle of reflection and refraction of light.
	Be able to explain that spectra are produced by dispersion phenomena due to differences in wavelength.
	Be able to explain diffraction and interference of light with specific examples.
Electrostatic fields (field of electricity)	Be able to explain the difference between conductors and nonconductors in relation to free electrons.
	Be able to perform calculations on the electrostatic force acting between point charges by using Coulomb's law.
	Be able to explain electric fields and potentials; and perform calculations on electric fields and potentials generated around point charges, and simple shaped charged objects.
	Be able to understand the properties of capacitors and be able to determine their electrical capacitance etc.
Electric current (field of electricity)	Be able to perform calculations on the voltage, current, and resistance by using Ohm's law and Kirchhoff's law.
	Be able to perform calculations on the composite resistance of resistors connected in series and parallel.
	Be able to perform calculations on Joule heat and electric power.

2-2.2 II-B Physics experiments

[Learning achievement goals]	
1 Goals	
By experiencing the phenomena themselves through experiments, students are able to confirm that the laws of physics actually apply and systematically understand the knowledge they have learned in the classroom and elsewhere through discussion of the results.	
(1) Be able to understand the purpose of the experiment, its principles, and how to handle the equipment, the experiment is conducted safely according to the procedure and record accurately the measurement results.	
(2) Be able to determine the most probable value and error from experimental data.	
(3) Be able to find out the characteristics and regularities of physical phenomena from observations and experimental results and explain them in relation to what has been learned in classrooms and elsewhere.	
2 Approach to learning contents	
(1) Conduct experiments in at least three of the six fields of experimentation listed below (including demonstration experiments).	
(2) It is recommended to actively adopt the use of ICT and other technologies, small group exploration activities, and presentations.	
(3) In conducting experiments and preparing reports, the learning content of IV-A Engineering Experimental Techniques (various measurement methods, data processing, and discussion methods) should also be considered.	
3 Common course titles	
Physics, Applied physics, Physics experiments, applied physics experiments	
Learning contents	Achievement goals
Experiments	Be able to explain the purpose and principles of the experiment.
	Be able to maintain an appropriate experimental environment by being organized and following procedures to conduct experiments safely. (Common to chemistry experiments)
	Be able to accurately record experimental conditions and data. (Common to chemistry experiments)
Results and discussion	Be able to determine the most probable values and errors from experimental data.
	Be able to draw appropriate graphs and find the most reliable relationships between experimental data.
	Be able to express physical quantities using appropriate significant figures and units. (Common to chemistry experiments)

	Be able to explain the characteristics and regularities of physical phenomena from experimental results.
	Be able to explain the results of observations and experiments in relation to what has been learned in the classroom and other subjects. (Common to chemistry experiments)
Field	Be able to describe typical physical phenomena based on experiments in the following six fields.
	Fields related to mechanics
	Fields related to heat
	Fields related to waves
	Fields related to light
	Fields related to electromagnetism
	Fields relating to atoms (including electrons and radiation)

2-2.3 II-C Chemistry

[Learning achievement goals]	
1 Goals Acquire basic knowledge of chemistry and apply it to their own field of engineering. Furthermore, in the process, they develop the ability to think about natural phenomena systematically and logically, and acquire a chemical view and way of thinking to scientifically elucidate various phenomena of nature at large.	
2 Approach to learning contents (1) Devise ways to keep up with advances in science and technology and to enable students to acquire the basic knowledge needed to understand them. (2) Attention is also given to developing the ability to understand and consider chemical phenomena through experimentation and observation.	
3 Common course titles Chemistry	
Learning contents	Achievement goals
The relationship between chemistry and human life	Be able to explain the relevance of chemistry to contemporary social issues.
Composition of substances	Be able to explain that matter is made up of atoms.
	Be able to describe monads and compounds.
	Be able to explain isotopes.
	Be able to explain the distinction between pure substances and mixtures.
	Understand the separation methods for mixtures and be able to select an appropriate separation method.
The three phases of matter	Be able to explain that the molecules and atoms that make up matter are constantly in thermal motion.
	Be able to explain changes in the state of water.
	Be able to explain the three states of matter and their changes of state.
Equation of state for gases	Be able to explain Boyle-Charles' law and perform the necessary calculations.
	Be able to explain the equation of state of gases and perform the necessary calculations.
Atomic structure	Be able to explain the structure of the atom (nucleus and electrons), atomic number and mass number.
	Be able to explain isotopes and radioisotopes.
Electron configuration	Be able to write about the electron configuration of an atom using electron shells.
	Be able to explain the function of valence electrons.
Ion	Be able to explain ionization energy and electron affinity.
	Representative ions can be represented by chemical formulas.
Periodic table of the elements	Be able to consider the relationship between atomic numbers and the number of valence electrons.
	Be able to consider the properties of elements in terms of valence electrons and the periodic table.

Ionic bond	Be able to explain the chemical formulas of ions and the names of ions.
	Be able to explain ionic bonding.
	Be able to explain the properties of ionic crystals.
Covalent bond	Be able to explain covalent bonds.
	Be able to explain polarity and hydrogen bonding.
	Be able to write down molecules by means of structural and electronic formulae.
Metallic bonding and metal crystals	Be able to explain free electrons and metal bonds.
	Be able to explain the properties of metals.
Atomic, molecular and formula quantities and amount of substance	Be able to explain the relative mass and atomic weight of atoms.
	The quantity of substance (mol) can be used to express the amount of substance.
	Be able to explain molecular and formula weights.
	Be able to explain the relationship between the volume of a gas and the amount of substance.
Reaction formula	Be able to understand and construct reactants, products and coefficients for chemical reaction formulas.
	Be able to perform stoichiometric calculations using chemical reaction formulas.
Concentration of solution	Be able to explain ionization and distinguish between electrolytes and non-electrolytes.
	Be able to explain mass percent concentration and calculate mass percent concentration.
	Be able to explain molar concentration and calculate molar concentration.
Acids and bases	Be able to explain the definitions of acids and bases (Arrhenius' and Bronsted Lowry's definitions).
	Be able to explain the chemical formulas of acids and bases and the valence of acids and bases.
	Be able to explain the degree of ionization and the strength of acids and bases.
pH (measure of acidity)	Be able to explain pH and calculate pH and hydrogen ion concentrations.
Neutralizing	The neutralization reaction can be represented by a chemical equation.
	Be able to calculate neutralization titrations.
Oxidation and reduction	Be able to explain redox reactions.
Ionization tendency of metals and batteries.	Ionization tendency can be explained.
	The reactivity of metals can be explained based on their ionization tendency.
	Primary batteries can be described in terms of their reactions.
	Be able to describe the rechargeable battery and its reactions.
Electrolysis	Be able to explain electrolysis reactions.
	Be able to perform calculations according to Faraday's law.

2-2.4 II-D Chemistry experiments

[Learning achievement goals]	
1 Goals To confirm and deepen the knowledge and understanding of what has been learned in the classroom and elsewhere through observation and experimentation, and to increase interest and inquisitiveness about chemical things and phenomena.	
(1) Be able to understand how to handle laboratory equipment and reagents, and conduct experiments safely.	
(2) Be able to accurately record experiments and handle experimental data using appropriate significant figures and units, e.g.	
(3) Be able to explain the results of observations and experiments in relation to what has been learnt in classrooms and elsewhere.	
2 Approach to learning contents	
(1) It is recommended to actively incorporate the use of ICT and other technologies, small-group exploratory activities and presentations.	
(2) When carrying out experiments and preparing reports, the learning content of IV-A Engineering Experimental Techniques (various measurement methods, data processing and discussion methods) should also be taken into account.	
3 Common course titles Chemistry experiment	
Learning contents	Achievement goals
Experiment	Select and correctly use laboratory equipment (e.g. electronic balances and glassware) according to purpose and accuracy.
	Able to handle reagents (powder and liquid).
	Can maintain an appropriate experimental environment by being organized and can conduct experiments safely and in accordance with procedures. (Common to physics experiments)
	Be able to explain how to deal with accidents. (e.g. chemical adhesion, ignition, burns, cuts)
	Accurately record experimental conditions and data. (Common to physics experiments)
Results and discussion	The results of experiments can be organized in tables and graphs in an easy-to-read format.
	Express physical quantities using appropriate significant figures and units. (in common with physics experiments)
	Can explain the results of observations and experiments in relation to what has been learnt in classroom and other activities. (in common with physics experiments)

2-2.5 II-E Life Sciences, Earth Sciences

[Learning achievement goals]	
1 Goals Acquire the basic knowledge in life and earth sciences necessary to build a sustainable society that takes into account the global and biological environment, which is essential in the future as an engineering or science engineer.	
(1) The commonality and diversity of life To understand the diversity and commonality of life on Earth and to understand the origins of life.	
(2) Biological life and ecosystems To understand that the global environment is closely related to human activities, not only by understanding the life activities of living organisms on Earth, but also by understanding the components of ecosystems.	
(3) The Earth as a planet To understand that the Earth is one of the planets in the solar system and that its activity is driven by the sun's radiant energy.	
(4) Earth's history and the global environment To understand the history of the Earth and the geological events found on the Earth's surface and inside.	
(5) Human activity and the global environment Consider ways in which human activities can improve the global environment.	
2 Common course titles Integrated science (i.e. collaboration of various sciences and arts)	
Learning contents	Achievement goals
Commonality and diversity of living organisms	Be able to explain the diversity of life on Earth.
	Understand the common characteristics of organisms and explain the relationship between commonality and evolution of organisms.
	Be able to explain the origins of life on Earth.
Biological life and	Be able to explain that energy is necessary for life activities.

Ecosystems	Understand the components of ecosystems (producers, consumers and decomposers) and explain that decomposers in ecosystems are closely related to human life.
	Understand vegetation succession and biome and be able to explain how they work and their distribution.
Earth as a planet.	Understand that the Earth is among the planets that make up the solar system and be able to explain the motion and periodicity of celestial bodies.
	Understand the general circulation of the atmosphere and be able to explain meteorological phenomena such as wind flows in the atmosphere.
	Explain global warming in relation to solar radiation energy and heat transport by the atmosphere and oceans.
Earth's history and the global environment	Be able to describe the evolution of the primordial earth.
	Understand magma formation and volcanic activity on the Earth and be able to explain its impact on human life.
	Understand earthquake generation and fault movement and be able to relate seismic activity to plate movement.
Human activity and the global environment	Be able to explain tropical deforestation and biodiversity loss due to human activities.
	Understand the bioaccumulation of toxic substances and be able to explain pollution problems in bioaccumulation.
	Be able to explain the problems of global warming and countermeasures.

2-3 III Humanities and Social sciences

2-3.1 III-A Japanese language

[Learning achievement goals]

1 Goals

By acquiring the linguistic and cultural education that forms the basis of humanity, and by practicing effective and interactive communication on their own initiative, students aim to develop a deep understanding of diverse others and improve their linguistic ability to respond flexibly to changing situations and their ability to use the Japanese language in relation to their field of specialization.

- (1) Express their own opinions on the ideas expressed in logical texts (editorials and reviews), based on their judgement of the validity of the arguments.
- (2) Be able to use terminology related to their field of expertise in their thinking and expression.
- (3) Have a broad interest in linguistic and cultural education and be able to use the knowledge and ideas gained in this area to express themselves effectively.
- (4) Appreciate literary works (novels, essays, poetry, classics, etc.) in context and, based on an understanding of the characters and perspectives depicted in them, be able to view themselves objectively and express their own opinions.
- (5) Be able to collect, analyze and organize information, structure and prepare reports and papers, and give oral presentations.
- (6) Be able to discuss issues on the basis of evidence, strive to understand new ideas and the perspectives of others, and summarize their thoughts and ideas as a group.

2 Approach to learning contents

- (1) The 'achievement goals in the educational domain' listed here are not to be achieved solely in the 'Japanese' language subjects. This is because the improvement of the language skills to be fostered in the 'Japanese' language subjects is also being achieved in other subjects through efforts to enrich language activities.
- (2) However, 'Japanese' plays a central role in the development of language skills, which is the foundation of all learning. For this reason, the majority of the 'achievement goals' are set out as those to be achieved by the 'national language' subjects, which play a 'central role' and are to be achieved in cooperation with other subjects.
- (3) For some of the achievement goals (those related to thesis writing, terminology related to specialized fields and information gathering from the internet), the attainment itself is mainly achieved in other subjects, but the knowledge and abilities to be acquired before the attainment of these targets are fostered mainly in the subjects of "Japanese language".
- (4) In order to improve language skills, it is important to link 'Japanese' with subjects other than 'Japanese'. In particular, in terms of "matters related to reports and papers, general handling of information including non-literary material, logical composition and development, oral presentation, discussion, acquisition of new ideas and viewpoints, organization and deepening of one's thoughts and ideas", close coordination with other class subjects and throughout the school's educational activities from the perspective of improving language skills are essential. Curriculum management is essential.

3 Common course titles

Japanese language, Modern literature, Classics, Language and culture, Japanese literature, Japanese culture, Japanese language expression, Japanese communication

Learning contents	Achievement goals
logical sentence	Can accurately grasp the structure and development of logical texts (editorials and reviews) and summarize the gist and main points.
	Express their own opinions on the ideas expressed in logical texts (editorials and reviews), based on their judgement of the validity of the arguments.
	To increase the vocabulary used in social life (including colloquialisms and idiomatic phrases) and use it in thinking and expression.
	Be able to use terminology related to their field of expertise in logical thinking and expression.
Language and culture	Be able to appreciate literary works (novels, essays, poetry, classics, etc.) in context and explain the view of things depicted in them and the feelings of the characters.
	Have a broad interest in linguistic and cultural education (vocabulary, knowledge, etc.) and can use the knowledge and ideas gained in this area to express themselves effectively.
	Through the reading of language works, deepen their ideas about the various ways of being of human beings and society, and be able to view themselves objectively and express their own opinions.
	Be able to read and write Japanese correctly, mainly in Joyo Kanji.
Expression and communication	Be able to produce practical texts (letters, emails, etc.) using style and language appropriate to the recipient and purpose.
	Be able to collect, organize and analyze appropriate information from printed material and the internet, depending on the purpose of the report/paper.
	Based on organized information, be able to structure, develop and express logic and prepare reports and papers so that arguments are effectively conveyed.

	Be able to summarize the contents of reports and papers prepared and their own thoughts and considerations in documents (illustrations, videos, etc.) and give an accurate oral presentation.
	Be able to argue on the basis of evidence, depending on the issue and conditions.
	To be able to summarize their thoughts and ideas as a group through discussion, while respecting the position and ideas of others.
	Can practice techniques for organizing their thoughts and ideas, striving to understand new ideas and the perspectives of others.

2-3.2 III-B English

[Learning achievement goals]	
1 Goals	
(1) Acquire the knowledge and skills that form the basis of English communication and be able to use them appropriately for different purposes, situations and circumstances. (Years 1-5) Develop an understanding of diversity and different cultures, and try to communicate proactively using English while taking others into consideration. (Years 1-5)	
(2) Understand and express information and ideas on daily and social topics in an appropriate and accurate manner. (Years 1-3)	
(3) Understand and express basic information and ideas about their field of expertise appropriately and accurately, and exchange simple opinions. (Years 3-5)	
2 Approach to learning contents	
(1) To improve English communication skills, it is important that 'English' and other subjects are linked and that various 'real communication opportunities' are created. For example, it is expected that more realistic communication situations can be reproduced by closely examining the educational content in conjunction with specialized subjects in terms of the format of English abstracts and experimental reports, and the organization of the contents to be reported. In any case, a comprehensive curriculum design including other subjects is desirable so that learning aimed at communication in real situations can be achieved.	
(2) Question and answer sessions, debates and discussions in oral presentations require a very high level of competence in the practice of English communication. It should be understood that the achievement goal is intended to be "preparation and foundation" rather than "completion" of these skills at the time of graduation from the main course.	
(3) In order to apply English to communication in real situations, in addition to acquiring basic knowledge, it is important to have a positive attitude towards communication based on respect for the other person's culture and position. We believe that such elements in this achievement goal will be more effective not only in the classroom, but also by making effective use of international exchange situations (opportunities) in the short and medium term.	
(4) The achievement goals represent the core, and other learning content (e.g. English conversation, academic writing, business English, etc.) should be actively incorporated where necessary.	
3 Common course titles	
English (I-V), English Communication (I-V), English Expression, General English, etc.	
Learning contents	Achievement goals
Voice	Can read or speak clearly with awareness of stress in words, phrases and sentences, rhythm and intonation in sentences, and sound connections and breaks, so that they are conveyed correctly to the listener.
Vocabulary	To consolidate vocabulary learned up to junior high school and to acquire and appropriately apply new vocabulary according to upper secondary school teaching guidelines, as well as vocabulary required for specialized education.
Grammar and syntax	In addition to the sentence structures and grammatical matters studied up to junior high school, acquire and appropriately apply sentence structures and grammatical matters in accordance with the high school curriculum guidelines.
English communication (laying the foundations for English language operational skills).	Can hear the necessary information and understand the speaker's intentions from what is spoken on daily and social topics, with clear pronunciation and at a regulated speed.
	Can talk about daily and social topics, using basic expressions to give information, thoughts and feelings.
	Can read texts written in plain English on daily and social topics, grasp the overview and read the necessary information, and understand the writer's intentions, outline and main points.
	Can organize their opinions and impressions on daily and social topics and write texts that convey information, ideas and feelings.
	Have a willingness to understand languages and cultures other than their own and communicate actively in practical situations.
	Can use basic communication strategies (gestures, eye contact) appropriately for practical situations and purposes.

English communication (learning to improve English operational skills)	Can listen to the necessary information and grasp the outline and main points of a matter of prior knowledge, such as one's own field of expertise, or a topic of interest, paying attention to the development of the conversation and the speaker's intentions.
	Can exchange opinions, arguments and solutions to problems in anticipation of discussions (debates if necessary) in English.
	Students are able to conduct preparatory activities and information gathering on their own and act proactively in order to conduct discussions (and debates, if necessary) in English.
	Be willing to understand languages and cultures other than their own and be able to communicate smoothly in English inside and outside the classroom.
	Can write multiple paragraphs that convey opinions and arguments on topics of interest, together with appropriate reasons and evidence.
	Be able to give presentations on topics of interest in plain English and exchange simple questions and answers about the content, with a view to giving oral presentations on their own field of expertise.
	Be able to outline and read the necessary information in articles and manuals on topics of interest and in their own field of expertise.
	Write English-language materials using basic vocabulary and expressions in English technical writing so that they can be used to prepare English-language abstracts for papers in their own field, materials for oral presentations, etc.

2-3.3 III-C Society

[Learning achievement goals]	
1 Goals Be able to participate proactively in society as a formulator of a peaceful and democratic state and society in the international community, and use knowledge, theories and information from the humanities and social sciences to solve problems faced by society.	
2 Approach to learning contents (1) The geo-historical and civic fields should be interrelated. (2) Some of the "contents of study" in "Society" should be closely related to "IV-B Engineer ethics", "IV-C Information literacy" and "IV-D Globalization and cross-cultural multicultural understanding" in Chapter 2 "IV Fundamentals of engineering", "II-E Life science and earth science" in "II Natural science" or MCC (model) "Fundamental qualities and abilities". The students should be aware of the deep connection with the MCC (model) 'Fundamental Qualities and Competences'. (3) To promote learning, taking into account recent developments in the country, such as the lowering of the age of adulthood to 18, while paying attention to developing an attitude to participate proactively in the formation of society as a sovereign and responsible citizen and consumer. (4) In light of the international community's efforts to achieve a sustainable society, when dealing with the SDGs, students should bear in mind that the 'three dimensions of sustainable development' comprise not only environmental but also social and economic aspects.	
3 Common course titles Geography, History, Public affairs, Ethics, Politics and economics, etc.	
Learning contents	Achievement goals
Geo-historical field (Note 1)	Understand the distribution and trends of population, resources and industry in different parts of the world, and the interconnectedness of these regions, and be able to explain modern society from a geographical perspective.
	Understand the diversity of ethnic, religious and living cultures, based on the interaction between humans and the natural environment, and be able to reflect on the importance of the coexistence of different cultures and societies.
	Be able to give an overview of the process by which modernizing Western countries united the world, including Japan, in the 19th century.
	Can give an overview of the developments in the world, including Japan, leading up to the two world wars through the struggles of the imperialist countries and consider the significance of peace.
	To be able to give an overview of developments in the world, including Japan, since World War II, the development and end of the Cold War, and thereafter to the present day, and to be able to consider historically the various issues that have arisen.
	Be able to give an overview of Japan's relations with its Asian neighbors since the late 19th century.

Civic field (Note 1)	Using the ideas of previous philosophers and their predecessors as a guide, the students are able to reflect on ideas concerning diverse lifelong self-formation, including better career building, the importance of living with others, and the desirable society and world.
	Understand basic principles such as fundamental human rights and democracy and basic political, legal and economic structures with regard to a society in which the self participates proactively, and be able to consider various issues in contemporary society.
Contemporary social considerations (Note 2)	Through activities such as setting appropriate subjects related to the characteristics and issues of contemporary society, exploring them using materials, and discussing and debating the results, students are able to consider, conceptualize and express, from the perspective of the humanities and social sciences, multidimensional and multifaceted ideas about the realization of a sustainable society in which people around the world can co-operate and coexist.
Note 1.	'Geographical-historical field' and 'civic field' do not necessarily mean the name of the subject or subject. In addition, there is no need to think of a fixed correspondence between the "learning content" and the "achievement objectives" in the table above. The subject structure of each school may be reconfigured in a different way.
Note 2.	<p>(a) The achievement objectives of the learning content "Reflections on Contemporary Society" will be integrated into each subject. As the knowledge and skills possessed by students vary from year to year, the lesson design of each subject may be flexible.</p> <p>(b) Teaching students to apply the knowledge and skills they acquire in the 'geographical-historical' and 'civic' fields and to use a variety of information and data critically to summarize and express their own views. The materials and data to be used may vary according to the characteristics of each subject, for example, geographical data, statistical data, official documents, private documents of a social nature, historical documents, etc.</p> <p>(c) In the achievement goal of the study content "Consideration of contemporary society", while assuming the character of the course as a basis for engineer education, it is expected that students will develop the ability to perceive themselves as engineers and their surroundings critically and relatively, and to develop the ability to relate to society by using the methods of humanities and social sciences, while utilizing the knowledge of the respective fields of expertise of the teachers. It is expected to cultivate an attitude of thinking and acting independently in relation to society.</p>

2-4 IV Fundamentals of engineering

2-4.1 IV-A Engineering laboratory techniques

[Learning achievement goals]		
1 Goals		
Engineering experiment techniques are the fundamental and essential achievement goals that include planning experiments, conducting experiments with safety, and organizing and discussing the results. The goal is also to acquire and practice the basic attitudes required for conducting engineering experiments.		
Acquire the experimental skills required to observe phenomena and evaluate the performance of equipment in the field of engineering. In addition, students learn how to conduct experiments safely, organize and discuss the results, and prepare reports.		
(1) Be able to understand how to use various types of measuring instruments appropriate to each engineering field, and utilize them appropriately to conduct experiments safely.		
(2) Be able to organize acquired data appropriately and make quantitative and logical discussions based on the results.		
(3) Be able to summarize the experimental objectives, methods, results, and discussed findings in a written report.		
(4) Be able to follow basic rules (e.g. initiative, cooperation, submission deadlines) in solving problems through experiments.		
2 Common course titles		
Engineering experiment		
Learning contents	Achievement goals	Guideline items for study
Conducting experiments	Be able to select appropriate experimental methods according to the purpose, and conduct experiments safely based on understanding experimental procedures and how to use experimental equipment and measuring instruments.	Explanation of experimental methods and procedures to clarify fundamental principles and phenomena in their own engineering field; operation of laboratory equipment and measuring instruments; correct handling of laboratory equipment, reagents, and materials; conducting safe experiments.
Reporting	Be able to understand the purpose of the experimental topic and express it clearly and effectively using graphs, diagrams, and tables, such as deriving approximate curves from data obtained by appropriate methods.	Analysis of experimental data, error analysis; evaluation of significant figures, data organization with an appropriate way of analyzing (including approximate curves such as the least squares method); representation of experimental data in appropriate formats using information technology tools.
	Be able to collect appropriate references and materials as required, explain experimental results, discuss them quantitatively and logically, and write reports.	Quantitative and logical discussion of experimental data, including the validity of experimental and measurement results; preparation of reports by experimental notes and appropriate way of writing report, and collection of references and materials necessary for discussion of experiments.
Attitudes toward experiments and practical training	Be able to recognize their own role and carry out experiments and practical training, when working individually or as a team.	Consideration of safety and prohibitions, consideration of initiative and cooperation; systematic practice of experiments, practical training, and report writing.

2-4.2 IV-B Engineer ethics

[Learning achievement goals]		
1 Goals The goal is to understand the following points and be able to think about them in terms of specific examples in order to think about and practice responsible behavior as an engineer. (1) Be able to understand and explain how engineering, science and technology have contributed to people and society. (2) Be able to understand and explain the issues facing the local community, our country and the international community and the challenges to be resolved. (3) Be able to understand and explain the responsibilities expected of engineers as professionals and the roles they can play towards people and society.		
2 Common course titles Engineer ethics, Law, Intellectual property, History of technology, Social subjects, PBL, Social implementation education, etc.		
Learning contents	Achievement goals	Guideline items for study
The role and significance of engineering and science and technology	Be able to explain the contributions and achievements of engineering, science and technology to humanity.	Human safety, health, well-being and welfare; contributions of engineering and technology; improvement of quality of life; history of technology.
	Be able to explain the role and significance of engineering, science and technology in modern society, based on trends in the development of science and technology.	The role that engineering and technology contribute in solving problems and challenges facing modern society (e.g. practical examples of research and development); respecting and realizing Society 5.0, diversity and Inclusiveness.
	Be able to explain the impact and changes of scientific and technological developments on society, the environment, and people (including applied ethics).	Basic knowledge of applied ethics, including environmental ethics, information and bioethics ethics, and dual-use issues
Contribution of engineering, science and technology to the problems and challenges of society and humanity	Be able to understand the various problems facing local communities and our country, and discuss and explain the contributions of engineering, science and technology.	Study of the SDGs, the various issues facing local communities and Japan (e.g. disaster prevention, safety, declining birthrates and aging populations, economy and industry); contribution of engineering and technology to local issues.
	Be able to understand the various problems facing the international community and humanity, and discuss and explain the contributions of engineering, science and technology.	Study of the SDGs, various issues and challenges facing the international community (e.g. poverty and hunger, dispute, environmental destruction, resource and energy issues, climate change, achieving sustainability, impacts of globalization, respect for diversity); contribution of engineering and technology to the challenges of modern society
Roles and responsibilities required of engineers as professionals	To be able to explain the roles and responsibilities of engineers in maintaining and achieving safety, based on an understanding of the characteristics of modern society.	Characteristics of modern society (e.g. complexity, increasing sophistication and complexity of science and technology, decreasing predictability, diversity); risk concepts; risk management methods; engineering methods for safety realization.

	Be able to explain the roles and responsibilities of engineers as professionals.	Impact and changes in the decisions and actions of engineers on people, society and the environment; the role of the professionals in supporting an increasingly complex society; Good Work as a professional; human, organizational and technological factors and background that caused pollution, environmental damage, accidents and incidents.
	Be able to explain the basics of legal liability.	Understanding of basic legal liabilities such as tort liability, contractual liability, and other legal liabilities related to the activities of engineers (e.g. product liability, intellectual property rights, Act on the Protection of Personal Information, etc.)
	Be able to explain the basics of ethical obligations.	Understanding of ethical obligations that differ from and include legal liabilities; understanding of codes of ethics in professional and other fields (e.g. codes of ethics of academic associations); codes of conduct required by companies and other organizations.
	Be able to explain the responsibilities and issues that professional engineers need to be required in their work.	Coordination of multiple values such as safety, cost, delivery time, etc.; factors such as accidents and incidents
	Be able to explain the responsibilities and issues that need to be required when working in an international field.	Necessity of respect and care for diversity, including the history and culture of other countries, as well as required attitudes and ways of thinking.
	Be able to explain the knowledge and attitudes required to promote fair research activities.	Understanding of the significance and role of scientific research; specific misconduct such as Fabrication, Falsification, and Plagiarism (FFP); Questionable Research Practice (QRP); attitudes and mindsets necessary for fair research activities.

2-4.3 IV-C Information literacy

[Learning achievement goals]

1 Goals

The goal is for students to be able to handle information correctly in consideration of security, utilize information technology and develop codes by considering basic algorithms for solving problems, regardless of their field of specialization. The aim is also to acquire the basic knowledge and skills to be able to use mathematics, data science and AI in daily life and work, and to be able to explain and utilize this knowledge and skills according to their own specialization.

- (1) use knowledge of basic hardware, software and networks to collect, process and disseminate information
- (2) Be able to devise and describe an algorithm for a specific task.
- (3) Be able to handle information correctly with due regard to information security.
- (4) Explain and use their knowledge and skills in information technology according to their field of expertise.
- (5) Develop a predisposition to use mathematics, data science and AI.

2 Common course titles

Information literacy, Information, Programming, Information security, Information fundamentals, Basic information engineering, Information and mathematical fundamentals, Probability and statistics, Mathematical and data science, Engineering ethics

*Practice in other subjects (e.g. mathematics, language, social studies and ethics subjects) is also conceivable.

Learning contents	Achievement goals	Guideline items for study
information basis	Understand and explain the development and challenges of the informatization of society.	Information technology as a social infrastructure (social networking, digitalization, IoT, development of mobile communications, accumulation and use of big data, openness of knowledge, etc.; social challenges: cybercrime, impact of accidents and failures, information gaps, legislation, etc.), information society and individuals (speed of information transmission sharing, ease of information transmission, digitalization operation of personal information, etc., issues: reliability of information and knowledge, information leakage, erasure difficulties, internet dependency, defamation, etc.), changes in social structure (Society 5.0, changes in industrial forms through information technology, digital manufacturing, smart agriculture, etc.)
	Be able to describe typical information systems and their modes of use.	Information terminals, groupware, cloud, on-premises, public systems and services (geography, finance, weather, disaster management)
	Understand the structure of a computer and the role of the operating system (OS) and be able to perform basic handling.	Hardware, operating systems, application software, computer components (arithmetic, control, storage, input/output)

	Explain the difference between analogue and digital information and how data (numerical, textual, etc.) is represented in computers.	Continuous values, discrete values, sampling, quantization, binary numbers, hexadecimal numbers, radix conversion, significant figures, integer and decimal representations, bits, bytes, character codes, quantification of information
	Be able to collect and obtain information appropriately.	Data acquisition, open data, statistical portals, big data, sensing
	Be able to explain the significance and overview of databases.	Relational databases, database management systems (DBMS), database languages (e.g. SQL), data storage and access
Programming and algorithms	Be able to create basic programs.	Programming, variables, control syntax, efficient programming (use of libraries or APIs, etc.)
	Can perform mathematical operations using a computer.	Processing, numerical calculation and functions (quadratic, trigonometric, exponential, logarithmic, etc.) using spreadsheet software or programming languages, etc.
	Understand basic algorithms and be able to describe them using any programming language.	Representation by flowcharts or pseudo-code, sorting algorithms, search algorithms, Newton's method, Sieve of Eratosthenes, computational models (Turing machines, automata, state transition diagrams, etc.), limitations of computers.
	Explain that for the same problem there can be more than one algorithm that can solve it.	Differences in efficiency (e.g. computation time) of different algorithms, modelling of events
Media	Be able to explain how to examine the truth or falsity of information on the basis of evidence.	Source, reliability and credibility of data, fakes (hoaxes, information manipulation, information dissemination), scientific evidence, logical judgement, cross-checking
	Select appropriate means of representation and communication of information, and send and receive information.	Abstraction, visualization, tables, diagrams, graphs, selection of appropriate software, communication tools (e.g. email, SNS), media literacy, content (text, images, etc.)
Network	Knowledge of the structure, composition and components of information and communication networks, the role of protocols and technologies, and be able to explain the role of information and communication networks in society.	Wireless communication, wired communication, mobile communication, internet, fiber optics, protocol, IP address, router, hub, Wi-Fi, LAN, URI.

Information security	Understand the need for information security and be able to explain countermeasures.	Informatization of society, information assets, cybercrime, cyber-attacks, personal data protection, information leaks, security software, specific forms and examples of cyber-attacks (phishing fraud, malware, ransomware, targeted attacks, intrusion, etc.), OS and app updates, etc.
	Be able to explain the fundamentals of cryptography supporting information security.	Cryptography, keys, digital signatures, etc.
	Be able to explain how to access information based on information security.	Access control, passwords, multi-factor authentication, encrypted communication (e.g. HTTPS)
	Explain the laws, regulations and rules related to information and communications and the need for such laws, regulations and rules.	Cybersecurity Basic Law, Unauthorized Computer Access Prohibition Law, Personal Data Protection Law, Copyright Law.
	Be able to explain the importance of manners and morals in living in an information society.	Information dissemination and responsibility, difficulties in deleting information, information ethics, information morality
	Be able to explain the concept and methods for operating information security.	CIA (confidentiality, integrity, availability), vulnerabilities, threats, incidents, risk assessment, initial response (reporting, preservation), security policy and information rating
Data science and AI	Provide an overview of data science and AI technologies.	Artificial intelligence, machine learning, neural networks, deep learning
	Be able to explain, based on application examples, that data science and AI technologies are useful tools for solving problems in society and daily life and create value when combined with knowledge from various specialist areas.	Big data, open data, data science, IoT, AI, human intellectual activity and AI technologies, examples of AI applications and problem solving
	Understand the morals and ethics required when using data science and AI technologies and be able to explain what is required to protect data.	Privacy laws, data ethics (fabrication, falsification, plagiarism), data bias
	Use basic skills (data acquisition, visualization and analysis) required for the use of data science and AI technologies.	Diagrammatic representation of data (e.g. bar graphs, line graphs, scatter plots), distribution of data (e.g. histograms) and representative values (mean, median, mode), variability of data (variance, standard deviation), data analysis (basic statistics, correlation and causation, regression analysis, hypothesis testing)
	Be able to explain the relationship between data science and AI technologies and their use in society and daily life in their own field of expertise.	Data-driven society, examples of AI technology applications

2-4.4 IV-D Globalization and intercultural multicultural understanding

[Learning achievement goals]		
1 Goals Assuming that countries and regions are interdependent in contemporary society and that mutual cooperation is essential, the goal is to understand the knowledge and concepts necessary for this. (1) Understand that the culture, customs and values of each country and region must be understood and respected. (2) Understand the impact and changes resulting from the development of globalization and the importance of interdependence and mutual cooperation between countries and regions.		
2 Common course titles Cross-cultural exchange, Geography, History, Politics and economics, PBL, Overseas training, etc.		
Learning contents	Achievement goals	Guideline items for study
Globalization, cross-cultural and multicultural understanding	Be able to describe different cultures and multiculturalism.	Differences and diversity, including geographical characteristics, such as different historical and cultural backgrounds and religious beliefs of various countries, regions, ethnic groups, etc.
	Explain the concept of diversity and its importance.	Importance of diversity, inclusion and respect for individual human rights in relation to history, culture, race, ethnicity or sexuality and characteristics.
	Explain the industrial, economic and political consequences of the development of globalization and the interaction between globalization and science and technology.	Globalization of research and development, trends in the international economy and globalization due to developments in science and technology.
	Explain the knowledge, qualities and abilities required when working globally as an engineer.	Laws and institutions in different countries, including differences in business practices; international qualifications of engineers; changes in methods and modalities of activities associated with the development of science and technology (e.g. activities in virtual and physical space); respect for diversity and tolerance for heterogeneity and difference.

Chapter 3: Achievement goals for field-specific competencies engineer should acquire

3-1 V Competencies in specific fields

3-1.1 V-A Mechanical engineering fields

V-A-1 Design and drafting

<p>[Learning achievement goals]</p> <p>1 Goals The design and drawing area aims to provide students with a basic knowledge of mechanical drawing standards, drawing methods and the content of drawings.</p> <p>(1) Understand the standards for mechanical drawing and be able to accurately create production drawings of machine components etc.</p> <p>(2) Be able to design the main components of various machines and equipment based on their specifications and create the production drawings.</p> <p>2 Common course titles Mechanical drawing, Mechanical design drawing</p>		
Learning contents	Achievement goals	Guideline items for study
Mechanical drawing	Understand and use the role of drawings, the types and uses of lines, how to draw projections of objects and the tools used to produce drawings.	Mechanical drawing, drawings, drawing tools, line types, projection methods, CAD.
	Understand how to represent shapes, specify dimensions, tolerances and surface texture, and sketch parts to create production drawings.	Representation of shapes, cross-section diagrams, dimensional tolerances, fits, geometric tolerances, surface textures, sketches, production drawings.
	Understand the drawing standards for machine elements and be able to create drawings.	Drawing of machine elements
Design and drafting of machinery	Understand how to design major elemental components and be able to create production drawings.	Design and drawing of main parts of machinery and equipment

V-A-2 Mechanical design

<p>[Learning achievement goals]</p> <p>1 Goals The mechanical design area aims to provide basic knowledge for the design of machine elements.</p> <p>(1) Be able to design machine elements using basic knowledge of machine materials, machine production methods, strength of materials, industrial dynamics and mechanical dynamics, etc.</p> <p>(2) Be able to select the materials of machine elements for fastening according to their intended use and determine the dimensions of machine elements both theoretically and in accordance with standards.</p> <p>(3) Be able to select materials for power-transmitting machine elements according to their intended use and determine the dimensions of machine elements both theoretically and in accordance with standards.</p> <p>2 Common course titles Mechanical element studies, Machine design methods, Mechanics</p>		
Learning contents	Achievement goals	Guideline items for study
Fundamentals of mechanical design	Be able to explain the significance of standard specifications and apply them to machine designs.	Standards
	Explain basic terminology related to mechanical design.	Allowable stresses, safety factor, fatigue fracture, stress concentration
Screws, nuts and bolts	Understand, the types, uses, standards and design of screws, bolts and nuts and be able to apply them to make calculations.	Screws, nuts and bolts, tightening torque, shear stress, contact surface pressure
Shafts and shaft couplings	Understand, the types, uses and design of shafts and keys and be able to apply them to make calculations.	Shaft, strength, deformation, critical speed of shaft, key
	Understand and apply the types and uses of shaft couplings.	shaft joint

Bearing	Describe the structures, types and uses of bearings.	Slide bearings, ball bearings, life
Gear wheel	Understand, explain and calculate gear types, terminology and design.	Gears, gear curve, tooth size, bending strength of tooth, surface durability of a tooth, transmission ratio
Link mechanism	Understand the link mechanism and be able to explain and calculate its motion.	Linkage, displacement, velocity, acceleration.
Cam mechanism	Understand the mechanism of the cams and be able to explain their movement.	Cam, cam diagram.

V-A-3 Mechanics

[Learning achievement goals]		
1 Goals		
The mechanics area aims to provide students with the basic knowledge to understand the various phenomena that occur in objects due to forces acting on them.		
(1) Explain the forces acting on objects, the motion of objects and changes in force and motion states.		
(2) Explain the relationship between loads and deformations acting on materials.		
(3) Be able to express the vibration of single degree of freedom systems in terms of the equations of motion and explain the motion of the system.		
2 Common course titles		
Engineering mechanics, Strength of materials, Mechanical dynamics		
Learning contents	Achievement goals	Guideline items for study
Forces and moments of force	Be able to calculate the composition and decomposition of forces.	Force, magnitude, direction, resultant force, component force.
	Understand the meaning of moments of force and couples and be able to calculate them.	Moment of force, couple
	Be able to explain the equilibrium conditions for forces acting at a single point and for forces with different points of application.	Conditions for the equilibrium of forces
Center of gravity	Understand the meaning of the center of gravity and be able to calculate the position of the center of gravity of simple shapes.	Center of gravity
Velocity and acceleration	Understand the meaning of velocity and acceleration and explain the relationship between time, displacement and velocity.	Time, displacement, velocity, acceleration, uniform motion, motion of uniform acceleration
Laws of force and motion	Be able to explain the three laws of motion and express the relationship between force, mass and acceleration in terms of the equations of motion.	Three laws of motion, force, mass, acceleration, equation of motion, inertia, action and reaction
Rotational movement	Understand the meaning of peripheral velocity, angular velocity, rotational speed, centripetal acceleration, centripetal force and centrifugal force in rotational motion and be able to calculate them.	Rotational movement, peripheral velocity, angular velocity, rotational speed, centripetal acceleration, centripetal force, centrifugal force
Work and energy	Understand the meaning of work and motivity and be able to calculate them.	Work, motivity.
	Understand the meaning and types of energy, the law of conservation of energy and be able to calculate mechanical energy.	Energy, law of the conservation of energy, mechanical energy, potential energy, kinetic energy
Momentum and impulse	Be able to explain momentum and the law of conservation of momentum.	Momentum, impulse, law of conservation of momentum, collisions.
Friction	Understand the meaning of sliding friction and explain the relationship between frictional force and coefficient of friction.	Friction, sliding friction, frictional force, coefficient of friction
Movement of rigid bodies	The rotational movement of a rigid body can be expressed using the equations of motion.	Rigid bodies, rotational motion, equations of motion.

	The moment of inertia for simple shapes can be calculated.	Moment of inertia
Stress and strain	Be able to calculate stresses and strains when a load is applied to a material.	Load, deformation, stress, strain.
	Understand the relationship between stress and strain and be able to calculate the elastic coefficient and safety factor.	Hooke's law, modulus of longitudinal elasticity modulus of rigidity, allowable stress, safety factor.
Tensile and compression	Calculate the stresses and deformations of rods subjected to tensile and compressive loads.	Tensile load, compressive load, stress, deformation.
	Be able to calculate stresses acting on materials for simple statically indeterminate problems and problems involving thermal stresses.	Statically indeterminate problems, coefficient of linear thermal expansion, thermal stress.
Torsion	Be able to calculate shear strains, shear stresses and torsion angles on shafts subjected to torsional moments.	Torsion, torsional moment, shear strain, shear stress, transverse modulus of rigidity, polar moment of inertia of area, torsional rigidity, torsional angle.
Bending	For various types of beams, shear forces and bending moments can be calculated at any position on the beam.	Beam, support method, concentrated load, distributed load, shear force, bending moment, shear force diagram, bending moment diagram
	Understand the center of figure and moment of inertia of area of various cross-sections and be able to calculate the bending stresses in beams subjected to bending moments.	Bending stress, moment of inertia of area.
	Calculate deflections and deflection angles for various types of beams.	Deflection, deflection curve, differential equations for deflection
Vibrations of single degree of freedom systems	Be able to describe the free vibrations of a one-degree-of-freedom system using the equations of motion and explain the motion of the system.	Equations of motion, free vibration, undamped system, damped system
	Be able to express the forced vibrations of a one-degree-of-freedom system using the equations of motion and explain the motion of the system.	Equations of motion, forced vibration, harmonic force, harmonic displacement.

V-A-4 Thermal fluid

[Learning achievement goals]		
1 Goals		
The area of thermal fluid aims to provide basic knowledge of heat and fluids pertaining to machinery.		
(1) Understand the properties of fluids, their dynamics in static and kinetic state, and the forces of fluid acting on objects, and be able to calculate various flow problems.		
(2) Understand the basic laws of heat and be able to calculate problems related to thermodynamics.		
2 Common course titles		
Hydraulics, Fluid engineering, Fluid dynamics, Thermodynamics, Industrial thermodynamics		
Learning contents	Achievement goals	Guideline items for study
Nature of fluids	Understand the various physical properties that describe the properties of fluids and explain the classification of fluids.	Physical properties of fluids, viscosity, compressibility, Newton's law of viscosity.
Statics of fluids	Understand how pressure is indicated and the pressure distribution of static fluid and be able to calculate the pressure of a fluid.	Absolute pressure, gauge pressure, Pascal's principle, manometer.
	Understand the forces due to pressure acting on surfaces in contact with a fluid and be able to calculate the forces acting on wall surfaces and on objects in a static fluid.	Total pressure, center of pressure, buoyancy
Fluid dynamics.	Understand fluid flow velocities, flow rates and flow states and be able to apply the laws of conservation of mass and energy in fluids.	Velocity, flow rate, streamline, continuity equation, Bernoulli's equation

	Understand and apply momentum theory of fluids.	Momentum equation, forces exerted by fluids on objects.
Flow in a pipe	Understand the different types of flow conditions and be able to describe the flow states in a pipe based on Reynolds number.	Laminar flow, turbulent flow, Reynolds number
	Understand energy losses when fluid flows in a straight pipeline and be able to calculate pipe friction losses.	Darcy-Weisbach equation, pipe friction loss.
Force of drag and lift	Understand and explain characteristic phenomena that appear in the flow around objects.	Boundary layer, flow separation, wake flow
	Understand the force factors acting on an object placed in a flow and be able to calculate the fluid forces acting on the object.	Drag force, drag force coefficient, lift force, lift force coefficient.
Fundamentals of thermodynamics	Understand the basic physical quantities of thermodynamics and the various systems subject to analysis and be able to explain their thermodynamic natures.	Temperature, pressure, heat, specific heat, specific volume, density, closed system, open system, state quantity
First law of thermodynamics	Understand the first law of thermodynamics, apply the energy equations for various systems and explain the work of various systems using diagrams.	First law of thermodynamics, absolute work, industrial work, internal energy, enthalpy, p-V diagram.
Properties and changes of state of an ideal gas	Understand the equation of state for an ideal gas and explain the calculation of quantities of state and the relationship between specific heat and gas constants.	Ideal gas, equation of state, specific heat at constant volume, specific heat at constant pressure, specific heat ratio
	Understand the various changes of state of ideal gases and be able to calculate various thermodynamic quantities using equations for change of state.	Isobaric change, isometric change, isothermal change, adiabatic change, polytropic change
Second law of thermodynamics	Understand the second law of thermodynamics and be able to calculate the thermal efficiency of a heat engine composed of an ideal gas.	Second law of thermodynamics, cycle, thermal efficiency.
	Understand entropy, be able to calculate entropy change and explain heat cycles using diagrams.	Entropy, T-s diagram.

V-A-5 Manufacturing engineering

[Learning achievement goals]		
1 Goals		
The manufacturing engineering area aims to provide basic knowledge of manufacturing methods of machinery materials.		
(1) Understand the fundamentals of casting and be able to explain its types and characteristics.		
(2) Understand the fundamentals of welding and be able to explain its types and characteristics.		
(3) Understand the fundamentals of plastic forming and be able to explain its types and characteristics.		
(4) Understand the fundamentals of cutting and be able to explain the types and features of cutting processes.		
(5) Understand the fundamentals of grinding processes and be able to explain their types and characteristics.		
2 Common course titles		
Manufacturing technology		
Learning contents	Achievement goals	Guideline items for study
Casting	Be able to explain the process, types and characteristics of casting.	Casting, casting mold, precision casting method, die-casting method
Welding	Be able to explain the types and characteristics of welding.	Welding, welding methods, gas welding, arc welding
Plastic forming	Be able to explain the principles, types and characteristics of plastic forming.	Plastic forming, forging, rolling, extruding, press work
Cutting	Be able to explain the principles of cutting, types of cutting tools and cutting conditions. Also explain the types and construction of lathe, milling machine and drilling machine.	Cutting, cutting tool, cutting condition, lathe, milling machine, drilling machine
Grinding	Be able to explain the principles of grinding, grinding methods and grinding wheels.	Grinding, cylindrical grinding, surface grinding, finishing, grinding wheel

V-A-6 Materials

[Learning achievement goals]		
1 Goals The materials area aims to provide basic knowledge of materials used in machinery. (1) Explain the materials used in machinery, including their types, manufacturing methods, properties, purposes, workability and processing techniques.		
2 Common course titles Machinery materials		
Learning contents	Achievement goals	Guideline items for study
Types and properties of machine materials	Describe the types and properties of mechanical materials.	Metallic materials, non-metallic materials, composite materials, functional materials
Mechanical properties and test methods	Understand the mechanical properties of materials and be able to describe each test method used to investigate mechanical properties.	Tensile test, hardness test, impact test, fatigue test, creep phenomenon, brittleness, toughness, S-N curves.
Crystallization and changes in states of metals and alloys	Understand the crystal structures and changes in states of metals and alloys and be able to describe the phase diagram.	Crystal structure, change in state, solidification process, phase diagram of alloys.
Deformation and crystallization of metallic materials	Understand the deformation mechanisms of metallic materials and explain the relationship between material properties and crystals.	Plastic deformation, work hardening, recrystallization
Carbon steel	Understand the methods of production of steel and the phase diagram of carbon steel and be able to explain the properties of carbon steel.	Iron and steel, carbon steel, Fe-C equilibrium diagram.
Heat treatment of carbon steel	Understand the methods of heat treatment of carbon steel and be able to explain the purpose and process of each method.	Annealing, normalizing, quenching, tempering

V-A-7 Measurements and control

[Learning achievement goals]		
1 Goals The measurements and control area aims to provide students with the fundamentals of measurement, methods for measuring various physical quantities, mathematical expressions of control systems and basic knowledge for analyzing their properties. (1) Understand the fundamentals of measurement and be able to explain the measuring method for typical physical quantities. (2) Understand the concept of control and be able to represent control systems using mathematical models. (3) Calculate time and frequency responses and explain their characteristics. (4) The stability of the control system can be determined.		
2 Common course titles Measuring engineering, Control engineering		
Learning contents	Achievement goals	Guideline items for study
Fundamentals of measurement	Understand the fundamentals of measurement, including errors, accuracy, uncertainty and systems of units of measurement, and be able to describe the methods and equipment for measuring typical physical quantities.	International unit system of Units, measurement, error, accuracy, uncertainty.
Overview of automatic control	Understand automatic control and be able to explain the basic structure of control systems.	Automatic control, feedback control
Laplace transform	Solve the differential equations using Laplace transforms.	Laplace transform, inverse Laplace transform, differential equations
Transfer functions and block diagrams	Understand transfer functions and be able to represent control systems using block diagrams.	Transfer function, block diagram.
Response of control systems	Be able to calculate the response of a control system and explain its transient, steady-state and frequency response.	Transient response, steady-state response, frequency response

Stability of the control systems	The stability of the control system can be determined.	Stability-criterion method, stable, unstable.
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3-1.2 V-B Materials-based sectors

V-B-1 Material properties

[Learning achievement goals]		
<p>1 Goals The materials properties area aims to acquire basic knowledge of the quantum mechanical behavior of electrons, and the atomic structures and crystal structures that are affected by this behavior, which are essential for understanding various physical phenomena of materials. (1) Explain the crystal structure of materials and the types and characteristics of bonding. (2) Understand the basic properties of intrinsic and impurity semiconductors.</p> <p>2 Common course titles Materials properties, Electronic properties, Metallography, Inorganic chemistry</p>		
Learning content	Achievement goals	Guideline items for study
Metal construction	Be able to describe the general properties of metals.	Electrical conductivity, thermal conductivity, ductility, polycrystalline
	Be able to explain the types of bonding of atoms and their characteristics, including bonding forces and examples of substances.	Free electrons, metallic bonding
	Be able to describe the properties of pure metals, alloys and compounds in terms of their crystal structure features.	Perfect crystals, lattice defects, equilibrium state diagram, microstructure of materials
Atomic structure and the periodic law	Be able to explain energy levels using Bohr's hydrogen atom model.	Orbitals and Bohr radii, ground states, transition states, spectral series, Planck's constant.
	Be able to describe quantum states using four quantum numbers, e.g. electron shells and number of electrons occupied.	Quantum conditions, Hund's rule, shielding effects, ionization energies, inter-orbit transitions.
Structure of solids	Be able to describe seven crystal systems and 14 Bravais lattices.	Cubic, tetragonal, orthorhombic, rhombohedral, hexagonal, monoclinic and triclinic crystal systems, Bravais lattice
	Be able to describe lattice orientation and lattice planes using Miller index.	Lattice direction, lattice plane, Miller index
	Be able to draw atomic configurations of typical crystal structures and calculate filling factor.	Lattice points, unit lattice, atomic radii, lattice constants, filling factor
	X-ray diffraction techniques can be applied to the analysis of crystal structures.	X-rays, wave interference, X-ray scattering, Bragg's conditionals.
Fundamentals of quantum mechanics	Be able to explain the nature of particle and wave of electrons, using examples of phenomena and equations.	de Broglie wave, photoelectric effect, wave function, slit, Schrodinger equation, complex representation of waves, wave number space, uncertainty principle.
	Be able to explain phenomena such as electrical conduction from a quantum mechanical perspective.	Stochastic waves, drift velocity, Hall effect, Joule heat, resistance factor, mobility, conductivity, thermal velocity, wavenumber space, Brillouin zone.
semiconductor	Be able to explain the conduction mechanism of intrinsic semiconductors.	Semiconductor type, carrier density, density of states, effective density of states, occupancy probability, energy band structure, Fermi energy.
	Be able to draw the energy bands and impurity levels of impurity semiconductors and explain the conduction mechanism.	n-type and p-type semiconductors, impurity levels, carrier density, impurity ionization, probability of occupation at impurity levels, charge neutrality conditions, pn junctions, depletion layers, Einstein relationship, diffusion current, excitation current, electrical conduction.

V-B-2 Material organization

[Learning achievement goals]		
1 Goals In the materials microstructure area, the aim is to learn how to view the geometrical arrangement of atoms and equilibrium phase diagrams, which are the basis of materials microstructure, and to learn about microstructural changes during deformation and heat treatment. (1) Be able to explain phase diagrams and phase transformations and use them to solve basic problems. (2) Be able to explain the crystal structure, deformation, atomic diffusion, defects and crystalline microstructural changes in solids and use their information to solve basic problems. (3) Be able to explain how to control the crystalline structure and use it to solve basic problems.		
2 Common course titles Materials microstructure, Metallography, Inorganic chemistry, Microstructural control		
Learning content	Achievement goals	Guideline items for study
lattice defect	Be able to describe the types and characteristics of lattice defects.	Point, line and surface defects
States of matter and equilibrium conditions	Be able to describe the equilibrium states of a material system, including static, quasi-static and unstable states.	Systems, components, phases, equilibrium
	Be able to explain the degrees of freedom of the system by determining the degrees of freedom from Gibbs' phase rule.	Degrees of freedom, Gibbs' phase rule
Unary phase diagram	Be able to describe the supercooling state, nucleation and grain growth stages in the solidification process of pure metals.	Thermal analysis curves, nucleation and growth, equilibrium phase diagram (temperature-pressure), triple point
Binary phase diagram	On a binary equilibrium phase diagram, the proportion of each phase can be calculated using the principle of leverage.	principle of leverage
	Explain the phase diagram of the all-proportional solid solution type in relation to the Gibbs energy curve.	Gibbs energy, Gibbs energy composition diagram.
	Be able to explain the formation processes of eutectic, eutectoid and peritectic microstructures using binary phase diagram.	Eutectic, eutectoid and peritectic reactions
Deformation and strength	Explain the characteristics of elastic and plastic deformation modes of deformation.	Elastic and plastic deformation
	Be able to explain the characteristics of sliding and twinning deformation in plastic deformation from a crystallographic point of view.	Sliding deformation, twinning deformation, Schmidt factor.
	Explain blade and helical dislocation and the function of dislocation in plastic deformation.	Blade dislocation, helical dislocation
	Explain the relationship between lattice defects and the strengthening mechanisms of metallic materials.	Work hardening, solid solution hardening, precipitation hardening, dispersion hardening, strengthening by grain refinement
Diffusion	Explain the interstitial atomic and vacancy diffusion mechanisms.	Interstitial diffusion, vacancy diffusion
	Explain the physical meaning of diffusion coefficients.	Brownian motion, atomic jumps, Fick's law, diffusion coefficient, driving force of diffusion.
Recovery and recrystallization	Be able to explain the processes of recovery, recrystallization and grain growth of the working structure and changes in various properties.	Cold working, annealing, recovery, recrystallization, grain growth, mechanical properties, Hall-Petch's law.
	Be able to explain the nucleation mechanism and preferential nucleation sites of recrystallized grains.	Nucleation and growth of recrystallized nuclei, incubation period, recrystallization temperature, primary recrystallization, normal grain growth, abnormal grain growth (secondary recrystallization), strain concentration zone

Phase transformation	Be able to explain phase transformations using Gibbs energy changes.	Phase equilibrium and Gibbs energy, phase transformations, diffusional transformations, eutectic transformations, pearlitic transformations, order-disorder transformations
	Be able to explain the characteristics of phase transformations from a crystallographic point of view with regard to non-diffusive transformations.	Expansion and contraction, martensitic transformation, non-diffusive transformation, shuffling

V-B-3 Physical chemistry

[Learning achievement goals]		
1 Goals In the area of physical chemistry systems, the goal is to understand various physicochemical phenomena of changes of state of pure substances and mixtures by means of mathematical formulae and to be able to predict states such as energy using numerical values. (1) Be able to explain the basic issues of the first and second laws of thermodynamics and the relationship between Gibbs energy changes and phase and chemical equilibrium, and use them to solve basic problems.		
2 Common course titles Chemistry, Physical chemistry		
Learning content	Achievement goals	Guideline items for study
First law	Explain the concept of the first law of thermodynamics and internal energy.	First law, internal energy.
	Be able to explain the rules for the signs of internal energy, heat and work, and calculate work of expansion.	Mechanical equivalent of heat, compression, expansion, equation of state
	Be able to define enthalpy and explain that enthalpy is a state quantity.	Enthalpy, state quantity.
	Be able to calculate temperature changes associated with adiabatic changes.	adiabatic change
	Understand the physical meaning of standard enthalpies of formation and be able to calculate reaction enthalpies.	Standard enthalpy of formation, enthalpy of reaction, Hess's law.
	Equations relating constant pressure heat capacity to constant volume heat capacity can be derived.	Constant pressure heat capacity, constant volume heat capacity
Second law	Understand the definition of entropy and explain entropy generation during irreversible processes.	Second law, Clausius' principle, Thomson's principle
	Be able to explain definition of the Helmholtz and Gibbs energies and their relationship to the direction of spontaneous change.	Helmholtz energy, Gibbs energy.
	Standard reaction Gibbs energies can be calculated based on the definition of standard molar Gibbs energies.	Standard molar Gibbs energy, standard reaction Gibbs energy, standard production Gibbs energy
	Be able to derive the relationship between internal energy and macroscopic thermodynamic quantities.	Carnot cycle, entropy changes in various processes.
	Understand the definition and physical meaning of the chemical potential of a pure substance and be able to calculate the chemical potential of an ideal gas.	chemical potential
Phase and chemical equilibria	Can calculate phase and chemical equilibrium from Gibbs energy changes.	Henry's law, Raoult's law, Van't Hoff's equation, Clausius-Clapeyron equation, reaction rate

V-B-4 Mechanics

[Learning achievement goals]		
1 Goals The mechanics area aims to provide an understanding of the various internal forces and deformations that occur in machines and structures due to the loadings, and to be able to utilize this knowledge in safe and rational design and in the evaluation of the mechanical properties of various materials. (1) Be able to explain the various parameters and analytical methods related to stress and strain induced by tension, compression, shear, bending, torsion and their combinations acting on objects and use them to solve basic problems.		
2 Common course titles Mechanics of materials		
Learning content	Achievement goals	Guideline items for study
Stress and strain	Be able to calculate stresses and strains when a load is applied to a material.	Load, deformation, stress, strain.
	Understand the relationship between stress and strain and be able to calculate the modulus of elasticity and safety factor.	Stress-strain curve, Hooke's law, yield point, 0.2% proof stress, longitudinal modulus of elasticity, transverse modulus of elasticity, allowable stress, safety factor, Poisson's ratio.
Tensile, compressive and shear stresses	The stresses (normal stresses) and deformations of rods subjected to tensile and compressive loads can be calculated.	Tensile loads, compressive loads, normal stresses, deformations
	Calculate the shear stress (tangential stress) and deformation of a bar under shear loading.	Shear loads, tangential stresses and deformations
	Normal and shear stresses in any plane can be calculated.	Biaxial stresses, principal stresses, principal shear stresses, Mohr's stress circle.
	Be able to calculate the stresses in the material for problems under thermal condition.	Coefficient of linear expansion, thermal stress
Bending	For various types of beams, shear forces and bending moments can be calculated at any point in the beam.	Beams, support conditions, concentrated loads, distributed loads, shear forces, bending moments, shear force diagrams, bending moment diagrams
	Understand the center of the cross-section and moment of inertia of area of various cross-sections and be able to calculate the bending stresses in beams under bending moments.	Bending stress, moment of inertia of area.
	Calculate deflection angles and deflections for various types of beams.	Deflection, deflection curves, differential equations of deflection
Torsion	Be able to calculate shear strains, shear stresses and torsion angles on shafts under torsional loadings.	Torsion, torsional moment, shear strain, transverse modulus of elasticity, polar moment of inertia of area, torsional stiffness, torsional angle.

V-B-5 Environment

[Learning achievement goals]		
1 Goals The Environmental Systems area aims to provide basic knowledge on the relationship between the environment and chemical materials and the future direction of environmental science. (1) Be able to explain the history, phenomena and issues related to pollution and environmental contamination, global warming, energy resources and waste treatment technologies, and their relationship to materials, and use them to solve basic problems.		
2 Common course titles Environmental science, Geo-environmental science, Environmental engineering, Environmental systems studies, Environmental protection engineering		
Learning content	Achievement goals	Guideline items for study
Pollution and environmental pollution	Be able to explain the relationships between pollution and human health and the environment and human health.	Environmental factors and diseases, practical examples.

	Explain methods to prevent pollution and environmental contamination.	Air pollution, soil pollution, water pollution, environmental standards, exhaust gas purification technology, wastewater purification technology.
Global environmental issues	Be able to explain global environmental issues.	Global warming, ozone depletion, developing countries, resource issues
Energy resources problem	Be able to explain energy resource issues.	Global environment, depletion of energy resources
Waste management technology	Be able to explain the purpose of disposal treatment and resource recovery.	Definition of waste according to the Waste Disposal and Public Cleaning Act, segregation, recycling, recycling and landfill.

V-B-6 Metallic materials

[Learning achievement goals]		
1 Goals		
The metallic materials area aims to understand the basic properties of steel materials, non-ferrous metal materials and their alloys commonly used in industry, as well as the effects of microstructural changes due to heat treatment and processing on their properties.		
(1) Explain the raw materials, the main equipment and the main furnace reactions in pig iron and steel making processes.		
(2) Understand the phase diagram of carbon steel and explain the standard microstructure.		
(3) Explain the purpose of heat treatment of carbon and alloy steels and the changes in microstructure and mechanical properties associated with heat treatment.		
(4) Explain the characteristics of copper, aluminum and their alloys, which are typical non-ferrous metal materials.		
2 Common course titles		
Steel materials, Non-ferrous materials, Constituent materials, Microstructures of materials		
Learning content	Achievement goals	Guideline items for study
Iron and steel	Be able to explain the pig iron and steel making process.	Steel, blast furnace process, electric furnace process, recycling
	Be able to explain the standard microstructure and mechanical properties of carbon steels using phase diagrams.	Pure iron, carbon steel, allotropic transformation, Fe-C system equilibrium phase diagram, Cottrell atmosphere, yield point phenomena.
Heat treatment of carbon steel	Understand the purpose of heat treatment of carbon steel and describe the operation of each heat treatment and the characteristics of the microstructure obtained.	Annealing, normalizing, quenching, tempering, martensite, martensitic transformation, isothermal transformation curve, continuous cooling transformation curve, surface hardening treatment
Alloyed steel	Describe the phase diagram and microstructural features of alloy steels.	phase diagram, carbides, secondary hardening, tempering brittleness, isothermal (isothermal) transformation curve, continuous cooling transformation curve.
	Be able to describe the types, characteristics and typical uses of alloy steels.	General structural steel, machine structural steel, tool steel, stainless steel, heat-resistant steel
Cast iron	Describe the properties and microstructure of cast iron using phase diagrams.	Casting, Maurer's structural diagram, grey cast iron, malleable cast iron, spheroidal graphite cast iron.
Copper and copper alloys	Describe the types of pure copper and copper alloys and their mechanical characteristics, physical and chemical properties.	Pure copper, brass, bronze
Aluminum and aluminum alloys	Explain the mechanical characteristics, physical and chemical properties of pure aluminum and aluminum for casting and drawing.	Aluminum for casting, die-casting and drawing, heat treatment
Titanium and titanium alloys	Describe the types of pure titanium and titanium alloys and their mechanical characteristics, physical and chemical properties.	Practical titanium alloy, heat treatment

Metallic materials	Be able to explain the applications, manufacturing methods and structure of metallic composite materials.	Fiber-reinforced composites, laminate-reinforced composites, particle dispersion-reinforced composites, composition-graded composites
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V-B-7 Inorganic materials

[Learning achievement goals]		
1 Goals		
The inorganic chemistry area aims to enable students to understand the properties of matter, such as atomic structure and bonding states, and to explain basic matters such as inorganic materials and coordination chemistry.		
(1) Understand the properties of the various elements that make up matter and explain, in relation to the periodic table, that these properties are due to the behavior of electrons.		
(2) Explain the structure, bonding states and properties of inorganic elements and compounds consisting of combinations of elements.		
(3) Understand chemical reactions and be able to explain heat of reaction, reaction rates and battery reactions.		
(4) Explain applications, structures, synthetic reactions, etc. with regard to basic inorganic materials.		
*For the model core curriculum in the inorganic materials area, reference may be made to the learning content of the inorganic chemistry area of the chemical system.		
2 Common course titles		
Chemistry, Inorganic chemistry, Inorganic materials, Ceramic materials, Surface chemistry, Electrochemistry		
Learning content	Achievement goals	Guideline items for study
Atomic structure	Understand the constituent particles of an atom and explain atomic number, mass number and isotopes.	Protons, neutrons, electrons, atomic number, mass number, isotopes.
Electron configuration of atoms and the periodic law	Indicate the electron configuration using The Pauli exclusion principle, the energy levels of the orbitals and Hund's rule.	Principal quantum numbers, azimuthal quantum numbers, magnetic quantum numbers, Pauli's exclusion principle, energy levels of orbitals, Hund's rule.
	Understand valence electrons and explain noble gas structures and ion formation.	Valence electrons, noble gas structures, cations, anions
	Understand the periodic law of elements and be able to describe the general properties of typical and transition elements.	Alkali metal elements, alkaline earth metal elements, halogen elements, rare gas elements, transition elements (iron, copper, chromium, manganese)
	Explain ionization energy, electron affinity and electronegativity.	Ionization energy, electron affinity, energy sign, electronegativity prediction of bond polarity.
Chemical bonding and molecular structure	Explain the electron configuration to be shown in the Lewis structure with the octet rule (octagonal theory) as an initial theory of chemical bonding.	Octet rule, Lewis structure, isolated electron pair (non-bonded electron pair), bonded electron pair, single bond, multiple bond
	Explain covalent bonds with the valence bond method.	Valence bonding method, shape of s and p orbitals, covalent bonds, sigma bonds, hybridized orbitals.
	Be able to explain the formation and characteristics of ionic bonds.	Ionic bonding, Born-Haber cycle, sublimation, lattice energy.
	Be able to explain the formation and characteristics of metallic bonds.	Metallic bonding, free electrons, ductility

Crystal structure and lattice	Be able to perform basic calculations on the packing structure, packing ratio and ionic radius ratio of crystals.	Body-centered cubic lattice, face-centered cubic lattice, hexagonal close-packed lattice, packing ratio, ionic radius ratio
Oxidation-reduction reaction	Be able to calculate the concentration of oxidizing and reducing agents, etc. from the oxidation-reduction reaction equation using knowledge of oxidation-reduction.	Redox reactions, oxidation numbers, oxidizing agents, reducing agents.
	Explain ionization tendencies and battery electrodes and typical batteries.	Ionization tendency, cathode, anode, voltaic cell, Daniel battery.
	Be able to use knowledge of electrolysis to calculate Faraday's law.	Electrolysis, anode, cathode, Faraday's law.
Inorganic substance	Explain the properties of representative non-metallic elements both individually and in compounds.	Hydrogen, carbon, nitrogen, oxygen.
	Explain the properties of single and compound forms of typical metallic elements.	Sodium, magnesium, calcium, aluminum.
Inorganic materials	Explain the uses, manufacturing methods and structure of inorganic materials, including ceramics, carbon materials and inorganic composites.	Alumina, diamonds, glass, aluminosilicates, semiconductors, superconductors, cermets
	Explain the materials synthesis methods required for mono-crystallization, sintering, thin-film, particulation and porous materials.	Hydrothermal synthesis method, flux method, chemical vapor deposition, pulsed current sintering, discharge plasma sintering, vacuum evaporation, doctor blade method, sol-gel method, self-assembly
Reaction heat	Be able to calculate the amount of heat produced or absorbed in a chemical reaction.	Exothermic reactions, endothermic reactions, heat of combustion, heat of formation, heat of dissolution, heat of neutralization, Hess' law, binding energy
Reaction kinetics	Be able to calculate the rate of chemical reactions and rate constants in reaction rate equations.	Reaction rate, reaction rate equation, reaction rate constant, catalysis, activation state, activation energy.

V-B-8 Organic materials

[Learning achievement goals]		
1 Goals		
In the organic materials area, the aim is to provide students with an understanding of basic matters such as nomenclature, molecular structure, chemical properties and stereochemistry of organic materials, and to provide them with knowledge of organic chemistry, including the manufacturing methods, properties and reactions of organic compounds.		
(1) Explain organic compounds by linking their names to their structures.		
(2) Be able to explain the structure and properties of the functional groups of typical compounds, synthetic methods and reactions.		
*For the model core curriculum in the organic materials area, reference may be made to the learning content of the organic chemistry area of the chemical system.		
2 Common course titles		
Organic chemistry, Organic materials, Polymeric materials		
Learning content	Achievement goals	Guideline items for study
Definition of organic chemistry	Be able to explain that organic compounds are carbon skeletons and convert their structures and names according to IUPAC nomenclature.	Organic compounds, carbon, IUPAC nomenclature.
Structure and bonding of organic compounds	Understand the Lewis structures of organic compounds and use orbital hybridization to describe molecular bonding states, shapes, polarity and reactions.	Covalent bonds, Lewis structures, sigma bonds, pi bonds, orbital hybridization, dipole moments, acid-base.

Hydrocarbon	Be able to describe the different types of hydrocarbons and the properties and typical reactions associated with them.	Alkanes, alkenes and alkynes, physicochemical properties.
Stereochemistry	Be able to describe structural isomers, geometric isomers and mirror-image isomers of organic compounds, and use various notations to describe three-dimensional structures.	Newman projection formula, Fischer projection formula, structural isomers, geometric isomers, mirror isomers, stereo conformation, stereo configuration, R,S notation, E,Z notation.
Classification by functional group and properties of each compound, reactions.	Be able to explain the structure, properties, synthetic methods and reaction mechanisms of compounds containing typical functional groups.	Alcohol, ether, aldehyde, ketone, carboxylic acid, amine, thiol, alkyl halide, resonance contribution, nucleophilic substitution reaction (SN1, SN2), elimination reaction (E1, E2)
Introduction to polymer chemistry	Be able to explain the types and structures of typical polymer compounds and the various properties of different structures.	Molecular weight, primary structure, higher order structure, thermophysical properties, glass transition temperature, melting point, decomposition temperature, mechanical properties, viscoelasticity, Maxwell model, Voigt model, solubility.
Polymer synthesis	Understand the characteristics of polymer synthesis reactions such as polycondensation, addition polymerization, polyaddition and ring-opening polymerization, and explain which polymerization reactions produce the specific polymers.	Polycondensation, addition-condensation, polyaddition, ring-opening polymerization, radical polymerization, cationic polymerization, anionic polymerization
Polymer materials	Be able to explain the applications, manufacturing methods and structure of polymer-based composites.	Fiber-reinforced composites, laminate-reinforced composites, particle-reinforced composites, composition-graded composites

V-B-9 Design and processing

[Learning achievement goals]		
1 Goals		
The design and machining area aims to teach drafting methods and how to work with machine materials and apply them to real-world tasks.		
(1) Be able to produce production drawings and sketches of machine parts, etc., in accordance with the standards for mechanical drafting.		
(2) The role of CAD systems and their basic functions can be used and applied to real-world problems.		
(3) Be able to explain the types, characteristics and principles of machining techniques and use them to solve basic problems.		
2 Common course titles		
Drafting, Basic drafting, Design drafting, Craft methods, Plastic working		
Learning content	Achievement goals	Guideline items for study
Cartography	Understand and utilize the role of drawings, the types and uses of lines, how to draw projections of objects and the role of drafting tools.	Mechanical drawing, drawing methods, drafting tools, line types, projection methods, CAD.
	Understand how to draw fabrication drawings, indicate dimensions, tolerances and surface properties, and sketch parts.	Representation of figures, cross sections, dimensional tolerances, fits, geometric tolerances, surface properties, sketches, fabrication drawings.
	Understand the drafting standards for machine elements and be able to produce draftings.	Bolts and nuts, shaft couplings, bearings, CAD drafting
Casting	Understand the casting process and be able to describe its types and features.	Casting, molds, precision casting methods, die casting methods
Welding	Explain gas and arc welding joining methods and their characteristics.	Welding, welding methods, gas welding, arc welding, non-destructive testing methods
Plastic working	Understand plastic working methods and be able to describe their types and characteristics.	Plastic working, forging, pressing, extruding, drawing, rolling

Additional manufacturing technology	Understands the multilayer molding method and can explain its types and features.	Liquid-phase photopolymerization, powder bed melt bonding, 3D printers
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3-1.3 V-C Electrical and electronic fields

V-C-1 Electrical circuits

[Learning achievement goals]		
1 Goals		
In the electrical circuits area, the aim is to learn how to handle DC and AC circuits, how to analyze transient phenomena in electrical circuits and to develop the basic skills required to study electrical and electronic engineering.		
(1) Understand the relationship between voltage and current in resistors, inductors and capacitor elements and use it to calculate electric circuits.		
(2) Understand theorems such as Kirchhoff's Law and the Theorem of Superposition, and be able to use them to calculate electric circuits.		
(3) Understand instantaneous values, phasors and complex displays and be able to use these to calculate sinusoidal AC circuits.		
(4) Be able to calculate resonant and coupled circuits, etc.		
(5) Calculate the transient response of an electrical circuit and explain the characteristics of the transient response.		
2 Common course titles		
Electric circuits, AC circuits, Theory of transient phenomena		
Learning contents	Achievement goals	Guideline items for study
Fundamentals of electrical circuits	Understand the relationship between charge, current, voltage and power and use it to calculate circuits.	Charge, voltage, current, power, wattage, Ohm's law.
	Be able to calculate circuits using the concepts of synthetic resistance and voltage and current dividing.	Synthetic resistance, partial pressure law, partial current law
Circuit network fundamentals and calculations	Understand theorems such as Kirchhoff's law and the principle of superposition, and be able to calculate voltage, current and power in circuits.	Kirchhoff's Law, Theorem of Superposition, Thevenin's Theorem, Bridge's Equilibrium Condition.
AC circuit fundamentals	Understand instantaneous values and use them to calculate resistance, inductance and capacitance circuits.	Sine wave, instantaneous value, frequency, phase, resistance, inductance, capacitance
	Explain mean and RMS values and be able to calculate these.	Average, RMS value
	Understand phasors and complex representations and be able to use these to calculate sinusoidal AC circuits.	Phasor, complex number display.
	Explain impedance and admittance and be able to calculate these.	Impedance, admittance.
	Explain AC power and power factor and be able to calculate these.	Apparent power, active power, reactive power, power factor
Resonance circuit	Be able to calculate resonant circuits.	Series and parallel resonant circuits
Coupled circuit	Be able to calculate coupled circuits.	Mutual inductive circuits, ideal transformers
Transient	Calculate and characterize the transient response of resistance, inductance and capacitance circuits.	RL series circuit, RC series circuit, RLC series circuit, DC response, time constant.

V-C-2 Electromagnetism

[Learning Achievement goals]

1 Goals

In the area of electromagnetics, the aim is to acquire theories on electromagnetic phenomena such as electrostatic fields, currents and magnetic fields, and to develop the basic skills required to study electrical and electronic engineering.

- (1) Be able to explain charges, electric fields and potentials in electrostatic fields and calculate them.
- (2) Be able to explain magnetic fields due to currents and calculate magnetic fields using various laws.
- (3) Explain conductors, dielectrics and magnetic materials.
- (4) Be able to explain capacitance and inductance and calculate them.
- (5) Be able to explain electromagnetic induction and calculate induced electromotive force, self-induction and mutual induction.

2 Common course titles

Fundamentals of electricity, Basic electrical engineering, Electromagnetism, Electrical circuits, Physics, Applied physics, Radio engineering, Communications engineering

Learning contents	Achievement goals	Guideline items for study
Electrostatic field	Be able to explain electric charge and Coulomb's law and calculate the forces, etc. acting on a point charge.	Charge, Coulomb force.
	Be able to describe electric fields, potentials, lines of electric force and electric fluxes and perform calculations using these.	Electric field, electric potential, electric flux.
	Be able to explain Gauss's law and use it to calculate electric fields.	Gauss's law, charge density and electric field on conductor surfaces.
Dielectric	Explain dielectrics, polarization and flux density.	Dielectric, polarization, flux density, permittivity
Capacitance	Be able to explain capacitance and calculate the capacitance of e.g. parallel plate capacitors.	Capacitance, parallel plate capacitors
	Explain series and parallel connections of capacitors and calculate their combined capacitance.	Series-parallel connection of capacitors, composite capacitance
	Explain electrostatic energy.	electrostatic energy
Currents and magnetic fields	The magnetic field created by a current can be calculated using Biot-Savart's law.	Biot-Savart law
	The magnetic field created by a current can be calculated using Ampere's law.	Ampere's law
	Explain the Lorentz forces acting on currents in magnetic fields.	Lorentz force
Magnetic body	Explain magnetic materials, magnetization and flux density.	Magnetic materials, magnetic flux density, specific permeability, hysteresis properties.
Electromagnetic induction	Be able to explain electromagnetic induction and calculate induced electromotive force.	Electromagnetic induction, induced electromotive force
	Be able to explain self-induction and mutual induction.	Self-inductance and mutual inductance
Inductance	Self-inductance and mutual inductance can be determined.	Self-inductance, mutual inductance
	Can explain magnetic energy.	magnetic energy

V-C-3 Electronic circuits

[Learning achievement goals]		
1 Goals		
In the electronic circuits area, the aim is to understand the basic operation of diodes, transistors and operational amplifiers and the basic issues of amplification circuits.		
(1) Understand the basic operation of diodes and transistors and explain equivalent circuits etc.		
(2) Understand the fundamentals of amplification circuits and be able to calculate operating quantities etc.		
(3) Understand the basic operation of an operational amplifier and be able to explain amplification circuits etc.		
2 Common course titles		
electronic Circuit		
Learning contents	Achievement goals	Guideline items for study
Electronic circuit components	Explain the characteristics of diodes.	diode
	Be able to describe the characteristics and equivalent circuit of a bipolar transistor.	Features and equivalent circuits of bipolar transistors
	Be able to describe the characteristics and equivalent circuit of a FET.	Features of FETs and equivalent circuits
Amplifier circuit	Explain the fundamentals of amplification circuits, including gain, frequency bandwidth and input and output impedance.	Gain, frequency bandwidth, input and output impedance
	Be able to describe the bias circuit of a transistor amplifier.	bias circuit
Operational amplifier	Explain the characteristics of operational amplifiers.	Characteristics of operational amplifiers
	Be able to explain the operation of basic circuits using operational amplifiers.	Basic circuits of operational amplifiers

V-C-4 Electronics

[Learning achievement goals]		
1 Goals		
In the area of electronics, the goal is to learn the fundamentals of electronic properties and the basic matters of semiconductors and semiconductor devices.		
(1) Understand the basic properties of electrons, atoms, etc. and use them to understand the physical properties of metals and semiconductors.		
(2) Understand the basic properties of semiconductors and be able to explain the characteristics of pn junctions and the principles of transistor operation.		
2 Common course titles		
Electronic engineering, Electronic materials, Semiconductor engineering		
Learning contents	Achievement goals	Guideline items for study
Nature of electrons	Explain the basic properties of electrons, such as their charge and mass.	Charge and mass of electrons.
	Explain the definition of the electron volt and perform calculations such as unit conversions.	Definition of electron volt
Atomic structure	Be able to explain the structure of atoms.	Atomic structure
	Understand Pauli's Exclusion Rule and explain the electron configuration of atoms.	Pauli exclusion criterion
Solid structure	Understand crystals, energy band formation, Fermi-Dirac distributions and explain energy band diagrams for metals and semiconductors and insulators.	Crystals, energy band diagram, Fermi-Dirac distribution.
Metal	Describe the electrical properties of metals and calculate their mobility and conductivity.	Electrical properties of metals, mobility and conductivity
Semiconductor	Explain true and impurity semiconductors.	True and impurity semiconductors.
	Explain the energy band diagram of semiconductors.	Energy band diagram of semiconductors.
Semiconductor device	Be able to explain the structure and operation of pn junctions.	pn junction
	Be able to explain the structure and operation of bipolar transistors.	bipolar transistor
	Explain the structure and operation of field-effect transistors.	Field Effect Transistor

V-C-5 Electricity

[Learning achievement goals]		
1 Goals		
In the area of electric power systems, the objective is to be able to explain how to convert various energy sources into electrical energy and how to transport and utilize that electrical energy appropriately, as well as the relationship between the generation, transport and utilization of electrical energy and environmental issues.		
(1) (1) Explain the basic principles of three-phase alternating current, which is the fundamental principle of electric power.		
(2) (2) Explain the operating principles and construction of rotating and stationary machines used to generate, convert and utilize electrical power.		
(3) (3) Explain the methods and characteristics of generating electricity from various energy sources, as well as their effectiveness in addressing environmental issues.		
(4) (4) Explain how the components of the electricity transport system in Japan work and how to maintain electricity quality and stable supply.		
2 Common course titles		
Electrical circuits, Electrical equipment, Generation and substation engineering, Transmission and distribution engineering, Power system engineering, Energy conversion engineering		
Learning contents	Achievement goals	Guideline items for study
Three-phase alternating current	Explain voltage and current (phase voltage, line voltage and line current) in three-phase AC.	Phase voltage, line voltage, line current and effective power of three-phase AC.
	Explain the voltage, current and power of Y- and Δ -wired power supplies and symmetrical three-phase loads.	Y-connection, Δ -connection, Δ -Y conversion
Rotator	Be able to explain the principles and construction of DC machines.	Principles, construction and electrical characteristics of DC machines.
	Be able to explain the principles and construction of induction and synchronous machines.	Principles, construction and electrical characteristics of induction and synchronous machines.
Static apparatus	Be able to explain the principle, construction and characteristics of transformers and describe their equivalent circuits.	Transformer principles, construction, characteristics and equivalent circuits.
	Be able to explain the types of semiconductor devices and operating principles of semiconductor power conversion devices.	Types of semiconductor devices, principles of operation.
Generation (e.g. power)	The principles and main equipment of thermal power generation and the environmental impact of power generation can also be explained.	Principles of thermal power generation, equipment and environmental issues.
	The principles and main equipment of nuclear power generation and the environmental impact of power generation can also be explained.	Principles of nuclear power, equipment and environmental issues.
	Be able to explain the principles and main equipment of hydropower generation.	Hydropower principles and equipment.
	Provide an overview of power generation using other new and renewable energy sources and explain their environmental effectiveness and challenges in their introduction.	Electricity generation and availability from new and renewable energy sources.
	Explain how a combination of different power generation schemes provides electricity to meet electricity demand.	Baseload, middle and peak power sources
Electric power transmission and distribution	Be able to describe Japan's electricity system, which combines AC and DC transmission and distribution systems and frequency converter stations, and explain the characteristics of each.	AC and DC transmission and distribution, frequency converter stations, power systems, smart grids
	Be able to calculate voltage, current and power in three-phase wiring of transformers in substations and explain the characteristics of the wiring method.	Transmission facilities, substation facilities, Δ - Δ connections, Y-Y connections, Δ -Y connections, Y- Δ connections, V connections

	Explain the different types of transmission facilities and how they maintain a stable supply of electricity in relation to environmental and climatic conditions.	Power line equipment, overhead power line theory, lightning damage, wind and snow damage, salt damage
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V-C-6 Measurement

[Learning achievement goals]		
1 Goals In the area of measurement systems, the goal is to acquire the theory of electrical and electronic measurement and the knowledge and methods required for electrical and electronic measurement. (1) Explain the fundamentals of measurement, including classification methods, definitions of instrumental accuracy and measurement error, and the formation of units. (2) Explain the methods and precautions for measuring electrical quantities.		
2 Common course titles Measurement engineering, Electrical measurement, Electronic measurement, Electrical and electronic measurement, Electrical circuits		
Learning contents	Achievement goals	Guideline items for study
Fundamentals of measurement	Explain the classification of measurement methods (deviation/zero method, direct/indirect measurement, analogue/digital measurement).	Polarization method/zero method, direct measurement/indirect measurement, analogue measurement/digital measurement.
	Understand accuracy and error and be able to process measurements taking into account significant figures and error propagation.	Accuracy and error, significant figures
System of units and standards	Explain basic and assembly units in the SI system of units.	SI system of units, basic units, assembly units
	Explain the relationship between measurement standards and traceability.	Measurement standards and traceability
Fundamentals of electrical instrumentation	Understand the principle of operation of indicating instruments and explain how they are used to measure voltage and current.	Indicators, voltmeters and ammeters
	Explain methods for extending the measurement range of voltage and current using a multiplier/shunt.	Multiplier/shifter
	Explain the principles of digital instrumentation using A/D conversion.	A/D conversion, digital instruments
Resistance and impedance measurements	Explain the principles of resistance measurement by the voltage drop method.	Resistance and impedance measurements using the potential drop method.
	Explain the principle of measuring impedance using a bridge circuit.	Resistance and impedance measurements with bridge circuits
Electricity, measurement of electrical energy	Explain the principles and methods of measuring active power, reactive power and power factor.	Measurement of active power, reactive power and power factor
	Be able to explain the principles of power quantity measurement.	Measuring the amount of electricity
Waveform observation	Explain the principle of operation of an oscilloscope.	Oscilloscope operating principles and waveform measurements

V-C-7 Control

<p>[Learning achievement goals]</p> <p>1 Goals</p> <p>The subjects in the control systems area aim to provide students with the knowledge necessary for control engineering theory and automatic control applications.</p> <p>(1) The behavior of a system can be represented using transfer functions and block diagrams.</p> <p>(2) Acquire methods to describe the transient, steady-state and frequency characteristics of the system.</p> <p>(3) Learn how to determine the stability of feedback systems.</p> <p>2 Common course titles</p> <p>Control engineering, Automatic control</p>		
Learning contents	Achievement goals	Guideline items for study
Transfer functions and block diagrams	Be able to represent the input/output of a system using transfer functions.	Transfer function-based systems.
	Block diagrams can be used to represent the system.	System representation using block diagrams.
System response	Be able to explain the transient characteristics of the system using the impulse and step responses.	Impulse response, step response
	The steady-state characteristics of the system can be explained using steady-state deviations.	stationary deviation
	Explain the frequency response of the system.	frequency response
Stability discrimination of feedback systems	Explain the stability discrimination method for feedback systems.	Stability of feedback systems.

3-1.4 V-D Information-based sectors

V-D-1 Programming

<p>[Learning achievement goals]</p> <p>1 Goals</p> <p>The programming area is where students learn how to write codes, read codes, use tools for software generation and understand structures of software generation tools.</p> <p>(1) In the programming field, students should understand the basic concepts and software development processes required for software development. Students can make simple software using at least one programming language or language processor.</p> <p>(2) In the programming language field, students understand the roles and functions of the various tools that make up the language processor. Students can explain how the various programming languages can be classified according to the different computational models.</p> <p>2 Common course titles</p> <p>Programming, Programming exercises, Programming languages</p>		
Learning contents	Achievement goals	Guideline items for study
Elements of programming	Understand the basic structure of programming and be able to write codes.	Variables, data types, operators, basic control structures (sequential, conditional branch, iteration)
	Understand the concept of subroutines and be able to write codes containing them.	Subroutine, module, generalization, call by value, call by reference
Software development	For a given problem, students can write a specification or code to solve it.	Flowcharts, pseudo-language, UML, coding
	Be able to analyze a given source code and predict the behavior of the code.	Analyzing and debugging codes
	Be able to use the tools required for software generation and to run source codes.	Program execution, compilation, linking, editors, IDEs, libraries, APIs
Language processor	Be able to describe the types and features of the main language processors.	Compilers, interpreters, preprocessors and assemblers

V-D-2 Software

<p>[Learning achievement goals]</p> <p>1 Goals</p> <p>The software systems area is to study algorithms and data structures, which are concepts that abstract software basically the perspective of procedures for solving problems.</p> <p>(1) In the fields of algorithms and data structures, explain that the choice of algorithm and data structure is important for efficient problem solving</p> <p>(2) In the fields of numerical processing, students can explain how errors that occur in the representation of numerical values on a computer can adversely affect processing results.</p> <p>2 Common course titles</p> <p>Programming, Algorithms and data structures, Numerical analysis, Numerical computing</p>		
Learning contents	Achievement goals	Guideline items for study
Algorithm	Understand the concept of algorithms and be able to explain how a given algorithm solves a problem.	Algorithms, sorting and search.
	Explain that algorithms can be compared and evaluated according to computational complexity.	Time-computed quantities, domain-computed quantities, order notation
Data structure	Understand that there are variations in the way data is represented inside computers or data structures and be able to explain basic data structure concepts and operations.	List, stack, queue, tree and graph structures
Numerical processing and errors	Explain that errors can occur due to the way numerical values are represented and calculated on a computer.	Rounding errors, censoring errors, off-digit errors, propagation of errors

Numeric calculation	Be able to give an overview of the main numerical algorithms for computers and their features.	Approximation of functions, solution of non-linear equations, solution of simultaneous equations, solution of integrals, solution of differential equations.
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V-D-3 Computer engineering

[Learning achievement goals]		
1 Goals		
The computer engineering area is an area where the hardware principles of digital computers, which are currently the mainstream, and the hardware elements used in actual computers are studied.		
(1) In the field of logic circuits, understand the principles of digital representation of data and the principles of processing digitally represented data, and be able to design simple circuits to process data.		
(2) In the area of computer architecture, understand the structure of digital computers and the functions of the components used in practice, and be able to describe the main technologies used in them.		
2 Common course titles		
Logic circuits, Computer architecture, Computer fundamentals, Information mathematics, Information literacy		
Learning contents	Achievement goals	Guideline items for study
Number system	Integers and decimals can be expressed in binary, decimal and hexadecimal, and can be converted between each other.	Binary, decimal, hexadecimal and radix conversions.
	Explain how integers and decimals can be represented digitally in computer memory.	Digital, bit, byte and floating-point systems
Logical function	Can perform basic logical operations.	Logical operations (AND, OR, NOT, XOR)
	Combine basic logical operations to express logical functions as Boolean algebraic expressions.	Boolean algebra, de Morgan's law.
	Be able to explain the concept of simplification of logical expressions and simplify a given logical expression using various techniques.	Sums of products (additive) standard form, sums of products (multiplicative) standard form, Karnaugh diagram
Combinational logic circuit	Be able to represent logical expressions as combinational logic circuits using logic gates and explain the function of the circuits.	Logic symbols, combinational logic circuits, truth tables
	Be able to design combinational logic circuits.	Decoders, encoders and adders
Sequential circuit	Be able to describe the operation and characteristics of basic elements of sequential circuits such as flip-flops and explain the function of a given sequential circuit.	Sequential circuits, counter circuits, shift registers, timing charts.
	Can design sequential circuits.	State transition diagrams, state transition tables
Computer hardware	Be able to explain the role of the basic elements that make up a computer and describe the main technologies that make each element possible.	Arithmetic, control devices, storage devices, input/output devices, instruction code, instruction cycles, registers, caches, interrupts
	Explain the trade-offs in computer architecture.	Architecture, reliability and performance

V-D-4 Computer systems

[Learning achievement goals]		
1 Goals The computer systems area is for understanding the overall computer systems.		
(1) In the field of computer systems, explain the various forms of computer systems, focusing on those in practical use.		
(2) Explain the main flow of the design process in the system design field, where the specification of the overall system is first determined and the division of functions between hardware and software is based on this.		
2 Common course titles Computer architecture, Systems engineering, Computer systems, System design		
Learning contents	Achievement goals	Guideline items for study
Computer system	Be able to describe the features and typical examples of each type of computer system processing.	Centralized processing, distributed processing, thin clients, horizontally distributed, vertically distributed
	Describe typical system configurations to improve the reliability and functionality of computer systems.	Dual systems, multiprocessor systems, risk management.
System design	Be able to explain the process of designing a system according to user requirements.	Waterfall model, prototyping model, spiral model, agile process model
	Explain the need for project management.	Scheduling, version control, quality control, stakeholder management
	Be able to describe at least one of the project management methods.	WBS, PERT diagrams, Gantt charts

V-D-5 system programming

[Learning achievement goals]		
1 Goals The system programming area is an area where operating systems, which are essential for the efficient use of computers, are studied.		
(1) In the area of operating systems, be able to explain the role and function of operating systems in computer systems.		
2 Common course titles Operating systems, Computer systems		
Learning contents	Achievement goals	Guideline items for study
Operating system fundamentals	Explain the position of operating systems in computer systems.	Hardware abstraction, resource management
	Explain CPU virtualization, including process management and scheduling.	Multiplexing, processes and resources
	The basic concept of exclusion control can be explained.	Locking methods, deadlocks, Dekker's algorithm, interrupt control.
	The basic concepts of memory management can be explained.	Address space, paging

V-D-6 Information and communication networks

[Learning achievement goals]		
1 Goals The information and communication networks area is an area for studying the structure of information and communication networks, one of the social infrastructures, and the basic technologies that support this. (1) In the field of information and communication networks, to understand the concept of protocol hierarchies and to be able to take up the Internet Protocol Suite, one of the protocol systems embodying this concept, and to understand and practice the specific and standard techniques involved.		
2 Common course titles Information and communication networks, Computer systems		
Learning contents	Achievement goals	Guideline items for study
layered protocol	Understand the concept of protocols and be able to explain the concept and benefits of hierarchy.	Protocols, OSI reference model.
Local area networks and the Internet	Be able to explain concepts such as the Internet and local area networks.	Internet, WAN, LAN, WWW.
	Be able to explain the four layers of TCP/IP, the role of each layer and the specific and standard conventions and technologies involved in each layer.	TCP/IP, UDP, SSL, TLS, IPSec
Network Applications	Be able to explain how to build major servers.	Web servers, mail servers, DNS servers, file servers, DB servers

V-D-7 Information mathematics and information theory

[Learning achievement goals]		
1 Goals The Information Mathematics and Information Theory area is an area that provides a foundation for understanding the basic mathematical theories required for computer science. (1) In the field of discrete mathematics, be able to explain concepts within the category of discrete structures, which is a general term for mathematical concepts that deal with symbols and are particularly relevant to computer science.		
2 Common course titles Information Mathematics, Digital Fundamentals, Computer Fundamentals		
Learning contents	Achievement goals	Guideline items for study
Discrete mathematics	Understand basic concepts about sets and be able to perform set operations.	Sets, maps, relations, propositions, predicate logic

V-D-8 Other learning contents

[Learning achievement goals]		
1 Goals Other content areas of study are those essential computer-related topics that information technology-savvy technicians need to know to perform their activities. (1) In the field of databases, the candidate should be able to explain basic knowledge of databases, which is essential for the efficient and secure use of data assets. (2) In the area of media information processing, be able to explain how information is represented in increasingly diverse media and how information is handled on computers. (3) Understand the importance of cyber security and explain the need to respond to cyber-attacks.		
2 Common course titles Database, Media information processing, Information security, Information and communication, Networks		
Learning contents	Achievement goals	Guideline items for study
Database	Be able to explain basic concepts related to data models and database design methods.	Conceptual data model, logical data model, physical data model, E-R diagram, hierarchical model, relational model
	Be able to describe basic data queries using database languages.	SQL, DBMS, data manipulation, data definition, data control
Media information processing	Explain the characteristics of digital and analogue signals.	Digital / analogue, sampling, quantization

	Explain the techniques and phenomena involved in discretizing information.	ADC, DAC.
	Explain the main representation formats and processing techniques for media information.	Image coding, audio coding, video coding, CSV
Cyber security	Understand the importance of cyber security and be able to explain its necessity.	Diversification of threats and attack methods, cyber-terrorism, import/export restrictions on cryptography and security technologies, reverse engineering
	Be able to explain secure communication methods in networks and the technologies required to build a basic environment.	Communication security, firewalls.
	Be able to explain basic response methods to check network operation and communication trails.	Network analysis, analysis of logs
	Explain vulnerabilities that can occur in networked systems and how to diagnose and counteract them.	System vulnerability assessment and penetration testing.

3-1.5 V-E Chemical and biological sciences

V-E-1 Organic chemistry

[Learning achievement goals]		
1 Goals This area covers the structure of organic compounds, their properties and reactions, which are fundamental to understanding the properties of compounds that serve as organic materials and life science phenomena. (1) Be able to link structures to names, using IUPAC nomenclature, in relation to organic compounds. (2) Be able to explain the properties of typical functional groups and show their reactions and methods of introduction. (3) Be able to explain the properties and synthesis of typical polymer compounds.		
2 Common course titles Organic chemistry, Polymer chemistry		
Learning contents	Achievement goals	Guideline items for study
Definition of organic chemistry	Be able to explain that organic compounds are compounds with a carbon skeleton.	Organic compound
	For compounds with representative functional groups, structures and names can be linked according to IUPAC nomenclature.	IUPAC nomenclature, conventional names
Structure and bonding of organic compounds	Be able to explain σ and π coupling.	σ -coupling, π -coupling
	Be able to describe the shape of molecules using hybridized orbitals.	sp ³ mixed orbitals, sp ² mixed orbitals, sp mixed orbitals.
	Lewis structures can be written and used to link them to reactions.	Lewis structure, lone pair of electrons.
	Understand induced and resonance effects and explain bond polarization and charge delocalization. Can explain bond polarization and charge delocalization, with an understanding of induced and resonance effects.	Induced effects, resonance effects, electronegativity, polarization, delocalization
Stereochemistry	Can visualize the three-dimensional structure of molecules and explain structural isomers, cis-trans isomers and mirror-image isomers. Can image the three-dimensional structure of molecules and explain structural isomers, cis-trans isomers and mirror-image isomers.	Structural isomers, cis-trans isomers, mirror isomers, optically active, chiral, racemic.
	Be able to correctly indicate the stereochemistry of a compound according to its notation. Can indicate correctly the stereochemistry of a compound according to its notation.	E, Z Nomenclature, R, S Placement
Classification of organic compounds, properties of each compound and reactions.	Understand the types of hydrocarbons and typical functional groups and explain their structures and properties. Can explain the structure and properties of hydrocarbons, with an understanding of their types and typical functional groups.	Alkanes, alkenes, alkynes, aromatic compounds, alcohols, aldehydes, ketones, carboxylic acids, amines
	Be able to describe the structure and stability of aromatic compounds.	Benzene, aromatic, Hückel's law.
	Be able to describe typical reactions of hydrocarbons, including aromatic compounds.	Alkene/alkyne addition reactions, aromatic electrophilic substitution reactions.
	Be able to explain synthetic methods and reactions of compounds containing typical functional groups.	Oxidation reactions, reduction reactions, SN 2, SN 1, E2, E1, nucleophilic addition reactions of carbonyl compounds, nucleophilic acyl substitution reactions, condensation reactions of carbonyl compounds
	For typical reactions, be able to explain the products obtained based on the reaction mechanism.	Reaction mechanisms, electron theory, orientation, regioselective reactions, stereoselective reactions.

Introduction to polymer chemistry	Be able to explain what polymer compounds are.	Monomers, polymerization reactions, average molecular weight, molecular weight distribution.
	Be able to describe typical types of polymeric compounds and their properties.	Commodity plastics, engineering plastics
	Understand and distinguish between synthetic and natural polymers. Understand and able to distinguish between synthetic and natural polymers.	Synthetic polymers, natural polymers and biobased polymers
	Be able to explain the stability of polymers in the natural environment, its importance and problems.	Plastic waste, biodegradable polymers
Polymer synthesis	Be able to describe typical polymer synthesis reactions and distinguish which polymers are formed by these reactions.	Addition polymerization, ring-opening polymerization, polycondensation, polyaddition, radical polymerization, cationic polymerization, anionic polymerization

V-E-2 Inorganic chemistry

[Learning achievement goals]		
1 Goals This educational area comprises subjects from the field of inorganic chemistry, which is fundamental to understanding the nature of matter, such as atomic structure and bonding states, and supports recent developments in materials development. (1) Be able to explain the structure, types and properties of atoms. (2) Be able to explain the structure, bonding states and properties of elements and compounds.		
2 Common course titles Inorganic chemistry		
Learning contents	Achievement goals	Guideline items for study
Electron configuration of atoms and the periodic law	Be able to explain principal quantum numbers, azimuthal quantum numbers and magnetic quantum numbers.	Principal quantum numbers, orientation quantum numbers, magnetic quantum numbers
	Be able to explain the shape of electron shells, electron orbitals and electron orbitals.	Electron shells, electron orbitals, electron orbitals.
	The Pauli exclusion principle, the energy levels of the orbitals and Hund's rule can indicate the electron configuration.	Pauli's Exclusion Principle, energy levels of orbitals, Hund's Rule.
	Understand valence electrons and be able to explain noble gas structures and ion formation.	Electron configuration, ions.
	Understand the periodic law of elements and be able to explain the general properties of typical and transition elements.	Periodic law, typical elements, transition elements.
	Be able to explain ionization energy, electron affinity and electronegativity.	Ionization energy, electron affinity, electronegativity.
Nuclear structure and radioactivity	Be able to describe typical types of radiation and their properties.	Radiation
	Be able to explain the half-life and stability of radioactive elements.	Half life (in physical chemistry)
	Understand fission and fusion and be able to explain their energy applications.	Fission and fusion
Chemical bonding and molecular structure	Be able to explain covalent, ionic and metallic bonding.	Covalent, ionic and metal bonding
	Be able to explain covalent bonding from the valence bond method (VB method) and molecular orbital method (MO method) for representative molecules.	Valence bond method (VB method), molecular orbital method (MO method)
	Be able to explain the formation of mixed orbitals from the electron configuration.	Composite orbit

	Be able to explain hydrogen bonding, coordination bonds and van der Waals forces.	Hydrogen bonding, coordination bonds, van der Waals forces.
Solid structure	Basic calculations such as packing structure, packing ratio and ionic radius ratio of crystals can be performed.	Filling structure, filling ratio and ionic radius ratio
	Describe metallic, ionic and covalent crystals.	Metallic crystals, ionic crystals, covalent crystals
Chemistry of complexes	Be able to explain terms used in complex chemistry (e.g. central atom, ligand, chelate, coordination number).	Central atom, ligand, chelate, coordination number.
	Can be named according to the nomenclature of complexes.	Naming of complexes
	Be able to explain the coordination number and structure.	coordination number
	Be able to describe the properties of typical complexes (e.g. color, magnetism).	Properties of complexes
Inorganic substance	Be able to describe the properties of single and compound compounds of typical elements.	Properties of inorganic substances

V-E-3 Analytical chemistry

[Learning achievement goals]		
1 Goals		
This educational area comprises subjects that teach theories and methods for analyzing substances (atoms, ions, molecules, single substances, compounds, etc.) required in all fields of chemistry, the environment, materials development and biology.		
(1) Be able to calculate units as a way of expressing physical quantities.		
(2) Be able to explain changes of state due to chemical reactions (e.g. precipitation formation, complex formation, ionization) and physical phenomena, and perform the necessary quantitative calculations.		
(3) Understand the purpose and characteristics of standard instrumental analysis and be able to make a choice according to the analytical target.		
It should be noted that some of the achievement objectives can be effectively understood (acquisition of practical skills) by or in conjunction with analytical or instrumental analysis experiments.		
2 Common course titles		
Analytical chemistry, Instrumental analysis		
Learning contents	Achievement goals	Guideline items for study
Qualitative analysis	Describe chemical reactions for the qualitative analysis of some representative cations and anions.	Qualitative analysis of cations and anions.
Chemical equilibrium	Understand ionization equilibrium and active mass and be able to perform calculations on the amount of substance.	Ionization equilibrium, activity
	Understand solubility and solubility product and be able to make the necessary calculations.	Solubility, solubility product
	Understand how to separate substances by precipitation and be able to calculate precipitation volumes from stoichiometry.	Gravimetric analysis
	Be able to explain the various equilibria for strong acids, strong bases and weak acids and bases.	Acid-base equilibrium
	Calculate the pH of strong acids, strong bases, weak acids, weak bases, salts of weak acids and salts of weak bases.	pH (measure of acidity)
	Explain the relationship between buffer solutions and pH.	Buffer solution
	Be able to explain the formation of complexes.	Formation of complexes
Chemical analysis	Understand chemical reactions involving cations and anions and be able to calculate the concentration of substances in solution (quantitative calculations).	Stoichiometry
	Understand the principles of neutralization titration and be able to calculate acid and base concentrations.	Neutral titration
	Understand the principles of redox titration and be able to calculate concentrations of oxidizing and reducing agents.	Oxidation-reduction titration
	Understand the principles of chelatometric titration and be able to calculate the concentration of metal ions.	Chelatometric titration
Photoanalytical method	Understand optical absorption and be able to describe typical analysis methods.	Spectroscopic analysis

	Calculations based on Lambert-Beer's law can be performed.	Lambert-Beer's law
Other analytical methods.	Outline the methods of separation by ion exchange.	Ion exchange laws
	Describe analytical methods using solvent extraction.	Solvent extraction method
Instrumental analysis	Be able to describe typical structural, qualitative and quantitative analytical methods for inorganic and organic substances.	Instrumental analysis (principles)
	Understand how to analyze gases, liquids and solids using specific analytical equipment and be able to analyze data based on measurement examples.	Instrumental analysis (data analysis)

V-E-4 Physical chemistry

[Learning achievement goals]		
1 Goals		
As theoretical chemistry, this subject provides an understanding of the three pillars of physical chemistry: structure and properties, equilibrium and kinetics.		
This course covers the basics of physical chemistry, with a focus on thermodynamics.		
(1) Understand the properties of gases and be able to perform relevant calculations.		
(2) Be able to calculate the molecular weight of a solute from its freezing point depression, boiling point rise, osmotic pressure, etc.		
(3) Be able to explain the first, second and third laws of thermodynamics and perform relevant calculations.		
(4) Be able to explain chemical equilibrium and perform relevant calculations.		
(5) The reaction rate can be explained and relevant calculations can be made.		
(6) Be able to explain typical chemical batteries.		
(7) Understand the significance of quantum chemistry and explain its role.		
2 Common course titles		
Physical chemistry		
Learning contents	Achievement goals	Guideline items for study
Properties of gases	Understand gas laws and be able to explain the ideal gas equation.	Equation of state of an ideal gas
	From the molecular kinetic theory of gases, define pressure and prove the ideal gas equation.	Equation of state of an ideal gas
	Be able to describe the characteristics of real gases and the equation of state.	Equation of state of real gases.
	Be able to describe critical phenomena and the characteristics of the vicinity of the critical point.	Critical phenomenon
	Be able to calculate the partial pressure of a gas mixture.	Dalton's law
Properties of mixtures	Be able to explain the bundle-integral property.	Phase equilibrium
	The molecular weight of a solute can be calculated from the freezing point depression and boiling point rise.	Freezing point depression, boiling point increase
	From the osmotic pressure, the molecular weight of the solute can be calculated.	Osmotic pressure
	Understand the definition of phase law and be able to calculate the degrees of freedom (temperature, pressure and composition) of pure substances and mixtures and describe the equilibrium state.	Homologous
Thermodynamics	Define and explain how to apply the first law of thermodynamics.	First law of thermodynamics
	Define and explain how to apply the second and third laws of thermodynamics.	Second law of thermodynamics, third law of thermodynamics.
	Be able to define enthalpy and explain how it is applied.	Enthalpy
	Be able to perform calculations related to enthalpy.	Standard enthalpy of generation, Kirchhoff's law.
	Be able to calculate internal energy changes, work and heat associated with various changes in gases.	Internal energy changes, work, heat.
	Be able to define and apply internal energy and heat capacity.	Internal energy, heat capacity

	Can perform calculations related to entropy.	Absolute entropy, entropy change.
	Gibbs energy can be calculated.	Standard generating free energy
Chemical equilibrium	Be able to explain the laws of chemical equilibrium.	Law of chemical equilibrium (Le Chatelier's principle)
	Be able to explain Le Chatelier's principle.	Le Chatelier's principle
	Be able to explain the equilibria of homogeneous reactions and phase equilibria (phase diagrams) of heterogeneous systems.	Equilibrium of homogeneous reactions, phase equilibria of heterogeneous systems.
	The equilibrium constant and composition can be calculated from the Gibbs energy change in the reaction.	Gibbs energy, equilibrium constant, equilibrium composition.
	The temperature dependence of the equilibrium constant can be calculated.	Temperature dependence of equilibrium constants
Reaction velocity	Understand the definition of reaction rates and be able to explain how they are experimentally determined.	Reaction velocity
	Understand the concepts of reaction rate constants and reaction orders and be able to obtain them by calculation.	Reaction rate constants, reaction order
	Understand the temperature dependence of the reaction rate and be able to determine it by calculation.	Arrhenius formula, activation energy.
Quantum chemistry	Understand the significance of quantum chemistry and be able to explain the role it has played.	Atomic spectrum, photoelectric effect.
	Be able to explain the role of the Schrodinger equation.	Schrodinger equation

V-E-5 Chemical engineering

[Learning achievement goals]		
1 Goals		
This educational area consists of subjects for studying the equipment and instruments used in chemical plants that support the chemical industry, and the chemical reactions and physical phenomena therein.		
(1) Understand the basic content of chemical engineering stoichiometry (units, material balance, etc.) and unit operations, and be able to perform various calculations.		
(2) The student has a basic understanding of basic equipment and unit operations in chemical plants, such as fluid transport and reactors.		
2 Common course titles		
Chemical engineering		
Learning contents	Achievement goals	Guideline items for study
Matter balance	Able to convert units to SI units.	SI units, unit conversion
	Understand the difference between circular and continuous operations and be able to explain their characteristics and uses.	Batch operation, continuous operation, batch reactors, tube reactors
	Be able to calculate the material balance of a process with and without chemical reactions.	Material balance, stoichiometric equations, reaction rates
Heat transfer	Be able to calculate heat and temperature changes in chemical processes.	Heating, cooling, latent heat, sensible heat, reaction heat, heat balance, heat exchange
	Understand and explain the differences in heat transfer modes.	Conduction heat transfer, convection heat transfer and radiation heat transfer.
Liquid and gas flows	Can calculate the velocity and flow rate of fluid through a pipe.	Volume flow, mass flow, velocity and continuity equations
	The Reynolds number can be calculated to determine whether the flow state is laminar or turbulent.	Reynolds number, laminar flow, turbulence.

	Understand the energy balance of the flow and be able to calculate energy losses and fluid transport dynamics.	Energy balance, Bernoulli's equation, energy loss, friction loss, Fanning's equation, power
Separation and purification of substances	Understand monodistillation and continuous distillation systems and be able to explain their principles.	Single distillation, continuous distillation, vapor-liquid equilibrium, Raoult's law, relative volatility.
	Be able to perform calculations on distillation using Rayleigh's equation and the McCabe-Siele method.	Rayleigh's equation, McCabe-Siele method, distillate composition, theoretical number of stages, annulation ratio, feedstock feed stage
	Understand the purpose and methods of basic extraction and be able to calculate extraction rates etc.	Single extraction, multiple extraction, triangulation diagram, extraction rate

V-E-6 Biological chemistry

[Learning achievement goals]		
1 Goals		
Biochemistry is the field of explaining life phenomena and biological substances by means of chemistry, and is the basis not only of biotechnology, which has been developing rapidly in recent years, but also of industrial technology involving a wide range of living organisms. Biochemistry includes the biochemistry of biological substances and the content of enzymes and metabolism, and it is necessary to be able to understand both in relation to each other. The course aims to achieve the following.		
(1) Explain carbohydrates, proteins, nucleic acids and lipids, linking their functions in vivo to their chemical structure and properties.		
(2) Understand the role and properties of enzymes and their role in living organisms, and be able to explain the Michaelis-Menten equation based on enzyme reaction kinetics.		
(3) Explain the link between changes in matter and energy input/output in metabolism.		
2 Common course titles		
Biochemistry, Biochemistry, Basic biology		
Learning contents	Achievement goals	Guideline items for study
Sugar	Give examples of monosaccharides and polysaccharides and be able to explain their biological functions.	Monosaccharides and polysaccharides
	Be able to describe the chemical structure of monosaccharides and explain the various isomers.	Chemical structure of monosaccharides
	Be able to explain glycosidic linkages.	Glycosidic bond
Lipid	Multiple functions of lipids can be listed.	Lipid functions.
	Can explain the structure of triacylglycerols. Can explain the structure of fatty acids.	Structure of fatty acids
	Be able to describe the micelles and lipid bilayers created by phospholipids and explain the chemical properties of biomembranes.	Structure of biological membranes
Protein	Be able to name the functions of proteins and explain that proteins are central to life activities.	Protein function.
	Be able to name the amino acids that make up proteins and describe the characteristics of their side chains.	Amino acid
	Be able to explain the structure of amino acids and the formation of peptide bonds using structural formulas.	Peptide
	Be able to explain that proteins take on higher-order structures through chemical bonds (e.g. hydrogen bonds, ionic bonds, hydrophobic interactions).	Chemical bonds and higher-order structures of proteins.
Nucleic acids and the expression of genetic information.	Be able to describe the different types of nucleic acids and their nucleotide structures.	Types of nucleic acids, nucleotide structures.
	Be able to explain the double helix structure of DNA, complementary binding of bases and semi-conservative replication of DNA.	DNA duplexes, semi-conservative replication of DNA.
	Be able to list the types of RNA and their functions.	Types and functions of RNA

	Be able to explain the relationship between genomes and genes.	Genomes and genes
	Be able to explain the cell cycle.	Cell cycle
	Differentiation can be explained.	Differentiation
	Be able to give an overview of central dogma, transcription and translation and protein expression.	Central dogma, protein expression.
Enzyme	Be able to describe the properties of enzymes (substrate specificity, optimum temperature, optimum pH and substrate concentration).	Nature of enzymes.
	Be able to explain the Michaelis-Menten equation based on enzyme reaction kinetics.	Enzyme reaction kinetics, significance of Km and Vmax
Bioenergetics and metabolism	Be able to explain the role of ATP as the currency of energy for vital activities.	Role of ATP
	Provide an overview of the glycolytic system, β -oxidation and citric acid circuits.	Glycolytic system, beta-oxidation, citric acid circuit
	Be able to explain the synthesis of ATP in the oxidative phosphorylation process.	Respiratory chain
	Be able to explain the process of anaerobic respiration (alcoholic and lactic acid fermentation).	Anaerobic respiration
	Understand the mechanism of photochemical reactions and be able to outline the mechanism.	Photosynthesis
	Be able to explain the process of carbonic acid fixation.	Carbonic acid fixation
	Be able to describe the general processes of photosynthesis and respiration and explain the relationship between the two processes.	Assimilation and dissimilation

V-E-7 Biotechnology

[Goals to be achieved in the educational area		
1 Goals		
The aim is to learn about cell structure, properties of micro-organisms and their handling, metabolism and its uses, and genetic engineering as a basis for bioengineering.		
(1) Understand the types and characteristics of cell organelles and be able to explain the structure of cells.		
(2) Understand the mechanisms for maintaining homeostasis in living organisms and be able to explain the techniques applied.		
(3) Understand the growth of micro-organisms and be able to explain culture methods.		
(4) Be able to explain the use of micro-organisms, animal and plant cells, etc.		
(5) Understand the principles of genetic engineering and be able to explain how it can be applied.		
2 Common course titles		
Basic microbiology, Biotechnology, Biotechnology		
Learning contents	Achievement goals	Guideline items for study
Cellular and biological homeostasis	Describe the types and characteristics of prokaryotes and eukaryotes.	Eukaryotes, prokaryotes.
	Describe the structure and function of the nucleus, mitochondria, chloroplasts, plasma membrane, cell wall and vacuole.	Organelle
	Be able to explain the mechanisms of homeostasis in cells and the body.	Homeostasis in the body
	Be able to explain the mechanisms of biological defense by the immune system and their application in medicine, including vaccines.	Biological defense, immune system, vaccines.
Microbial growth and culture	Be able to explain microbial growth (growth curves).	Microbial proliferation
	Be able to describe microbial breeding methods.	Mutation, cell fusion
	Be able to describe the culture methods of micro-organisms and explain safety measures.	Microbial culture, biohazard.
Use of micro-organisms, animal	Be able to explain the relationship of micro-organisms to liquor production and food processing.	Fermentation production, food processing

and plant cells, etc.	Give examples of medicines and bioactive substances and be able to explain how they are produced using micro-organisms, animal and plant cells, etc.	Antibiotics, pharmaceuticals and bioactive substances
	Be able to explain wastewater treatment and bioremediation using micro-organisms.	Bioremediation
Genetic engineering	Be able to explain the principles of genetic engineering (e.g. genetic modification and PCR).	Genetic recombination technology, PCR.

3-1.6 V-F Construction sector

V-F-1 Surveying

[Learning achievement goals]		
1 Goals		
In the surveying system area, students understand the construction, adjustment and use of various surveying instruments and equipment, and acquire basic knowledge and skills in surveying through the study of various basic types of surveying, as well as developing the ability to apply this knowledge to the design and construction of works.		
(1) In the field of surveying, competence in the various surveying methods, mainly used in planimetric surveying, as indicated above.		
(2) In the field of applied surveying, competence in the various surveying methods used primarily in geodetic surveying, as indicated above.		
2 Common course titles		
Surveying, Applied surveying, Spatial information engineering, Remote sensing, Applied mathematics		
Learning contents	Achievement goals	Guideline items for study
Classification of surveying, legislation	Explain the purpose of surveying, classification by size of surveyed area, classification by method of surveying and classification of surveying by law.	Reference points, basic surveying, public surveying, survey law.
	Be able to explain the surveying system (e.g. national datum points).	Triangles, level points, plane rectangular coordinate system
Distance surveying	Be able to explain the errors made in surveying with a tape measure and make calculations from survey results.	Reading error, characteristic value compensation, temperature compensation, tension compensation
	Explain distance surveying by lightwave and radio waves.	phase contrast
Angle measurement	Be able to explain the methods of angular surveying, the handling of errors in measurement and be able to make calculations from survey results.	Single-measurement method, double-measurement method
Traverse survey	Be able to explain the types of traverse surveys and how they are calculated.	Closed traverse, coupled traverse, closed difference, closed ratio
Levelling	Be able to explain the method of direct levelling by elevation or instrument height and the handling of errors that occur, and be able to calculate them from the survey results.	Elevated, vessel-height type
Calculating area and volume	Can calculate area and volume from measurement results.	Coordinate method, shunt method, section method, point height method
Topographical survey	Be able to explain topographic surveying methods.	Frame surveying, detail surveying
	Explain the nature of contour lines and their use.	Principal curves, total curves
Route survey	Explain monocenter curves, relaxation curves and longitudinal curves.	Monocenter curves, relaxation curves, longitudinal curves
Photographic surveying	Be able to explain the principles and methods of photogrammetry.	Overlap, side-lap, mutual and absolute identification.
GNSS surveying	Explain the principles of GNSS surveying.	Single positioning method, relative positioning method.
Error theory, mathematics used in surveying	Be able to explain how to round significant figures and numbers, and perform calculations that take this into account.	Significant figures, rounding of numbers
	Be able to explain the principle of the least-squares method and perform calculations taking this into account.	Error theory, error propagation

V-F-2 Material

[Learning achievement goals]		
1 Goals		
The materials area develops the ability to understand the manufacturing methods, composition and properties of the main materials used in civil engineering, to select materials appropriately for their intended use, and to utilize materials in a planned and economical manner.		
(1) In the field of materials, the applicant shall have the competencies indicated above in relation to all the main materials used in construction works.		
(2) In the field of concrete, in addition to achieving the above objectives in greater depth, particularly with regard to concrete, be able to perform design calculations for concrete structures.		
2 Common course titles		
Construction materials science, Concrete engineering, Construction composite materials, Concrete structural science, Reinforced concrete		
Learning contents	Achievement goals	Guideline items for study
Basic properties of materials	Explain terms and definitions relating to mechanical and physical properties required of materials.	Strength, weight, heat
Metallic materials	Be able to describe the types and shapes of steel.	JIS standard
	Explain the mechanical properties of steel with regard to stress-strain relationships, yield stress, tensile strength and modulus of elasticity.	Stress-strain relationships, yield stress, tensile strength, modulus of elasticity
Cement, aggregates and admixture materials	Be able to describe the physical and chemical properties of cement.	Setting and hardening, weathering, hydration reactions, heat of hydration
	Be able to explain the characteristics and uses of various types of cement.	Portland cement, mixed cement
	Be able to describe the water content, density, grain size and actual volume fraction of aggregates.	Water absorption, unit volumetric mass
	Be able to describe the types and characteristics of aggregates.	Crushed stone, slag aggregate
	Be able to describe the types and characteristics of admixtures and admixtures.	AE agents, fly ash
Concrete	Explain the advantages and disadvantages of concrete.	Strength properties, economic efficiency, quality control
	Explain the workability, slump and air content of fresh concrete.	Consistency, plasticity and finishability.
	Explain the compressive strength, stress-strain curve, modulus of elasticity and drying shrinkage of hardened concrete.	Compressive strength, stress-strain curves, modulus of elasticity and drying shrinkage creep of hardened concrete.
	Be able to explain frost damage, alkali-silica reaction, neutralization and salt damage with regard to the durability of hardened concrete.	Frost damage, alkali-silica reaction, neutralization, salt damage
	Understand and be able to calculate formulation design procedures.	Indicated blending, on-site blending.
Concrete structure	Be able to describe the structure and features with regard to reinforced and prestressed concrete.	Reinforced concrete structures, method of introducing prestressing, structural details.
	Be able to explain the allowable stress design method and limit state design method, which are typical design methods for concrete structures.	Verification, safety, usability, durability
	Be able to describe the failure modes of members subjected to bending moments and consider their safety against sectional failure.	Balanced rebar ratio, types of bending failure, equivalent stress blocks, bending capacity.
	Calculation of cross-sectional stresses in members subjected to bending moments and safety against cracking can be considered.	Converted section, bending stress, allowable crack width

	Be able to describe the failure modes of members subjected to shear forces and consider their safety against shear forces.	Shear reinforcement, types of shear failure, shear capacity.
Maintenance	Explain the basics of maintenance, non-destructive testing, repair and reinforcement of concrete structures.	Performance requirements for maintenance, repair and reinforcement methods.

V-F-3 Structure

[Learning achievement goals]		
1 Goals		
In the structural systems area, students understand basic theories and other aspects of mechanics, learn how to calculate stresses and deformations acting on structures, etc., and develop the ability to apply this knowledge to the design of various structures.		
(1) In the field of mechanics, the user shall be able to calculate the reaction forces and the stresses and deformations occurring inside the structure in response to external forces acting on the construction or building structure.		
(2) In the various structural disciplines, be able to explain the basic structural mechanisms and design procedures.		
2 Common course titles		
Structural mechanics, Basic mechanics, Applied mechanics, Bridge engineering, Steel structure engineering		
Learning contents	Achievement goals	Guideline items for study
Cross-sectional quantities	Understand the definition of the cross-sectional primary moment and be able to calculate the figure center.	Cross-sectional primary moment, figure center, cross-sectional secondary moment, sectional coefficient, cross-sectional secondary radius
	Understand the definitions of sectional secondary moment, sectional coefficient and sectional secondary radius and be able to calculate them.	
Static needle	It is possible to calculate the reaction forces at the fulcrum of various static flanges, calculate the sectional forces (axial forces, shear forces and bending moments) occurring in the section and draw the sectional force diagrams (axial force diagrams, shear force diagrams and bending moment diagrams).	Simple, cantilevered, overhanging and gerber flaps, concentrated loads, distributed loads, moment loads, axial forces, shear forces and bending moments.
Truss	Explain the types of trusses and their components and their stability.	Nodal method (grid method), sectional method
	Be able to calculate member forces of trusses using the nodal and sectional methods.	
Influence line	Lines of influence for fulcrum reaction forces, bending moments and shear forces can be drawn and used to calculate fulcrum reaction forces and sectional forces.	Fulcrum reaction forces, shear forces, bending moments, axial forces of trusses, continuous loads.
Jing Jing Ramen	Calculate the fulcrum reaction forces and sectional forces (axial forces, shear forces and bending moments) of a ramen and draw its sectional force diagrams (axial force diagrams, shear force diagrams and bending moment diagrams).	Axial forces, shear forces and bending moments
Stress and strain	Understand the definitions and relationships between stress and strain and be able to calculate stresses and strains in members subjected to axial forces. Be able to explain the definitions of modulus of elasticity, Poisson's ratio and Hooke's law.	Stress, strain, modulus of elasticity, Poisson's ratio, Hooke's law, shear modulus.
	Calculate the bending and shear stresses in the cross section of a member subjected to bending deformation.	Neutral plane, neutral axis, radius of curvature, edge stresses
Deflection of a needle	From differential equations and boundary conditions relating to beam deflections, it is possible to calculate beam deflections and deflection angles.	Curvature, solution by second-order differential equations, solution by fourth-order differential equations, elastic loading method, conjugate burr.

Pillar	Be able to describe buckling modes based on support conditions for long columns subjected to compressive forces and calculate Eulerian buckling loads.	Slenderness ratio, effective buckling length
	The stresses in short columns subjected to eccentric loads can be calculated.	Eccentricity distance, nucleus
Work and Energy Act.	Explain how to determine the deformation of a static structure using the virtual work principle.	Virtual work principle, strain energy, unit load method, Castigliano's theorem.
Non-stationary structure	Be able to discriminate between stable and unstable, static and non-stationary structures and calculate non-stationary orders.	nonstationary order
	Explain how to solve for non-stationary structures using the stress and displacement methods.	Remaining force method, triple moment method, deflection angle method, matrix method.
Bridge engineering	Explain the types of bridges, the types of members they comprise and the loads to be considered in their design.	Plate girder bridges, composite girder bridges, truss bridges, dead loads, live loads
	Be able to give an overview of the design methods used in the Specification for Highway Bridges and be able to perform design calculations for members subjected to various forces.	limit state design method
	Be able to explain design methods for members subjected to axial forces or bending, and members subjected to axial forces and bending, and calculate for simple examples.	
	Be able to explain the types and principles of steel joining.	Welded joints, high-strength bolted joints

V-F-4 Geotechnical

[Learning achievement goals]		
1 Goals		
The geotechnical area develops basic knowledge of the engineering properties of soils, an understanding of the theory of soil mechanics, methods for calculating stress, deformation and stability of soils, and the ability to apply this knowledge to the design and construction of construction works.		
(1) In the field of soil mechanics, be able to use the basic properties of geomaterials, hydraulic properties in the ground and soil mechanics to understand ground deformation and apply it to ground stability analysis.		
2 Common course titles		
Soil mechanics, Geomechanics, Geotechnical engineering		
Learning contents	Achievement goals	Guideline items for study
Basic properties of geomaterials	Be able to explain the formation, basic physical quantities and structure of soil.	Pore volume and moisture content indicators, density indicators
	Understand soil grain size, grain size distribution and consistency and apply them to the engineering classification of geomaterials.	Particle size additive curve, liquid limit, plastic limit
	Be able to describe the compaction characteristics of soils.	Compaction curves, optimum moisture content ratio
Hydraulics in the ground	Explain Darcy's law, hydraulic conductivity and permeability testing.	Indoor permeability tests, on-site permeability tests
	Explain the phenomenon of seepage fracture caused by permeability.	Boiling
Mechanical properties of soil	Be able to describe soil shear tests.	Uniaxial shear test, triaxial compression test, uniaxial compression test
	Explain the shear properties of soils.	Shear properties of clays and sands.
	Explain the soil failure criterion.	Maul Coulomb's destruction criterion.
Ground	Be able to explain the stresses in the ground.	Boucinescu's solution.

deformation	Explain the principle of effective stress.	Effective stress
	Be able to explain soil consolidation phenomena and one-dimensional consolidation theory.	Terzaghi's consolidation theory
	Be able to explain the amount and time of consolidation settlement.	Compressive properties of clays
Ground stability analysis	Be able to explain Rankine and Coulomb earth pressures and apply them to earth pressure calculations.	Coefficient of active earth pressure, coefficient of passive earth pressure
	Be able to explain the different types of foundations and their bearing capacity formulae and apply them to the calculation of bearing capacity of earth structures.	Bearing capacity
	Be able to explain slope stability calculation methods and apply them to the calculation of factors of safety etc.	Safety factor
Dynamic properties of soil	Be able to explain liquefaction mechanisms in saturated sand.	Liquefaction
geotechnical survey	Be able to explain the classification and content of geotechnical investigations.	Drilling, sounding

V-F-5 Hydraulic

[Learning achievement goals]		
1 Goals		
The hydrological area develops the ability to understand the physical properties of water and the basic theories and calculation theories of hydrostatics and hydrodynamics, to learn how to calculate flows and to use this knowledge for issues related to flood control, water use and the environment.		
(1) The hydraulic field should be able to explain hydrostatic pressure and the theory of flow in pipe and open channels.		
(2) In the field of rivers, the student should understand the basic properties of river flow, be able to calculate runoff and hydrological quantities, and explain various river issues related to flood control, water use and the environment.		
(3) The coastal field should be able to explain the basic properties of waves.		
2 Common course titles		
Hydraulics, River engineering, Hydrology, Water resources engineering, Coastal engineering		
Learning contents	Achievement goals	Guideline items for study
Properties of water	Be able to explain the system of units used in hydraulics.	Specific gravity, viscosity coefficient, kinematic viscosity coefficient
Hydrostatics	Be able to explain hydrostatic and total water pressure and calculate the magnitude and point of action of total water pressure acting on planar and curved surfaces.	Water pressure, total water pressure, manometers, differential pressure gauges
	Can calculate buoyancy and stability of floating bodies.	Center of buoyancy, draft, inclination
Basic flow theory	Explain the continuity equation.	Steady and unsteady flow, flow product, cross-sectional mean velocity
	Be able to explain Bernoulli's theorem and apply it to calculations.	Total and individual water heads, Torricelli's theorem, Pitot tube, Venturi meter.
	Be able to explain the law of conservation of momentum and apply it to calculations.	Forces acting from fluid
Normal and projectile currents	Be able to explain specific energy, Froude number, normal and projectile flow, critical water depths and the phenomenon of water jumping.	Specific energy, number of fluids, critical depth, specific power
Laminar and turbulent flows	Be able to explain laminar and turbulent flows and losses due to fluid friction.	Reynolds number, limiting Reynolds number, friction loss coefficient, D'Arcy-Weisbach equation.
Steady flow in piped waterways	Be able to explain various loss coefficients other than friction in a pipe channel and calculate the flow in a pipe channel.	Various types of lost hydraulic head, single-tube conduits, siphons

Steady flow in open channels	Be able to explain equal and unequal flow in open channels and calculate equal flow (mean velocity formula, equal depth of flow).	Mean velocity formulae, isostatic depths, water surface profile of unequal flows.
Fluvial geomorphology.	Be able to explain river management and maintenance, river classification and catchments.	Changes in the River Act, definition of water systems under the River Act, river action and landforms.
River hydrology.	Be able to explain the water cycle, rainfall characteristics and hydrological quantities in our country.	Hydrological cycle, global warming issues, runoff phenomena, basin-averaged rainfall.
Rivers and flood control	Be able to explain how river channels and dams can be used to prevent flooding and urban flooding.	Planned rainfall, probability year, inland water treatment, basin flood control
Rivers and water diversion	Be able to explain the current status of water resources in Japan.	Changes in water use planning, conservation of water quality.
river structure	Explain the role of river embankments, revetments and water controls.	River structures, types and functions of embankments, names of various parts of embankment cross-sections.
coastal disaster prevention	Explain the basic properties of waves and the characteristics of tsunamis and storm surges.	Wavelength, wave speed, tsunami propagation and storm surge generation mechanisms.

V-F-6 Environment

[Learning achievement goals]		
1 Goals The environmental system area develops the ability to understand basic knowledge about global environmental problems and pollution, to acquire methods for social infrastructure projects to eliminate and prevent these problems, and to use this knowledge for issues such as water pollution, water purification and waste.		
2 Common course titles Environmental engineering, Sanitary engineering, Water and wastewater engineering, Environmental assessment, Geo-environmental studies, Environmental hygiene engineering, Environmental protection engineering		
Learning contents	achievement goals	Guideline items for study
Global environmental issues	Be able to explain global environmental issues.	Global warming, developing countries, resource issues.
Environment and human health	Be able to explain the relationship between pollution and human health, and between the environment and human health.	Environmental factors and diseases, practical examples.
water pollution	Explain indicators of water pollution.	DO, SS, BOD, nitrogen
	Be able to explain the sources and transfer processes of water pollutants and calculate them, including source units and generated loads.	Point sources, surface sources, various loads
	Explain water quality transformation processes related to aquatic ecosystems and self-purification, eutrophication and bioaccumulation.	Independence, heterotrophy and Streeter-Felpes formula.
	Be able to explain the current status of water pollution and prevention measures.	Environmental standards, Water Pollution Control Act.
Waterworks	Be able to explain the role and types of water supply in Japan.	Water Supply Law
	Understand and be able to calculate water supply plans relating to basic planning, water supply, water quality and water pressure.	Planned average daily water supply, water quality standards, various facilities
	Describe the unit operations of water purification relating to flocculation, sedimentation, filtration and disinfection.	Stokes formula, flocculants, rapid filtration, chlorine.
Drainage system	Be able to explain the role of sewage systems, their current status and the types of sewage treatment and maintenance.	Sewerage law, sewerage-like facilities.

	Be able to explain the basic planning and facility planning of the sewerage system and the composition of the sewerage system, and be able to perform calculations relating to this.	Sewage volume, rainwater volume, influent load
	Explain the basics of aerobic biological wastewater treatment.	Activated sludge process, operating factors.
	Be able to explain sludge treatment and disposal.	Physical treatment, biological treatment, VSS/SS, effective use
Air pollution	Be able to explain the current situation and sources of air pollution.	environmental standard
Noise and vibration	Be able to explain the current situation and sources of noise.	Environmental standards, sensory pollution.
Waste	Be able to explain the current state and sources of waste.	Definition of waste according to the Waste Disposal and Public Cleaning Act.
	Be able to explain waste collection, treatment and disposal.	Separation, reclamation, recycling, landfill
	Be able to explain the measures taken to prevent illegal dumping, reduce and recycle waste through policies.	Manifest system, Basic Law on the Promotion of a Recycling-oriented Society
Environmental impact assessment	Be able to explain the objectives, indicators, sequence and examples of environmental impact assessment.	Environmental Impact Assessment Act
	Be able to explain risk assessment.	Hazard Management
	Explain life cycle assessment.	Environmental burden
Ecological engineering	Be able to explain the current state of biodiversity and the crisis.	Red List, causes of degradation.
	Explain the relationship between the material cycle and living organisms.	Carbon, nitrogen.
	Be able to explain conservation measures through ecosystem conservation methods and measures.	Biodiversity Basic Act
Soil pollution	Be able to explain the current status of soil contamination.	Environmental standards, forms of hazardous substances present.

V-F-7 Plan

[Learning achievement goals]		
1 Goals		
The planning area develops the ability to understand the origins of land, regions and cities, to acquire methodologies and statistical calculation methods for urban and transport planning, and to use this knowledge in planning the development of social infrastructures.		
(1) In the planning field, students should understand the history of national, regional and urban planning and be able to explain the methods used to plan for future land use, transport and disaster prevention		
(2) In the field of roads, the student should understand the characteristics of traffic and be able to explain the criteria required for road design.		
(3) In the field of mathematical planning, the student should be able to explain the statistical calculation methods required for urban planning and traffic planning.		
2 Common course titles		
Urban planning, Regional planning, Actuarial planning, Road engineering, Traffic planning, Pavement engineering		
Learning contents	Achievement goals	Guideline items for study
Land, regional and urban concept	Be able to explain the position of national (land) planning, regional planning and urban planning.	Spatial planning, regional planning, urban planning
Changes in urban and eco-urban planning	Be able to explain the historical evolution of urban planning in Japan and the rest of the world.	Ancient urban planning, medieval urban planning, modern urban planning.
Relevant Japanese land, regional and urban planning legislation.	Be able to explain the legislation relating to urban planning.	Urban planning laws, urban planning related laws

Regional and urban planning procedures (formulation)	Be able to explain the master plan.	Comprehensive plans, urban planning master plans, urban planning area master plans
Land use planning	Be able to explain urban planning zones, zoning and zoning districts.	Urban planning zones, urbanization zones, urbanization control zones, use zones
Traffic and transport facility planning	Be able to explain the methods of traffic flow studies, traffic flow studies and traffic demand estimation.	Traffic volume surveys, speed surveys, person trip surveys, vehicle OD surveys, four-stage estimation method
Park green space planning	Be able to explain the planning of parks and green spaces.	Urban parks, green spaces and green basic planning
Disaster prevention and landscaping plans.	Be able to explain the concept of landscape planning.	Landscape element
	Be able to explain urban disaster risk reduction structuring.	Fire zones, local disaster management plans.
Urban development methods	Land readjustment projects can be explained.	Reduction, conversion and reservation of land
	Be able to explain urban redevelopment projects.	Conversion of rights, rights floors, reserved floors
Road plan	Be able to explain traffic volume and traffic capacity as various quantities that describe the characteristics of traffic flows.	Traffic volume, traffic capacity
Probability statistics and statistical treatment	Explain the concept of statistical hypothesis testing using probability distributions and probability distributions for urban and transport planning.	Binomial distribution, Poisson distribution, normal distribution, Gumbel distribution, simultaneous probability density function
Optimization technique	Be able to explain the diagrammatic and simplex methods as linear programming methods.	Illustrative and simplex methods in linear programming.
Evaluation	Be able to explain the concept of cost-benefit analysis.	Present value, social discount rate

V-F-8 Construction and legislation

[Learning achievement goals]		
1 Goals The construction system area develops the ability to understand various construction machinery and materials and construction methods and regulations in civil engineering works, to acquire management methods for quality, cost, process, safety and health and the environment, and to use these methods to guide and supervise construction work. (1) In the area of management, trainees should be able to explain the management methods for quality, cost, process, health and safety and the environment. (2) In the field of construction, be able to give an overview of earthworks, foundation works, concrete works and tunneling.		
2 Common course titles Construction management, Civil engineering construction, Construction management studies		
Learning contents	Achievement goals	Guideline items for study
General remarks	Be able to explain each process of construction execution.	Tenders, legislation
Construction management	Be able to explain the basics of construction planning, quality control, cost control, process control, health and safety management and environmental management.	Budgeting, costing, process charts, noise
Construction machinery	Be able to give an overview of construction equipment and methods for calculating working capacity.	Bulldozers, backhoes and work capacity calculation methods.
Earthworks	With regard to earthworks, be able to explain the purpose, methods of cut and fill works.	Excavation, haulage, filling and compaction

Foundation works	Be able to explain the purpose and construction methods for each type of foundation works.	Direct foundations, pile foundations
Concrete works	With regard to concrete works, explain the purpose, formwork, reinforcement, scaffold support and pouring works.	Quality control, compaction and curing
Tunnel construction	Be able to explain the purpose and construction methods of tunnel construction.	Mountain tunneling method, shield tunneling method

V-F-9 Drafting

[Learning achievement goals]		
1 Goals		
The drafting and drawing area develops the ability to understand the fundamentals of drafting and civil engineering conventions, to learn how to draw and calculate designs, and to use this knowledge and skill in the design and drafting of structures.		
(1) The drawing and drafting area should be able to use drafting tools or CAD to explain how to draw lines, fill in dimensions and letters, and represent and project structures.		
(2) In the CAD field, the student should be able to understand the basic operation of the software and be able to create, modify and print two-dimensional drawings.		
(3) In the field of design and drafting, the student should understand the conventions of civil engineering drafting and be able to express the design and drafting of structures based on guidelines.		
2 Common course titles		
Graphics, Drawing		
Learning contents	Achievement goals	Guideline items for study
How to draw diagrams	Explain line types, text, drawing content and drawing methods.	Dimensions, scale, layout, each drawing and drawing method.
CAD	Be able to explain the functions and use of CAD software.	Tool.
	The designs can be drawn and used in CAD software.	Drawing, modification of graphic elements, layer management
Design and drawing	Be able to design and draft a design based on given conditions.	Design calculation

3-1.7 V-G Architectural fields

V-G-1 Material

[Learning achievement goals]		
1 Goals The materials (construction) area is to develop the ability to understand the manufacturing methods, composition and properties of the main materials used in buildings, to select materials appropriately for their intended use, and to utilize materials in a planned and economical manner. (1) In the structural materials field (wood, concrete and metal), the student should be able to understand structural performance in particular and explain the factors necessary to achieve the required performance. (2) In the finishing materials area (interior and exterior), be able to explain the functionality and application environment for the appropriate selection of many finishing materials.		
2 Common course titles Building materials, Building construction, Construction overview, General construction		
Learning contents	Achievement goals	Guideline items for study
Type of building materials	Be able to explain the types of building materials, their required performance and examples of their use	Material types, standards and performance
Woody material	Describe the types of wood materials and their characteristics (e.g. mechanical properties, durability).	Types, physical properties, durability, fire resistance, wood industry products.
Cement concrete	Explain the types and characteristics of cement and concrete (strength, durability, formulation, etc.).	Cement types and properties, aggregate types, admixtures, admixtures, water-cement ratio, slump, air content, strength and durability of concrete, various types of concrete
	Explain how cement and concrete are produced (including the use of waste materials).	Cement production methods, characteristics of concrete products.
Metallic materials	Describe the types of steel and their strength properties and durability (e.g. corrosion, electrical corrosion, fire resistance).	Durability, physical properties, structural steel for construction, steel products for construction.
	Classification and characteristics of non-ferrous metals (e.g. aluminum, copper, stainless steel) can be given.	Type and characteristics
Other materials.	Be able to describe the types, properties and use of other materials.	Stone, glass, roofing, paint, exterior and interior materials and openings

V-G-2 Structure

[Learning achievement goals]		
1 Goals The structural systems area is an area for studying calculation theory for designing various types of framework structures on the basis of subjects such as mechanics. (3) In the field of mechanics, students are able to calculate reaction forces and stresses and deformations occurring inside structures in response to loads acting on building structures. (4) In the various structural fields (steel structures, reinforced concrete structures, timber structures, etc.), students can explain the mechanical properties of various materials, as well as the deformation characteristics, mechanisms of various structures and design and calculation procedures.		
2 Common course titles Structural mechanics, Basic mechanics, Material mechanics, General building structures, Building structure planning, Reinforced concrete structures, Steel structures		
Learning contents	Achievement goals	Guideline items for study
Building structure overview	Be able to describe the types and characteristics of building structures.	Building structure origins, building structure types and load types.
Cross-sectional properties	Be able to calculate cross-sectional parameters (e.g. cross-sectional secondary moments, cross-sectional coefficients).	Cross-sectional primary moment, cross-sectional secondary moment, sectional coefficient, cross-sectional secondary radius.

Stress and strain	Be able to define stress and strain in the elastic state, explain the relationship between forces and deformations and calculate them.	Forces, strains, relationship between forces and deformations, stress distribution in cross-sections due to bending moments.
	Be able to describe the shear stress distribution in a beam cross-section.	Stress distribution in the beam cross-section.
Static structure	Calculate stresses (axial forces, shear forces and bending moments) in static ramen and stresses (axial forces) in static trusses.	Stable/unstable, non-stationary orders, equilibrium, synthesis and decomposition of forces, fulcrum reaction forces, axial forces and axial force diagrams for trusses, fulcrum reaction forces, stresses (axial forces, shear forces, bending moments) and stress diagrams for ramen.
	Calculate displacements (deflections and deflection angles) of static structures.	Differential equations for beam deflection, work and strain energy, virtual work method
Pillar mechanics	It is possible to classify columns subject to compressive forces (short and long columns) and calculate Euler buckling loads for various support conditions.	Short and long columns, Euler buckling loads
	Be able to describe the stress state of eccentric compression columns.	Stress state of eccentric compression columns.
Non-stationary structure	Calculate fulcrum reaction forces and stresses in non-stationary structures (Fig.	Stress and fulcrum reaction forces on non-stationary structures, stress method, displacement method (deflection angle method) and fixed moment method.
Construction	Be able to explain the characteristics, structural forms and building construction methods of timber structures.	Features of timber construction, structural forms and methods of construction
Steel construction	Be able to explain the characteristics, structural form and joint types of S construction.	Characteristics and structural forms of S structures, resilience properties of steel structures, structural design methods, high-strength bolted joints, welded joints.
	Be able to describe and design major components and joints.	Allowable stresses, structural design of columns, beams, braces, joints, joints and joints, holding strength connections.
Reinforced concrete construction	Be able to explain the characteristics, structural form and joint types of RC construction.	Features and structural forms of various types of reinforced concrete construction, and design routes for structural calculations.
	Capable of designing major components.	Allowable stresses, structural design for axial forces, bending moments and shear forces acting on columns and beams, ultimate bending moment.

Perspectives other than those listed above

Plasticity analysis	The maximum load-bearing capacity (ultimate load-bearing capacity) of a simple structure can be calculated.	Disintegrating systems, disintegrating loads
	The total plastic moment of a rectangular section can be calculated.	Total plastic moment
Infrastructure	Be able to describe the supporting ground.	bearing ground
	Be able to classify foundation types (direct, piled).	basic format
	Be able to explain how to calculate the bearing capacity of different foundation types.	bearing capacity
Building vibration	Be able to explain natural periods and modes of vibration.	Natural period and vibration modes
	Explain the characteristics of earthquakes (e.g. magnitude, intensity) and response spectra.	response spectrum

V-G-3 Environment and equipment

[Learning achievement goals]		
1 Goals		
The building environment and equipment field is a field for understanding natural phenomena surrounding buildings, learning measures to obtain a healthy and comfortable environment, and utilizing this knowledge in building design.		
(1) In the building environment field, students understand the climate of Japan or the construction area, understand architecture adapted to the environment, and are able to use environmental elements for heat, light, sound and air environment, and explain methods for achieving a healthy and comfortable living environment on the premise of an environmentally symbiotic society.		
(2) In the field of building equipment, on the premise of an environmentally symbiotic society, be able to explain methods for obtaining a healthy and comfortable living environment using measures such as water supply and drainage, air conditioning and electricity.		
2 Common course titles		
Building environmental engineering, Building equipment, Practical training and exercises in the building environment		
Learning contents	Achievement goals	Guideline items for study
Principles of the environment	Can explain climate and architecture.	climate
	Explain the formation of climate, weather, temperature and humidity.	Climate, weather, temperature and humidity formation
	Be able to explain the phenomenon of heat islands.	heat island
	Explain environmental performance and energy conservation.	Environmental performance, energy savings, air pollution, natural and renewable energy.
Sunlight and solar radiation environment	Explain solar radiation and sunlight.	Daylight hours, sunshade diagram, direct solar radiation, sky radiation, solar radiation shielding factor
Light environment	Explain the relationship between vision and light.	Visual, bright vision, glare.
	Be able to describe daylighting and daylighting schemes.	Daylighting, daylighting schemes
	Explain artificial lighting, lighting planning and illuminance.	Artificial lighting, lighting planning, illuminance
Color environment	Be able to describe the color system.	Chromatic system, effect of color
Thermal environment	Be able to explain the fundamentals of heat transfer and the thermal properties of objects.	Heat transfer, heat penetration, heat load
	Be able to explain thermal environment elements and thermal environment indicators.	Thermal environment elements, thermal environment indicators.
	The phenomenon of condensation can be explained by a moist air diagram.	Condensation, moist air diagram.

Air environment	Explain the types of air pollution and indoor air quality standards.	Air pollution, indoor air quality standards.
	Explain ventilation requirements, natural and mechanical ventilation.	Ventilation requirements, natural and mechanical ventilation
Sound environment	Explain the nature and units of sound.	Sound units, sound psychophysical properties, sound propagation, attenuation and diffraction
	Be able to explain sound absorption, sound insulation and reverberation.	Sound absorption, sound insulation, reverberation time, sound insulation materials
Water supply, drainage and sanitation facilities	Explain water supply systems, water consumption, hot water supply systems, drainage systems and sanitary fixtures.	Water supply system, amount of water used, hot water supply system, piping system, flow-diverting and flow-combining drainage system, septic tanks, sanitary fixtures.
Air conditioning and ventilation systems	Be able to describe air conditioning and ventilation systems.	Heat load calculation method, air diagram, air conditioning system, heat source system, heat transfer system
Electrical equipment	Be able to describe electrical installations.	Power receiving and transformer and trunk line equipment, lighting and outlet equipment, information and communication equipment, lifting equipment
Disaster prevention equipment	Be able to describe fire protection equipment.	Fire extinguishing systems, smoke exhaust systems, fire alarm systems, lightning protection systems

V-G-4 Planning and history

[Learning achievement goals]		
<p>1 Goals</p> <p>The Planning and History (Architecture) field aims to understand the changes in architectural styles in the West and Japan from primitive to modern times, and to understand the systems of cities in society, architecture in cities and housing in architecture, based on changes in social conditions, means of transport and lifestyles in each period. The following are some of the areas that can be studied in the field of urban planning.</p> <p>(1) In the field of urban planning, the student should be able to explain the transition and changes in urban development in response to changes in social structure (industrial revolution, changes in transportation), using examples from other countries and the legal system in Japan.</p> <p>(2) In the field of architectural planning, understand human dimensions (modules), as well as the functions required for different uses of buildings, zoning and flow line planning, and be able to utilize these in architectural design.</p> <p>(3) (3) In the history field, the student is able to explain the architectural styles of each period in terms of the development of construction methods and the theory of architectural composition as a solution to the changing demands on architecture and social issues associated with social change.</p> <p>2 Common course titles</p> <p>Urban planning, Regional planning, Architectural planning, Architectural history, Urban history, Modern architecture theory</p>		
Learning contents	Achievement goals	Guideline items for study
Urban planning	Be able to describe prominent modern and contemporary urban planning theories.	Modern and contemporary urban planning theory
	Be able to describe the planning of residential areas.	Street design, town block composition, park and green space planning

	Be able to explain how land use planning works in Japan.	Land use planning, use and form regulations, district planning
Architectural planning and design approach	Be able to explain architectural planning and design methods and environmental symbiosis.	Requirements (conditions) for architecture, architectural planning and design process, volumes, zoning, layout planning, exterior planning, environmental symbiosis
	Explain fire and disaster prevention planning.	Fire spread, evacuation plans, fire zones.
Dimensioning	Be able to explain flow lines and modus operandi.	Line of flow, module.
	Be able to explain the basic dimensions involved in architectural design (e.g. area requirements, heights and conditions).	Dimensional design, universal design, barrier-free legislation.
Residential facility	Be able to describe the planning of residential facilities (e.g. independent dwellings, apartment blocks, etc.).	Independent dwellings, apartment buildings
Education and welfare facilities	Describe plans for educational and welfare facilities (e.g. primary schools, nurseries, kindergartens, middle, high schools and universities) or similar facilities.	Primary schools, nurseries, kindergartens, secondary schools, high schools and universities, welfare facilities
Cultural and exchange facilities	Describe plans for cultural and exchange facilities (e.g. art galleries, museums, libraries, etc.) or similar facilities.	Museums, museums and libraries
Business facility	Describe plans for business facilities (e.g. office buildings, auditoriums, accommodation, etc.) or similar facilities.	Office buildings, auditoriums and accommodation.
Medical facilities	Describe plans for healthcare facilities (e.g. hospitals, aged care facilities, etc.) or similar facilities.	Hospitals, elderly care facilities
Modern and contemporary architectural styles	Be able to describe the characteristics of modern and contemporary architectural styles in Japan and abroad.	Modern and contemporary architectural styles
Western architectural styles	Be able to describe the characteristics of architectural styles from ancient to early modern times.	Egyptian, Orient, Greek, Byzantine, Islamic, Romanesque, Gothic, Renaissance, Mannerist, Baroque, Rococo.
Japanese architectural style	Be able to describe the characteristics of architectural styles from ancient to early modern times.	Ancient architecture, residential architecture, shinden-zukuri, shrine architecture, temple architecture, shoin-zukuri, townhouse, farmhouse, tea house castle

Perspectives other than those listed above

Planning Basis	Know the responsibilities and duties of an architect.	(Japanese) Architectural Act
	Be able to explain the types of design contracts and management.	Design supervision
	Be able to explain the methods of construction estimation.	Estimate

V-G-5 Construction and legislation

[Learning achievement goals]		
1 Goals		
The construction and regulations area is an area to understand the flow of the contract, preparation work, framework and finishing (interior and exterior) work, as well as the definitions and operation of the Building Standard Law and related laws and regulations.		
(1) In the construction field, the trainee understands the construction procedures (construction type) and methods (construction structure and method) for constructing wooden, reinforced concrete, steel structure and steel-framed reinforced concrete buildings, and can explain the management of Q (quality), C (cost), D (process), S (safety) and E (environment) items and notification.		
(2) In the legal field, understand the legal system and be able to use relevant laws and regulations, mainly the Building Code, and utilize them in the design or planning of buildings and urban planning.		
2 Common course titles		
Building construction, Building regulations, General structure, Building overview, Building structure, Urban planning		
Learning contents	Achievement goals	Guideline items for study
General construction	Explain the construction flow (temporary construction, preparation, foundations, groundwork, frame, finishing, equipment (electrical, HVAC, plumbing and sanitation) and demolition).	Temporary works, foundation works, ground works, frame works, finishing works, equipment works
	Explain contracting (including estimating and costing).	Contract (for work)
	Be able to explain site management, quality and materials management and process charts.	Construction Industry Act, Occupational Health and Safety Act, quality control, material control, process control, process charts
	Be able to explain the main applications and notifications.	Type of application/notification
	Explain the characteristics of the five major control items (quality, cost, process, safety and environment).	Control item
	Explain the process chart.	Process control, process charts
Various works	Be able to explain site and ground investigations.	Site and ground investigation
	Temporary works can be explained.	Temporary construction
	Be able to explain earthworks, mountain retaining, foundations and earthworks.	Earthworks and mounding, foundations and earthworks
	Be able to describe reinforcing steel, formwork and concrete works.	Reinforcing steel, formwork and concrete works
	Steelwork can be explained.	Steel framework
	Other construction work (e.g. woodwork, waterproofing) can be described.	Woodwork, waterproofing, plastering, glazing, interior and exterior work, roofing, installation work
Building codes and terminology	Be able to explain the system of law.	Laws, decrees and notices
	Explain basic terminology and definitions such as fire protection.	Terms related to buildings, structures and fire protection, building procedures, area, height and number of stories of buildings.
	Be able to explain building procedures.	Application for confirmation, interim and completion inspections, notification of building work

Stand-alone rule	Be able to apply the legal texts of general construction and building equipment to specific examples.	Lighting, boundary walls, staircase and landing dimensions, ventilation and ventilation equipment, plumbing system construction, lifts.
	Be able to apply the legal text of structural strength and structural calculations to concrete examples.	Wooden, steel-framed, reinforced concrete, structural strength, structural calculation conformity assessment.
	Legal texts on fire protection and evacuation regulations can be applied to specific cases.	Terms related to fire protection, fire zones, interior restrictions, terms related to evacuation regulations, smoke exhaust systems, evacuation safety verification methods.
Group rule	Be able to explain roads and sites as defined in the Building Code.	Definition of roads
	The legal text on zoning can be applied to specific examples.	Area zoned for use (e.g. as a Base for calculating inheritance rights)
	Be able to explain floor-area ratio, building-to-land ratio and height restrictions.	Floor-area ratio, building-to-land ratio, height restrictions
	Explain fire zones, building agreements, etc.	Fire protection zones, building agreements
Related laws and regulations	Find legal regulations related to the Building Standard Law (e.g. City Planning Law, Fire Service Law, Architect Law, Construction Industry Law, etc.).	City Planning Act, Fire Service Act, Architect Act, Construction Industry Act, Barrier Free Act

V-G-6 Design and drafting

[Learning achievement goals]		
1 Goals		
The drafting area is an area in which students design and design various architectural structures with a free conception and draw them so that they can share information with the people concerned, based on an understanding of the characteristics of drafting tools, the meaning of various line types and the concept of scale.		
(1) In the field of drawing, the student is able to use drawing tools and explain how to draw lines, fill in dimensions and letters by hand, and represent and project architectural structures.		
(2) In the CAD field, understand basic software operations and be able to create, modify and print drawings.		
(3) In the field of design and drafting, be able to design and design various types of buildings based on specified conditions, using free ideas, and be able to present the purpose of the design, etc.		
2 Common course titles		
Graphics, drawing, Design and drafting, CAD and CG, Design exercises		
Learning contents	Achievement goals	Guideline items for study
Cartography	Understand the characteristics of drafting tools and be able to draw lines (about three different types).	drafting (draughting, drawing) tools
	Understand the various types of architectural drawings and the scale and scale of drawings, and be able to reflect this in the drafting of drawings.	Notation to scale.
	Identify and apply drafting symbols in accordance with the General Rules for Architectural Drafting.	Drafting symbol
	Be able to conceive of and represent stereoscopic ideas (e.g. using orthographic, monoplane and perspective projection).	Orthographic (elevation, development), axometric projection (axome, isome) and perspective views.
CAD	software and be able to produce a range of architectural drawings.	CAD
3D representation	Able to examine the architecture to be represented by a model or 3D-CAD with a view to making drawings.	

Assignment design (e.g. residential, public buildings) (Note 1)	Based on the given conditions, the spatial configuration can be put together based on concepts to meet the analyzed flow lines and zoning.	Concept, flow lines, zoning, esq.
	Be able to produce requested drawings (e.g. layout plans, floor plans for each floor).	Layout, floor plans, elevations, sections and perspective views of each floor.
	Be able to make presentations at critique sessions, etc.	
Note 1	Other perspectives than the above should include issues such as housing complexes and commercial buildings.	

3-1.8 V-H Merchant marine sector (Navigation)

V-H-1 Voyage

[Learning achievement goals]		
1 Goals The goal of the nautical system area is to develop the basic skills required for navigation by acquiring the principles and handling of nautical charts, navigation signs, measurement and calculation methods for determining the position of one's vessel, and navigational instruments. (1) Correctly explain nautical charts and route markings. (2) Explain the characteristics of various navigational methods and calculate the estimated position, direct course and direct distance using these methods. (3) Search for information necessary for navigation, such as the geography of the sea area to be navigated and tidal currents and tides, and plan safe and efficient routes. (4) Understand the methods of measuring and calculating ship's position by celestial bodies and be able to determine ship's position. (5) Explain the principles, construction and handling of compasses, autopilots, logs, acoustic depth gauges, etc. (6) Explain the principles and operation and handling of radar/TT, ECDIS, satellite navigation systems, AIS, etc.		
2 Common course titles Geographical navigation, Positioning theory, Navigation theory, Astronomical navigation, Navigation systems theory, Navigational instruments, Radio navigation, Navigation studies		
Learning contents	Achievement goals	Guideline items for study
Hydrographic magazines and navigation signs	Understand the nautical chart schemes described on nautical charts and be able to use nautical charts correctly.	Nautical charts, nautical charts schematic, geodetic system, basic datum plane
	The hydrographic bibliography can be used to gather information necessary for navigation.	Hydrographic bibliography, hydrographic journal, amendments, minor revisions, navigation warnings, navigation safety information.
	Explain the types, names and meanings of navigation signs.	Navigation signs, lighthouses, light quality, reach, IALA marine buoy type.
Geosynchronous navigation	Understand and apply the types and characteristics of ship's position measurement by means of ground objects markers.	Cross-orientation method, running fix, positive lateral distance prediction method.
	Understand how to determine ship's position, course and course by charting and be able to obtain them by drawing.	Tidal navigation
	Understand the characteristics of various navigation methods and be able to perform navigation calculations.	Equirectangular navigation, mean-median latitude navigation, gradual long latitude navigation, continuous path navigation, great-sphere navigation, aggregated great-sphere navigation.
Sailing plan	Be able to correctly select and illustrate routes in general situations, including inbound and outbound ports.	Departure maneuvering, turning, lookout, arrival maneuvering, anchorage selection, anchoring methods, avoidance lines
	Be able to plan shipping routes, including special sea areas.	Narrow waterway navigation, rough weather navigation, narrow visibility navigation, river navigation, ice navigation, navigation planning
Tides and currents	Understand how tidal currents and tides occur and be able to use tide tables correctly.	Monthly tide interval, high tide, low tide, daily tide inequality, tide time, tide height, tide difference, tide height level, tide table
	Be able to describe the world's major ocean currents.	Names of warm, cold and major ocean currents

Celestial navigation	Explain terms used in astronomical navigation.	Celestial sphere, equinox, equinox, ecliptic, hour angle, position angle, azimuth angle, zenith, altitude, true horizontal, visual horizontal
	Time standards and on-board clocks may be amended.	Visual time, normal time, local time, world time, amount of time revision.
	Celestial sunrise and twilight times can be determined.	At sunrise for regular use, at moonrise for regular use, astronomical twilight, twilight for regular use
	Be able to correctly select and calculate the method of measurement of gyro error.	Azimuth of Appearance, Azimuth of Time, Azimuth of Time, Azimuth of Polaris
	Can measure ship's position by celestial bodies.	Celestial positions, diagrams for determining positions, meridian altitude latitude method, polar star latitude method.
Navigational instrument	Understand the principles of magnetic compasses and the causes of self-difference, and be able to handle them correctly.	Magnetic compass, deviation, self-difference, self-difference measurement method, self-difference curve, self-difference coefficient, self-difference correction, gaussian difference, tipping difference.
	Understand the gyrocompass pointing principle and handle it correctly.	Sperry system, Anschutz system, finger north action, damping action, latitude error, speed error, speed shift error, sway error, turning error
	Understand the principles and construction of autopilots, logs and acoustic depthfinders and be able to handle them correctly.	Autopilot, rudder angle adjustment, guess rudder adjustment, weather adjustment, PID control, electromagnetic log, Doppler log, sonar, acoustic depthfinder
Radio navigation	Understand the principles, operation and handling of radar/TT and be able to handle it correctly.	Radar configuration, display system, azimuth resolution, distance resolution, minimum detection distance, STC.FTC, false image, TT, CPA, TCPA
	Understand the principles, operation and handling of ECDIS and be able to handle it correctly.	ECDIS structure, route planning, route monitoring, ENC, duty and operations
	Understand the principles, operation and handling of satellite navigation equipment and be able to handle it correctly.	GPS positioning principles, other positioning systems.
	Understand the principles, operation and handling of ship automatic identification devices and be able to handle them correctly.	AIS equipment configuration, display of information on other vessels, transmission of messages

V-H-2 Operation

[Learning achievement goals]

1 Goals

In the operational area, the aim is to learn about ship structure and equipment, weather and sea conditions, maneuverability and cargo stowage, which are necessary for ship operators, and to develop the necessary competence as a ship operator. The course also aims to provide students with specialist knowledge on 'hull structure' and 'resistance and propulsion'.

- (1) Hull elements to be able to explain the structures and components that make up a ship's hull.
- (2) Be able to explain the resilience of hulls and evaluate the safety of hulls from the perspective of resilience.
- (3) Explain terms and phenomena related to meteorological and maritime phenomena.
- (4) Explain the maneuverability of ships and the effects of external forces and sea areas on ship operations.
- (5) Explain safety considerations in the transport of dangerous goods.

2 Common course titles

Ship engineering, Shipbuilding engineering, Mechanics of materials, Basic maritime engineering, Loading theory, Ship safety engineering, Shiphandling theory, Ship motions, Marine meteorology, Marine environment, Life science, Earth science

Learning contents	Achievement goals	Guideline items for study
Ship structure, equipment, restoration and damage control	Be able to explain hull requirements.	Main dimensions, tonnage, shear, camber
	Be able to describe the main structural components and structures of ships.	Bow structure, stern structure, double bottom, watertight bulkheads, hull, deck, frame, beam, keel, bilge keel
	Explain the relationship between resilience and ship safety.	Shaking cycles, synchronous action, free water effects, compartmental flooding, restoration force curves.
	Understand terms related to resilience and explain their meaning.	Center of gravity, buoyancy, metacenter, GM, restoring power, drywall
	Understand and explain center of gravity shifts and trims caused by moving and loading/unloading cargo.	Shifts in the center of gravity and changes in trim and draught due to the movement or loading/unloading of cargo.
	Understand draught and its indications and be able to explain changes in draught.	Discharge and other curves, full draft indication, bow draft correction, trim correction, hogsag correction, specific gravity correction.
Cargo handling and loading	Understand and explain precautions in cargo handling, loading and maintenance.	Types of cargo, handling of heavy, hazardous and bulk cargoes, and precautions when loading.
	Understand and explain how to handle and preserve and care for cargo handling equipment and grubbing equipment.	Cargo handling equipment, ropes, tails, dunnage, slings, shackles, hooks
	Understand and explain basic knowledge of tanker safety handbooks.	Combustion triad, flash point, ignition point, explosion limits, tank cleaning, IGS.
Handling a ship	Understand and explain the maneuverability of ships.	Rudder, propulsor, manoeuvrability, turning diameter, manoeuvrability tests, power, propulsion efficiency, hull resistance, starting inertia, stopping inertia, reversing inertia, advance distance, propeller action.

	Be able to explain the effects of external forces on ship operation.	Wind pressure, flow pressure, following waves, facing waves, encounter period, broaching, bow diving
	Be able to explain the impact of the water area on maneuvering.	Shallow water effects, sidewall effects, bank suction, hull subsidence phenomena, interaction between two vessels.
	Be able to explain the points to be considered when maneuvering a vessel when navigating in general sea areas.	Departure and arrival maneuvers, lifting and anchoring maneuvers, method of diminishing speed, use of tugs, mooring lines, amount of anchor chain extended and discharged.
	Be able to explain the considerations to be taken into account when maneuvering a vessel when navigating in special waters.	Narrow waterway navigation, ice navigation, narrow visibility navigation, rough weather navigation, towing
Emergency measures	Understand and explain emergency measures in maritime casualty encounters.	Emergency measures (collision, boarding, flooding, fire, rudder failure), damage control, ship rescue
Search and rescue	Understand the International Air and Maritime Search and Rescue Manual (IAMSAR) and be able to explain search and rescue methods.	Location reporting system, falling overboard, search, Williamson Turn, Charnoturn.
Weather and sea conditions	Explain meteorological elements	Barometric pressure, temperature, humidity, atmosphere, clouds.
	Understand and explain the terminology used in meteorology and oceanography.	Front, high pressure, low pressure, air mass configuration, geostrophic winds, tilt winds, seasonal winds
	Be able to explain the onset and disappearance of storms.	Tropical cyclones, storms, hazardous areas, avoidance
	Understand the symbols on weather maps and be able to use weather maps.	Ground weather maps, high-rise weather maps

V-H-3 Legislation

[Learning achievement goals]		
1 Goals		
The goal of the Laws and Regulations area is to acquire knowledge of the legal system necessary for the safe operation of ships as stipulated in the three maritime traffic laws (Maritime Collision Prevention Law, Maritime Traffic Safety Law and Port Regulations Law), the laws pertaining to ships themselves such as the Ship Law and Ship Safety Law, and the laws pertaining to seafarers such as the Seafarers Law, etc., and to develop the basic ability to operate and manage ships safely by utilizing knowledge of the laws. The objective is to develop the basic ability to operate ships safely and to operate and manage ships by using knowledge of the law.		
(1) Comprehensively understand the three maritime traffic laws and be able to judge the relevant applicable laws and clauses in cases of maritime collisions.		
(2) To be able to explain the legal systems and regulations concerning ships, such as the Ship Law and the Ship Safety Law.		
(3) Explain the legal system and provisions relating to seafarers, such as the Seafarers' Act.		
(4) Explain maritime treaties such as the SOLAS and MARPOL conventions.		
2 Common course titles		
Navigation laws and regulations, Maritime regulations		
Learning contents	Achievement goals	Guideline items for study
Maritime Collision Prevention Act, Maritime Traffic Safety Act and Port	Understand the Maritime Collision Prevention Act and its implementing regulations and be able to apply navigation in accordance with the Act.	Maritime Collision Prevention Act and the Regulations for Enforcement of the Act.

Regulations Act.	Understand the Maritime Traffic Safety Act and its implementing regulations and be able to apply navigation in accordance with the Act.	Maritime Traffic Safety Act and the Regulations for Enforcement of the Act.
	Understand the Port Regulations Act and its implementing regulations and be able to apply navigation in accordance with the Act.	Port Regulations Act and the Regulations for Enforcement of the Act.
Law on Ships, Law on Tonnage Measurements of Ships.	Understand and be able to make lawful decisions on the Law on Ships and the Law on the Measurement of Tonnage of Ships.	Law on Ships and the Law's Enforcement Regulations, Law on the Measurement of Tonnage of Ships.
Seafarers' Act and the laws thereunder.	Understand the Seafarers' Act and the laws based on it, and be able to make lawful decisions.	Seafarers' Act and Regulations for Enforcement of the Act; Seafarers' Occupational Safety and Health Regulations.
Ship safety laws and legislation based on these laws	Understand the Ship Safety Act and the ministerial ordinances based on it, and be able to make legal decisions.	Ship Safety Act and the Regulations for Enforcement of the Act, Ship Equipment Regulations, Ship Fire Fighting Equipment Regulations, Ship Fire Fighting Equipment Regulations.
Act on Prevention of Marine Pollution and Other Marine Disasters	Understand the Act on the Prevention of Marine Pollution and Other Marine Disasters, the Order for Enforcement of the said Act and the Regulations for Enforcement of the said Act, and be able to make lawful decisions.	Act on the Prevention of Marine Pollution, etc. and Maritime Disasters, the Order for Enforcement of the said Act and the Regulations for Enforcement of the said Act.
Public international law	Understand and apply the provisions set out in the SOLAS and STCW conventions, etc.	SOLAS Convention, STCW Convention, MARPOL Convention
Ship's Officers and Small Vessel Pilots Act	Understand the Ship Personnel and Small Vessel Pilots Act and the Marine Casualty Act and be able to make lawful decisions.	The Ship Personnel and Small Vessel Pilots Act, the Order for Enforcement of the Act and the Regulations for Enforcement of the Act, and the Marine Casualty Tribunal Act.

3-1.9 V-I Merchant marine sector (Engine)

V-I-1 Internal combustion engine studies

[Learning achievement goals]		
1 Goals		
The Internal Combustion Engines course aims to provide students with the knowledge and skills related to internal combustion engines, which are mainly used as the driving source for ships and automobiles, and to develop the basic skills required to make practical use of these engines.		
(1) Learn about and be able to outline the construction and operation of internal combustion engines, in particular diesel engines, and their characteristics.		
(2) Learn about gas exchange processes and combustion processes, and be able to evaluate and explain how internal combustion engines generate power.		
2 Common course titles		
Internal combustion engines, Lubrication engineering		
Learning contents	Achievement goals	Guideline items for study
Operating principles, structure and Features of internal combustion engines and ancillary equipment	Recognize and explain the differences between internal and external combustion engines.	Differences between internal and external combustion engines
	Explain the construction and operation of internal combustion engines and their characteristics.	Structure, operation and characteristics of internal combustion engines
	Be able to explain gas exchange processes.	gas exchange process
	Describe the types, characteristics and handling of equipment attached to internal combustion engines.	Types, characteristics and handling of equipment attached to internal combustion engines.
	Be able to describe the types and properties of lubricants.	Types, characteristics, handling and management of lubricants.
	Explain the performance and heat cycle of internal combustion engines.	Performance of internal combustion engines, heat cycles.
Combustion processes, various power outputs and efficiencies of internal combustion engines	Explain the combustion process in internal combustion engines.	Combustion processes in internal combustion engines
	Explain the types and properties of fuel oils.	Fuel oil types and properties, fuel oil handling and management

V-I-2 Steam engineering

[Learning achievement goals]		
1 Goals		
In the area of steam engineering, the goal is to acquire knowledge and skills related to steam power plants. In particular, the course focuses on boilers and steam turbines, which are used as steam generators and power generators in steam power plants, and aims to develop the basic skills required for the safe operation and management of steam power plants, including the structure, performance and maintenance of boilers, steam turbines and related equipment.		
(1) Explain the construction and action of boilers and related equipment.		
(2) Explain the operation, maintenance and safe handling of boilers.		
(3) Be able to give an overview of the components of a steam power plant and the plant.		
(4) Explain the thermal cycle and thermal efficiency of a steam-powered plant.		
(5) Explain the construction and action of steam turbines and related equipment.		
(6) Explain the operation, maintenance and safe handling of steam turbines and associated equipment.		
2 Common course titles		
Steam engineering, Steam engine engineering, Heat transfer engineering		
Learning contents	Achievement goals	Guideline items for study
Boiler	Be able to explain the phase change between vapor and water.	Isobaric evaporation processes of water, vapor state quantities and vapor tables and vapor diagrams.

	Be able to describe the construction of the boiler and the general ancillary equipment.	Types, construction and characteristics of boilers; construction, action and handling of boilers and various related equipment (devices) attached to boilers; calculation of various boiler-related performances (e.g. boiler efficiency).
	Explain boiler operation and maintenance.	Handling of boilers and associated equipment, automatic control of boilers, boiler water management, damage to boilers and associated equipment and countermeasures.
Steam turbine	Explain the basic configuration, construction and types of steam turbines.	Types, components and operating principles of steam turbines; construction and action of various parts of a steam turbine; over-expansion, under-expansion, supersaturation and adiabatic heat drop.
	Explain energy conversion in steam turbines.	Various velocities occurring inside the rotating blades (blades), velocity diagram (velocity triangle), types and characteristics of losses in steam turbines.
	Be able to describe the ancillary equipment of a steam turbine.	Types, construction and action of turbine-related equipment.
	Explain the operation and maintenance of steam turbines.	Handling of steam turbines and associated equipment; opening and inspection of steam turbines and associated equipment.
Thermal cycle, thermal efficiency and steam power plants	Provide an overview of the components of a steam power plant and the plant.	Elements and functions comprising a steam power plant.
	Thermal efficiency can be derived from the thermal cycle of a steam-powered plant.	Characteristics of steam-powered plant thermal cycles (Rankine cycle, regeneration cycle, reheat-regeneration cycle, reheat-regeneration cycle), calculation of thermal efficiency.

V-I-3 Auxiliary mechanical engineering

[Learning achievement goals]		
1 Goals		
<p>The auxiliary machinery engineering area aims to develop the basic skills required to handle fluid machinery and refrigeration equipment based on fluid engineering and thermal engineering, amongst the general auxiliary machinery involved in ship operations.</p> <p>Auxiliary machinery on ships refers to equipment other than the main engine and electrical equipment directly related to propulsion, and includes a very large number of types and various mechanisms. The objective is to develop the basic skills required to handle pumps and chillers as the core, based on knowledge and understanding of these marine auxiliary machinery in general.</p> <p>(1) Explain the construction and action of fluid machinery such as pumps and chillers. (2) Explain the operation, maintenance and handling of fluid machinery such as pumps and chillers.</p>		
2 Common course titles		
Fluid mechanics, Hydraulics, Fluid machinery		
Learning contents	Achievement goals	Guideline items for study
Auxiliary equipment for marine vessels	Explain the fundamentals of refrigeration and the configuration of refrigeration units.	Elements and functions of the refrigeration cycle, and the state of each component of the refrigeration system and the refrigerant during operation.
	Explain the types, construction and operating principles of fluid machinery (auxiliary equipment).	Types of fluid machinery (auxiliary equipment), construction and principle of operation; damage caused to pumps.

V-I-4 Thermal and fluid engineering

[Learning achievement goals]		
1 Goals		
<p>The objective of the heat and fluid engineering area is to develop a basic understanding of the principles of systems in which heat and fluids interact, such as the motion of main engines, auxiliary engines and hulls. It also aims to develop the ability to explain the fluid forces acting on the hull and the propulsion system as the core of the system.</p> <p>(1) Be able to explain basic concepts related to thermodynamics and apply them to the field of application. (2) Understand the properties of fluids and be able to explain the various actions acting on the hull. (3) Understand and explain propulsion systems (including stern tubes).</p>		
2 Common course titles		
Heat transfer engineering, Thermal engineering, Fluid mechanics, Fluid dynamics, Hydraulics		
Learning contents	Achievement goals	Guideline items for study
Basic laws on thermodynamics for use on ships	Be able to explain the laws of thermodynamics.	Definition and units of various physical quantities used in thermodynamics, calculation of energy equations (heat, work, internal energy, enthalpy), laws of thermodynamics (first and second laws) calculation of thermal efficiency (Karnaugh cycle), concept of entropy and calculation of change
	Be able to explain the forms of heat transfer.	Basic forms of heat transfer, heat transfer processes
	Be able to explain the change of state of an ideal gas.	Equation of state of ideal gas, specific heat of constant volume, specific heat of constant pressure and specific heat ratio, changes of state of gas (isobaric change, isovolumetric change, isothermal change, adiabatic change, polytrope change)

Basic laws on fluids used on ships	Explain the fundamentals of fluid mechanics.	Definitions and units of various physical quantities that describe the properties of fluids (liquids and gases); difference between laminar and turbulent flows; calculation of physical quantities using Bernoulli's equation and the continuity equation; action of friction.
	Be able to describe the forces acting on the hull.	Types of resistance acting on the hull (e.g. frictional resistance, wave-making resistance), forces acting on the hull
propulsion device	Be able to describe the content relating to marine propulsion systems	Propulsion system and stern tube types and construction, and evaluation of propulsion systems.

V-I-5 Electrical and electronic engineering

[Learning achievement goals]		
1 Goals The objective is to provide the student with the basic knowledge and computational skills in DC circuits, AC circuits, magnetic circuits and semiconductors required for the operation of ships. (1) Be able to calculate DC circuits. (2) Be able to calculate AC circuits. (3) Understand the basic laws of electrical engineering and be able to perform calculations. (4) Understand semiconductors and explain PN semiconductors, diodes and transistors.		
2 Common course titles Electrical and electronic engineering, Electro-mechanics, Electromagnetics		
Learning contents	Achievement goals	Guideline items for study
Basic laws of electrical and magnetic circuits and operating principles of electric motors and generators, semiconductor devices and electronic circuits used on ships	Be able to explain and calculate the basic laws of DC circuits.	Calculation of currents in series and parallel circuits; relationship between currents and magnetism.
	Be able to explain and calculate the basic laws of AC circuits.	Calculation of AC circuits using LCR, three-phase AC
	Be able to explain the structure and operating principles of electrical equipment.	Electric motor and generator construction, principles and operation of electric motors.
	Explain semiconductors and semiconductor devices.	PN semiconductor
	Be able to explain how electronic circuits work and how they are used.	How rectifier circuits work and are used, and how amplification circuits work.

V-I-6 Control engineering

[Learning achievement goals]		
1 Goals Technologies based on control engineering have practical applications in all areas, from society and industry to household electrical appliances, such as aircraft, ships and other vehicles, and machinery and equipment in the manufacturing industry. In addition, the control technology is always accompanied by measurement, i.e. measurement technology. Therefore, control is impossible without measurement in control. The aim is therefore to learn the basic concepts of automatic control, the mechanisms (sensors, regulators, operating ends) and principles of control devices, and the instruments and numerical processing related to measurement that are necessary for control, and to acquire the skills required for measurement and control. (1) Explain the composition of physical quantities and systems of units. (2) Explain the operating principles of basic measuring instruments. (3) Be able to read and understand sequence diagrams. (4) The components and basic workings of feedback control systems can be explained.		
2 Common course titles Measurement and control, Control engineering, Measurement engineering, Machine control, Electrical control, Mechanical engineering, Electrical equipment, Measurement and control engineering, Electrical machinery		

Learning contents	Achievement goals	Guideline items for study
Measuring with measuring instruments	Explain physical and industrial quantities, systems of units and the operating principles of basic measuring instruments.	Physical and industrial quantities and their systems of units, and measurement principles of measuring instruments and sensors corresponding to physical quantities.
Control unit	Explain machine control and sequence control.	Machine control terminology, equipment and sequence control schematics,
	Describe the configuration of the automatic controller and the system response and block diagram.	Block diagrams of feedback control systems, applications of automatic control, operation of various devices used in automatic control.

V-I-7 Materials and marine engineering

[Learning achievement goals]

1 Goals

In the area of materials and marine engineering, the goal is to clarify the stresses and deformations that occur in various parts of machines and structures when external forces are applied, to acquire the knowledge and skills to determine safe and economical material types, shapes and dimensions that match these, and to develop the ability to use these in the actual structure of ships. The course also aims to provide students with knowledge and skills in the dynamic behavior of machinery and structures and the ability to utilize this knowledge and skills in practice.

- (1) Be able to calculate stresses, strains, etc. for tension, compression and shear.
- (2) Be able to calculate reaction forces, shear forces, bending moments, bending stresses, etc. for bending of a beam.
- (3) Be able to calculate the torsion of a shaft.
- (4) Explain mechanical properties, principles of measuring material tests and heat treatment for various metallic materials.
- (5) Explain the name, construction and main dimensions of each part of the hull.

2 Common course titles

Mechanics of materials, Marine engineering

Learning contents	Achievement goals	Guideline items for study
Tension, compression, shear, stress and strain in ships	Explain stress and strain.	Calculation of the relationship between stress, modulus of longitudinal elasticity (Young's modulus) and strain (Hooke's law).
	Be able to calculate stresses, strains, etc. for tension, compression and shear.	Calculation of tensile and compressive stress (vertical stress), tensile and compressive strain, longitudinal strain, transverse strain and Poisson's ratio, shear stress (tangential stress) and shear strain
Axis torsion	Can be calculated for shaft torsion.	Calculation of shear strains and shear stresses in round bars subjected to torsion; for round bars, calculation of sectional quadratic polar moments and polar section coefficients.
Bending of a needle	Be able to calculate reaction forces, shear forces, bending moments, bending stresses, etc. for bending of beams.	Equilibrium of forces acting on beams, calculation of shear force diagrams and bending moment diagrams, calculation of sectional secondary moments and sectional coefficients at any cross-section, calculation of bending stresses or stresses occurring at any point in the cross-section of a beam, calculation of deflection angles and deflections for various beams.

Principles of measurement of mechanical properties and material testing in metallic materials; heat treatment	Be able to describe the properties and types of metals.	General properties of metallic materials
	Explain the principles of measurement in materials testing.	Principles of various material tests
	Explain the purpose and operation of heat treatment of metallic materials.	Purpose and operation of heat treatment of metallic materials.
Structure of each part of the hull, names, main Dimensions and forces applied to the hull (including resistance acting on the hull), propulsion equipment (including stern tubes)	Be able to describe the structure of the hull.	Names, construction and features of various parts of the hull structure.
	Be able to describe the main dimensions and various weights of hulls.	Names and differences in the main dimensions relating to the hull, and the various weights (gross tonnage, net tonnage, displacement tonnage, etc.) relating to the ship.
	Be able to explain the forces applied to the hull and calculate the stresses on the hull.	Characteristics of forces applied to the hull, calculation of stresses acting on the hull (shear stress, bending stress, etc.)

V-I-8 Mechanical drawing

[Learning achievement goals]		
<p>1 Goals</p> <p>In order to acquire knowledge and skills in specialized fields, the students acquire basic skills in mechanical drawing, mainly through exercises and drafting work, as well as the ability to read and create drawings correctly. In this area, the ability to grasp the shape of objects from drawings, which is necessary for a ship's engineer. The ability to grasp the shape of the object to be drawn and to draw it 'quickly', 'clearly' and 'accurately' is developed.</p> <p>(1) Acquire the basics of drafting and be able to correctly use lines, symbols and letters on drawings according to their intended use.</p> <p>(2) Be able to produce fabrication drawings of machine parts such as bolts and gears.</p> <p>(3) Able to draw from elevations and text.</p> <p>2 Common course titles</p> <p>Mechanical and design drafting</p>		
Learning contents	Achievement goals	Guideline items for study
Basic knowledge required for drafting	Understand and explain the fundamentals of mechanical drafting.	Role and types of drawings; types and uses of lines; material symbols; use of letters, symbols and lines; entry and projection drawings.
	Able to draw production drawings.	Fabrication drawings (scale, dimensions, tolerances, surface properties), sketch drawings of components
Fabrication drawings for machine parts	Be able to produce fabrication drawings of machine parts.	Production drawings of machine parts such as bolts, nuts (screws) and gears

3-2 VI Skills for engineering laboratory experiments and practices in specific fields

3-2.1 VI-A Mechanical engineering fields

[Learning achievement goals]		
1 Goals The goal of the laboratory and practical training areas is to acquire a hands-on understanding and basic knowledge of the fundamentals of manufacturing and the theory of mechanical engineering learned in the classroom. (1) Acquire the skills and techniques of various work methods and be able to carry out machining based on drawings. (2) Understand the principles and operation of the experimental apparatus and be able to explain the process and results of the experiment.		
2 Common course titles Mechanical work practices, Mechanical engineering experiments		
Learning contents	Achievement goals	Guideline items for study
How to handle measuring instrument	Understand how to use and measure various types of measuring instrument.	Calipers, micrometers, dial gauges, height gauges, depth gauges
Hand finishing	Hand finishing operations can be carried out using a variety of tools.	Scribing tools, files, threading tools.
Welding	Understand the principles of arc welding and be able to perform basic welding works.	Arc welding
Machining	Learn the basic operation of lathes, milling machines and drilling machines and be able to perform cutting operations.	straight turning, shoulder milling, step drilling, thread cutting, taper cutting, drilling, boring, face milling, side milling
NC machining	Learn the basic operation of NC machine and be able to carry out basic works.	NC machine tools, NC programs
Engineering experiment	Conduct experiments on mechanical engineering and be able to prepare for the experiments, operate the experimental apparatus, and sort out and discuss the results of the experiments.	processing engineering experiments, mechanical dynamics experiments, material science experiments, Strength of materials experiment, thermodynamics experiments, fluid mechanics experiments, control engineering experiments

3-2.2 VI-B Materials-based sectors

[Learning achievement goals]		
1 Goals The goal of the experimental and practical training areas are to enable students to understand the fundamentals of manufacturing, materials engineering theory and observation, analysis and evaluation methods, and to be able to perform basic operations. (1) In the machine tools practical training, the aim is not only to acquire the skills and techniques of various work methods, but also to acquire the desirable attitude and habits of an engineer. (2) Materials engineering experiments aim to develop an understanding of the principles and operation methods of experimental equipment and the ability to explain the process and results of experiments.		
2 Common course titles Materials engineering experiments, Practical work on crafts and instrumental analysis experiments		
Learning Content	Achievement goals	Guideline items for study
How to handle measuring equipment	Understand how to use and measure various types of measuring equipment.	Calipers, micrometers
metalworking	Understand casting and welding procedures and be able to perform basic operations.	Casting, welding, arc welding

Machining	Learn the basic operation of lathes, milling machines and drilling machines and be able to perform cutting operations.	Outer rounding, end face grinding, step grinding, thread cutting, drilling, boring, plane grinding, side grinding
Engineering experiment	Conduct experiments related to materials engineering and be able to set up experiments, operate laboratory equipment, and organize and discuss the results.	Metallic materials experiments, mechanical property tests, chemical experiments, analytical experiments, electrical engineering experiments
	Be able to analyze the crystal structure of materials using, for example, an X-ray diffractometer.	crystal structure analysis
	Be able to observe materials with optical and electron microscopes and evaluate them regarding their microstructure.	material texture observation
	The strength properties of materials can be assessed using hardness testers and universal testing machines.	Mechanical properties
	Can use analytical instruments to quantitatively assess components and other parameters.	Qualitative and quantitative analysis

3-2.3 VI-C Electrical and electronic fields

[Learning achievement goals]		
1 Goals In the laboratory and practical training areas, the objective is to acquire techniques for various measurement and testing methods related to electricity and electronics, as well as to understand and organize the content studied in specialized subjects through experiments. (1) Students can practice methods to achieve their objectives by using experimental equipment, instruments and information devices. (2) Students can organize knowledge related to the fundamentals of engineering through experiments. (3) Students can consider and explain the data obtained from experiments from an engineering perspective.		
2 Common course titles Experiments in electrical and electronic engineering		
Learning contents	Achievement goals	Guideline items for study
Measurement technology	Be able to measure the electrical characteristics of direct current and alternating current using laboratory equipment, instruments and information devices.	Methods for measuring electrical quantities, resistance and impedance, and how to use oscilloscopes.
	Be able to use experimental equipment, instruments and information equipment safely and correctly.	Correct use of laboratory equipment, safety training
Electric circuit	Be able to measure electrical quantities in DC circuits and discuss the results.	Actual measurements of Kirchhoff, superposition theory, partial pressure law, partial flow law, etc.
	Be able to measure electrical quantities in AC circuits and discuss the results.	Actual measurements of RLC impedance, impedance magnitude and phase, frequency response, etc.
Electronic circuit	The electrical characteristics of semiconductors and amplifier circuits can be determined by actual measurements and simulators and the results discussed.	Measurement of the static characteristics of diodes and transistors, and the gain and frequency response of amplifiers using operational amplifiers.
	Be able to determine the operation of logic circuits by means of actual measurements and simulators, and to discuss the results of such experiments.	Measurement of logic circuits combining AND, OR, NOT and NAND.
	Learn to use microcontrollers and PC-based control circuits.	Control experiments using microcontrollers and PCs.

3-2.4 VI-D Information-based sectors

[Learning achievement goals]		
1 Goals		
In the experimental and practical training areas, the goal is to acquire basic knowledge and skills in information engineering through hands-on experience through experimental practice and desk-based exercises.		
(1) In the basic programming practical training area, students can generate simple software and check its operation through experience in using standard software development tools and development environments.		
(2) In the practical training in logic circuit design, students can design simple combinational logic circuits and sequential circuits.		
(3) In the development environment construction practical training, be able to use and construct a development environment suited to the purpose.		
(4) In application design and production, students can create programs that meet specifications and obtain execution results.		
2 Common course titles		
Engineering experiments, Software exercises, Logic circuits		
Learning contents	Achievement goals	Guideline items for study
Basic programming practice	Be able to write a source program to solve a given problem using standard development tools and development environments.	Coding, running and debugging programs, editors, IDEs, libraries and APIs
	Be able to produce a blueprint of the program to be created, using standard methods.	Flowcharts, UML, pseudo-language
	Be able to design and evaluate combinational logic and sequential circuits that meet given specifications.	Truth tables, state transition diagrams, state transition tables

3-2.5 VI-E Chemical and biological fields

[Learning achievement goals]		
1 Goals		
In the area of experiments and practical training, the aim is to acquire skills in various measurement and testing methods related to chemistry and biology, as well as to understand and acquire the content studied in specialized subjects through experiments.		
(1) Understand the content of the experiment and be able to conduct the experiment in a safe manner.		
(2) Understand the experimental procedures and be able to carry out synthesis experiments using appropriate glassware, etc.		
(3) Learn how to handle microorganisms, biological samples and enzymes.		
(4) Understand the mechanism of the experimental apparatus, learn how to handle it and analyze the data obtained.		
2 Common course titles		
Organic chemistry experiments, Inorganic chemistry experiments, Analytical chemistry experiments, Physical chemistry experiments, Chemical engineering experiments, Biological engineering experiments		
Learning contents	Achievement goals	Guideline items for study
Safety education	Understand the hazards of the reagents used and be able to handle them appropriately.	Handling of reagents
	Understand how to classify laboratory effluents and be able to dispose of them appropriately.	Effluent treatment
	Be safety-conscious in their experiments and be able to explain what to do in the event of a disaster.	Disaster response
Basic operation	Be able to explain the purpose, theory and operation of the experiment.	Experimental operation
	Be able to handle experimental data correctly.	Organization of results
	Be able to write a report with appropriate structure and text.	Creating reports
Synthesis experiment	The appropriate laboratory apparatus can be assembled and synthetic reactions can be carried out.	Reflux, (suction) filtration
	Substances can be isolated or purified.	Distillation, recrystallisation, extraction using a separating funnel, thin-layer chromatography, melting point measurement, boiling point measurement
	The calculation of yields can be done.	Theoretical yield, yield rate.

Qualitative and quantitative analysis	Be able to perform qualitative and quantitative analysis using appropriate methods.	Neutralization titration, redox titration, chelatometric titration, cation separation and qualitative
Instrumental analysis	Be able to perform structural analysis of substances (materials), sample observation, measurement of physical properties, quantitative analysis and qualitative analysis using various instruments and equipment.	IR, NMR, MS, XRD, UV, optical microscopy, electron microscopy, HPLC, absorbance measurements, thermal analysis
Physical property measurement	Be able to measure various physical properties using appropriate instruments and analyze the data obtained.	Density measurement, viscosity measurement, molecular weight measurement, heat of dissolution measurement, reaction rate measurement, electromotive force measurement, activation energy measurement, flow and velocity measurement, mass balance, energy balance
Biochemistry	Microorganisms can be isolated, cultured and observed.	Isolation, cultivation and observation of micro-organisms
	Using appropriate methods and solvents, biological substances of interest can be extracted from biological samples and easily purified, e.g. by filtration or centrifugation.	Extraction and purification of biological substances.
	The activity of the enzyme can be examined quantitatively or qualitatively.	Enzyme activity

3-2.6 VI-F Construction-based sectors

[Learning achievement goals]		
1 Goals The experimental and practical fields include surveying, materials, structures, geology, hydraulics, planning and transportation, and the environment, and the students should develop an experiential understanding of the aims and methods of such experiments and the ability to explain the results in an engineering manner. (1) The experimental practice areas include surveying, materials, structures, geotechnics, hydraulics and the environment, and the student should be able to understand the aims and methods of such experiments and explain the results in engineering terms.		
2 Common course titles Environmental and urban engineering practice, Environmental and urban engineering experiments, Basic experiments		
Learning contents	Achievement goals	Guideline items for study
Surveying	Understand distance surveying methods and be able to measure them.	Direct distance surveying
	Understand and be able to perform angular surveying with theodolites.	Single-measurement method, double-measurement method
	Understand traverse surveying and be able to survey it.	Sum of internal angles, closing difference, closing ratio
	Understand level surveying and be able to perform such surveys.	Elevated, vessel-height type
Material	Understand and be able to perform sieve tests on aggregates.	Grain size, coarse grain fraction, maximum size of coarse aggregate
	Understand and be able to test aggregate density and water absorption.	Moisture content, density, water absorption.
	Understand and be able to perform slump tests on concrete.	Slump value, workability.
	Understand and be able to test the air content of concrete.	Air volume
	Understand and be able to test the strength of concrete.	Compressive, tensile and bending strength

Structure	Perform loading tests on concrete and metal specimens according to various structural forms, and observe the properties of deformation from a mechanical point of view.	Stress and strain, member stress and deflection
Geotechnical, soil	Understand and be able to test the density of soil particles.	Density of soil particles
	Understand and be able to test for liquid and plastic limits.	Liquid limit, plastic limit, plasticity index
	Understand and be able to test for particle size.	Particle size additive curves, equality coefficients, curvature coefficients
	Understand and be able to test for permeability.	hydraulic coefficient
	Understand and be able to test soil compaction by ramming.	Compaction curves, optimum moisture content, maximum dry density
	Understand and be able to test for uniaxial compression or one-sided shear.	Uniaxial compressive strength, coefficient of deformation, undrained shear strength
Hydraulic	Laminar and turbulent flows can be observed and Reynolds numbers can be calculated.	Friction loss hydraulic head, Reynolds number, critical Reynolds number
	Understand various methods of flow measurement and be able to perform experiments on them.	Triangular weirs, square weirs, venturi meters
	Understand and be able to perform experiments on normal flow, projectile flow and jumping water.	Specific energy, number of fluids, critical flow and critical depth, specific power
Environment	Understand and be able to perform experiments on DO and BOD.	Saturated DO, DO consumption
	Understand and be able to perform experiments on pH.	environmental standard

3-2.7 VI-G Architectural fields

[Learning achievement goals]		
1 Goals		
The experimental and practical fields are areas where students can gain an understanding and consolidate their knowledge of each educational area learned in classroom lectures through experience.		
(1) Experimental areas include materials, structure and environment, and students understand the purpose and methods of these experiments and can explain the results in engineering terms.		
2 Common course titles		
Experimental practice, Creative experimental exercises		
Learning contents	Achievement goals	Guideline items for study
Material	Be able to explain the purpose and methods of the experiment.	Experimental method (if described in ISO or elsewhere)
	The physical properties of structural materials used in construction (e.g. wood, concrete, metal, etc.) can be determined by experimentation.	Confirmation of classroom learning
	Be able to organize and discuss experimental results.	Validation of experimental data.
Structure	Be able to explain the purpose and methods of the experiment.	Experimental method (if described in ISO or elsewhere)
	Loading tests can be carried out on specimens of any structural type (e.g. rafter, truss, etc.) of any structural material (e.g. wood, concrete, metal, etc.) to observe the fracture shape and the nature of the deformation.	Confirmation of classroom learning
	Be able to organize and discuss experimental results.	Validation of experimental data.
Environment	Be able to explain the purpose and methods of the experiment.	Experimental method (if described in ISO or elsewhere)

	The environment surrounding the building (e.g. sound, light, temperature, humidity, vibration, etc.) can be determined through experimentation.	Confirmation of classroom learning
	Be able to organize and discuss experimental results.	Validation of experimental data.
Surveying	Be able to handle equipment for surveying used in construction production (e.g. levels, transits, total stations, GPS surveying, etc.).	Handling of equipment

3-2.8 VI-H Merchant marine sector (Navigation)

[Learning achievement goals]		
1 Goals The goal of the experimental and practical training areas is to understand and acquire the ship's services, shiphandling techniques, handling of navigational instruments, conservation and care of navigational instruments, and security response in emergencies that are necessary for ship operators. (1) The training on training vessels is aimed at acquiring the skills required to operate a vessel, as well as the normative awareness, seaworthiness and cooperativeness necessary for a marine engineer. (2) In experiments and practical training, the goal is to develop the ability to understand and put into practice the purposes and methods of licensing training as stipulated by law.		
2 Common course titles On-campus training ship training, Navigation training, Rowing communication, Rowing training, Merchant marine exercises, Experimental training		
Learning contents	Achievement goals	Guideline items for study
Experimental and practical training tips	Understand and practice the basics of group behavior, including how to line up, check personnel and salute.	Line up, check personnel, salute, group behavior
	Understand the significance of work clothing and protective equipment and wear them correctly.	Work clothes, safety shoes, safety protective equipment
(small) Boat	Understand the names of the parts of an end-boat and the rowing orders, and be able to operate the boat according to the orders.	Names of parts, oar rowing, signaling
	Learn basic rope work and be able to tie a real rope.	Rope work, technical work
Firefighting training	Understand how to use various fire extinguishers and fire hoses and be able to extinguish fires in the initial stages.	Carbon dioxide fire extinguishers, foam extinguishers, powder extinguishers, applicator nozzles, variable nozzles
	Fire extinguishers can be filled with spare extinguishing media.	Fire extinguishing agents, foam extinguishers
	Be able to wear breathing apparatus and fire protection clothing correctly.	Breathing apparatus, firefighter's equipment and fire protection clothing.
Lifesaving training	Understand and practice launching and maneuvering lifeboats, life rafts and rescue boats.	Lifeboats, life rafts, davit operations.
	Understand and practice the actions to be taken in an emergency situation, such as diving into the water and boarding a lifeboat or life raft from the water.	Diving, elementary back, group moving formation, group dense formation
	Understand and practice emergency medical care, including CPR.	Life support, chest compressions, artificial respiration, AED
	Understand the use of lifejackets and be able to fit them correctly.	Immersion suits, lifejackets, heat loss reduction posture
	Understand the use of signaling devices and radio life-saving equipment and be able to operate them correctly.	VHF radio telephones, satellite emergency position indicating radio beacons, radar transponders for search and rescue, two-way radio telephones
Navigational duty	Understand the matters relating to navigational duty standards in the deck section and the navigational logbook, and be able to perform duty.	Ship bridge duty, navigational logbook.

	Operate navigational instruments and obtain and use information necessary for navigation.	Radar/TT, ECDIS, logging, gyrocompass, acoustic depth finder
Practical business practice	Understand and practice security and emergency departments, including fire protection and waterproofing departments.	Fire drills, waterproofing drills
Departure and arrival port departments, casting and anchoring laws, entry and exit port laws.	Understand and be able to practice the roles and tasks in entering and leaving port and in lifting anchor.	Windlass operations, mooring operations, anchoring, mooring winch operations

3-2.9 VI- Merchant marine sector (Engines)

[Learning achievement goals]

1 Goals

In the experimental and practical areas, the aim is to acquire the basic knowledge and skills required of ship's engineers and to develop the basic competencies necessary to use them in the operation and maintenance of shipboard equipment.

- (1) Understand the basic principles and operation of marine engines and various types of machine tools, and be able to carry out experiments and practical training.
- (2) Understand the content of experiments and practical training and summarize it in a report.
- (3) To learn the basics of seamanship through navigation duty and engine duty.
- (4) Understand and be able to operate the main and auxiliary equipment in the engine room.
- (5) be able to operate their own (group) vessels safely.

2 Common course titles

Experimental training, Engine engineering experiments, On-campus training ship training, Rowing communications

Learning contents	Achievement goals	Guideline items for study
Tools, measuring equipment	Able to handle tools and measuring equipment.	Handling of tools, use and handling of various measuring instruments such as testers and micrometers
Metalworking	Understand welding procedures and be able to perform basic operations.	Handling of gas (arc) welding equipment, apparatus and welding torches (welding rods); basic gas (arc) welding and gas cutting operations.
Machining	Understand the basic operation of lathes and other machine tools and be able to handle machine tools.	Movement of tools on lathes and other machine tools, machining with machine tools
(small) Boat	Be able to explain the various names of endboats, their orders and the handling of rowing boats.	Basic actions required for group behavior such as lining up, checking personnel, reporting, saluting, etc., names of parts of endboats, rowing orders, operation according to the orders, basic rope work.
Firefighting and lifesaving training	Able to handle fire-fighting equipment.	Initial fire fighting using various fire extinguishers and fire hoses, filling portable fire extinguishers with spare extinguishing media, wearing breathing apparatus and fire protection clothing.

	Able to perform lifesaving tasks and handle lifesaving equipment.	How to use the life-saving equipment on board, practice leaving the vessel in an emergency situation, perform cardiopulmonary resuscitation using an AED from the detection of a person with cardiopulmonary arrest, use and wear lifejackets, use and operation of signaling equipment and radio life-saving equipment.
Engineering experiment	Conduct engineering experiments, operate laboratory equipment, and organize and discuss the results of experiments.	Internal combustion engine experiments, steam engineering experiments, auxiliary mechanical engineering experiments, electrical engineering experiments, control engineering experiments, material mechanics experiments, operation of experimental equipment, organization and discussion of experimental results
Equipment and piping surveys, in-school training ship exercises	Equipment and piping surveys (plant).	Names and uses of various marine equipment; types, construction and uses of valves; plant configuration (flow and role of fluids in each system such as fuel oil, lubricating oil, cooling fresh water and cooling sea water/role of components).
	Able to warm up and operate the main engine and be on duty (navigation, anchoring, MO).	Warming up (cooling) of the engine, preparation for operation (handover) / commissioning plan, standards of duty in the engine room (sailing / anchoring / MO), operation of various equipment, operation of suction and discharge valves and pumps according to various pumps, parallel operation of generators, measurement of temperature, pressure, etc., of various equipment, and ascertaining operating conditions.
LOG BOOK	The LOG BOOK can be described.	Measurement items for each piece of equipment, noon calculations, English description method of starting and stopping each piece of equipment.

3-3 Considerations for Multidisciplinary Departments/Courses

3-3.1 Mechanical fields

Learning area	Achievement goals in multidisciplinary departments/courses	Course considerations
V-A-1 Design and drawing	Understand and utilize the role of drawings, types and uses of lines, methods of depicting object projections, and tools used for drawing creation.	
	Understand methods of representing shapes, indications of dimensions, tolerances, and surface roughness, as well as techniques for sketching parts, and be able to create production drawings.	
	Understand the standards for mechanical component drafting and be able to create drawings.	
V-A-2 Mechanical design	Be able to explain the significance of standard specifications and apply them to mechanical design.	
	Be able to explain basic terminology related to mechanical design.	
	Understand the types, applications, standards, and design of screws, bolts, and nuts, and be able to apply and calculate them.	
V-A-3 Mechanics	Be able to determine the composition and decomposition of forces.	
	Understand the meaning of moments of force and even forces and be able to calculate them.	
	Be able to explain the equilibrium conditions between a force acting at one point and a force acting at a different point.	
	Understand the meaning of center of gravity and be able to calculate the position of the center of gravity of simple figures.	
	Understand the meaning of velocity and acceleration and be able explain the relationship between time, displacement and velocity.	
	Be able to explain the three laws of motion and express the relationship between force, mass and acceleration in terms of the equations of motion.	
	Understand the meaning of peripheral velocity, angular velocity, rotational speed, centripetal acceleration, centripetal force and centrifugal force in rotational motion and be able to calculate them.	
	Understand the meaning of work and power and be able to calculate them.	
	Understand the meaning and types of energy, the law of conservation of energy and be able to calculate mechanical energy.	
	Be able to explain momentum and the law of conservation of momentum.	
	Understand the meaning of sliding friction and explain the relationship between frictional force and coefficient of friction.	
	Be able to formulate the equations of motion for the rotational motion of a rigid body.	
	Be able to calculate the moment of inertia of simple geometries.	
	Be able to calculate stresses and strains when a load is applied to a material.	
	Understand the relationship between stress and strain and be able to calculate the elastic modulus and safety factor.	
	Be able to calculate the stresses and deformations of rods subjected to tensile and compressive loads.	
Be able to calculate shear forces and bending moments for different types of beams, at any position on the beam.		

V-A-4 Thermic fluid	Understand the various physical properties that describe the properties of fluids and be able to explain the classification of fluids.	
	Understand how pressure is indicated and the pressure distribution of a stationary fluid and be able to calculate the pressure of a fluid.	
	Understand fluid flow velocities, flow quantities and flow states and be able to apply the laws of conservation of mass and conservation of energy in fluids.	
	Understand the physical quantities fundamental to thermodynamics and the various systems under study, and be able to explain their thermodynamic properties.	
	Understand the first law of thermodynamics and be able to apply the energy equation for various systems and explain the work of various systems using diagrams.	
V-A-7 Instrumentation control	Understand the fundamentals of measurement, including errors, accuracy, uncertainty and systems of units of measurement, and be able to explain the methods and equipment for measuring typical physical quantities.	
	Understand automatic control and be able to explain the basic structure of control systems.	
VI-A Mechanical engineering (experiments and practice ability)	Understand how to use and measure various types of measuring instruments.	
	Learn the basic operation of lathes, milling machines and drilling machines and be able to perform cutting operations.	
	Conduct experiments related to mechanical engineering and be able to prepare for experiments, operate experimental equipment, and organize and discuss the results of experiments.	

3-3.2 Materials-based sectors

Learning area	Achievement goals in multidisciplinary departments/courses	Course considerations
V-B-1 Material properties	Explain the types of bonding of atoms and their characteristics, including bonding forces and examples of substances.	The structure of atoms, bonding patterns and unit lattices may be included in the study of chemistry
	Describe lattice orientation and lattice planes using Miller index.	
	X-ray diffraction techniques can be applied to the analysis of crystal structures.	
	Explain the conduction mechanism of intrinsic semiconductors.	
	Draw the energy bands and impurity levels of impurity semiconductors and explain the conduction mechanism.	
V-B-2 Material organization	Be able to describe the types and characteristics of lattice defects.	
	Explain the relationship between lattice defects and the strengthening mechanisms of metallic materials.	
	Be able to explain the degrees of freedom of the system by determining the degrees of freedom from Gibbs' phase rule.	
	On a binary equilibrium phase diagram, the proportion of each phase can be calculated using the principle of leverage.	
	Be able to explain the formation processes of eutectic, eutectoid and peritectic microstructures using a binary phase diagram.	
	Be able to explain the processes of recovery, recrystallization and grain growth of the working structure and changes in various properties.	
	Be able to explain phase transformations using Gibbs energy changes.	

	Explain the physical meaning of diffusion coefficients.	
V-B-3 Physical chemistry	Explain the concept of the first law of thermodynamics and internal energy.	
	Be able to explain the rules for the signs of internal energy, heat and work, and calculate work of expansion.	
	Be able to define enthalpy and explain that enthalpy is a state quantity.	
	Understand the physical meaning of standard enthalpies of formation and be able to calculate reaction enthalpies.	
	Understand the definition of entropy and explain entropy generation in irreversible processes.	
	Can calculate phase and chemical equilibrium from Gibbs energy changes.	
V-B-4 Mechanics	Be able to calculate stresses and strains when a load is applied to a material.	These may be limited to basic issues
	For various types of beams, shear forces and bending moments can be calculated at any point in the beam.	
	Understand the center of figure and moment of inertia of various cross-sections and be able to calculate the bending stresses in beams subjected to bending moments.	
	Be able to calculate shear strains, shear stresses and torsion angles on axes subjected to torsional moments.	
V-B-5 Environment	Be able to explain the relationship between pollution and human health, and between the environment and human health.	These may be included in the learning content of IV-B Ethics for engineers
	Be able to explain global environmental issues.	
	Be able to explain energy resource issues.	
	Be able to explain the purpose of waste disposal and resource recovery.	
V-B-6 Metallic materials	Be able to explain the pig iron and steel manufacturing process.	
	Be able to explain the standard microstructure and mechanical properties of carbon steels using phase diagrams.	
	Understand the purpose of heat treatment of carbon steel and be able to explain the operation of each heat treatment and the characteristics of the microstructure obtained.	
	Describe the phase diagram and microstructural features of alloy steels.	
	Be able to describe the types, characteristics and typical uses of alloy steels.	
	Explain the strength characteristics, physical and chemical properties of pure aluminum and casting and malleable aluminum.	
V-B-7 Inorganic materials	Be able to describe the properties of pure and compound forms of typical non-metallic elements.	
	Be able to describe the properties of pure and compound forms of typical metallic elements.	
	Explain the uses, manufacturing methods and structure of inorganic materials, including ceramics, carbon materials and inorganic composites.	
	Explain the materials synthesis methods required for mono-crystallization, sintering, thin-film formation, micronization and porous materials.	
	Indicate electron configuration from The Pauli exclusion principle, the energy levels of the orbitals and Hund's rule	

V-B-8 Organic materials	Understand the Lewis structures of organic compounds and use hybrid orbitals to describe bonding states, shapes, polarity and reactions of molecules.	
	Be able to explain that organic compounds are the compounds which have carbon skeletons and convert their structures and names according to IUPAC nomenclature.	
	Be able to explain the types and structures of typical polymer compounds and the various properties of different structures.	
	Understand the characteristics of polymer synthesis reactions such as polycondensation, polymerization, polyaddition and ring-opened polymerization, and explain which polymerization reactions produce the polymers they deal with.	
	Be able to explain the applications, manufacturing methods and structure of polymer composites.	
V-B-9 Design and machining	Understand and utilize the role of drawings, the types and uses of lines, how to draw projections of objects and the role of drawing tools.	
	Understand how to draw manufacturing drawings, indication of dimensions, tolerances and surface properties, and how to sketch parts, and be able to draw manufacturing drawings.	
VI-B Materials (experimental and practical skills)	Learn the basic operation of lathes, milling machines and drilling machines and be able to perform cutting operations.	Students should acquire the basic knowledge to perform basic experiments on materials systems. Basic knowledge for conducting experiments safely may be included in the learning content of IV-A Engineering experimental techniques.
	Be able to observe materials with optical and electron microscopes and evaluate them with regard to their microstructure.	
	Be able to evaluate the strength properties of materials using hardness testers and universal testing machines.	
	Can use analytical instruments to quantitatively assess components, etc.	

3-3.3 Electrical and electronic fields

Learning area	Achievement goals in multidisciplinary departments/courses	Course considerations
V-C-1 Electrical circuits	Understand the relationship between charge, current, voltage and power and use it to calculate circuits.	
	Be able to calculate circuits using the concepts of synthetic resistance and voltage and current dividing.	
	Understand theorems such as Kirchhoff's law and the principle of superposition, and be able to calculate voltage, current and power in circuits.	
	Understand instantaneous values and use them to calculate resistance, inductance and capacitance circuits.	
	Understand phasors and complex representations and be able to use these to calculate sinusoidal AC circuits.	
	Explain impedance and admittance and be able to calculate these.	
V-C-2 Electromagnetism	Be able to explain electric charge and Coulomb's law and calculate the forces, etc. acting on a point charge.	
	Be able to describe electric fields, potentials, lines of electric force and electric fluxes and perform calculations using these.	
	Be able to explain Gauss's law and use it to calculate electric fields.	
	Be able to explain capacitance and calculate the capacitance of e.g. parallel plate capacitors.	
	Explain series and parallel connections of capacitors and calculate their combined capacitance.	
	The magnetic field created by a current can be calculated using Ampere's law.	
	Be able to explain the Lorentz forces acting on currents in magnetic fields.	

	Be able to explain electromagnetic induction and calculate induced electromotive force.	
V-C-3 Electronic circuits	Explain the characteristics of diodes.	
	Be able to describe the characteristics and equivalent circuit of a bipolar transistor.	
	Explain the characteristics of operational amplifiers.	
	Be able to explain the operation of basic circuits using operational amplifiers.	
V-C-6 Measurement	Explain basic and assembly units in the SI system of units.	
	Understand the principle of operation of indicating instruments and explain how they are used to measure voltage and current.	
	Explain the principle of operation of an oscilloscope.	
VI-C Electrical and electronics (experimental and practical skills)	Be able to measure the electrical characteristics of direct current and alternating current using laboratory equipment, instruments and information devices.	
	Be able to measure electrical quantities in DC circuits and discuss the results.	
	Be able to measure electrical quantities in AC circuits and discuss the results.	

3-3.4 Information sector

Learning area	Achievement goals in multidisciplinary departments/courses	Course considerations
V-D-1 Programming	Understand the basic structure of programming and be able to write programs.	
	Understand the concept of subroutines and be able to write programs containing them.	
	For a given problem, be able to write a source program to solve it.	
	Analyze a given source program and predict the behavior of the program.	
	Be able to use the tools required for software generation and to run source programs.	
V-D-2 software	Understand the concept of algorithms and be able to explain how a given algorithm solves a problem.	
	Explain that algorithms can be compared and evaluated according to computational complexity.	
	Understand that there are variations in the way data is represented inside computers (data structures) and be able to explain basic data structure concepts and operations.	
	Explain that errors can occur due to the way numerical values are represented and calculated on a computer.	
V-D-3 Computer engineering	Integers and decimals can be expressed in binary, decimal and hexadecimal, and can be converted between each other.	
	Explain how integers and decimals can be represented digitally in computer memory.	
	Perform basic logical operations.	
	Combine basic logical operations to express logical functions as Boolean algebraic expressions.	
	Be able to explain the role of the basic elements that make up a computer and describe the main technologies that make each element possible.	
V-D-4 Computer systems.	Be able to describe the features and typical examples of each type of computer system processing.	
	Be able to explain the process of designing a system according to user requirements.	

V-D-5 system program	Explain the position of operating systems in computer systems.	
V-D-6 Information and communication networks	Understand the concept of protocols and be able to explain the concept and benefits of hierarchy.	
	Be able to explain concepts such as the Internet and local area networks.	
V-D-7 Information mathematics and information theory	Understand basic concepts about sets and be able to perform set operations.	
VI-D Information systems (experimental and practical skills)	Be able to write a source program to solve a given problem using standard development tools and development environments.	
	Be able to use standard methods to produce a blueprint of the program to be created.	

3-3.5 Chemical and biological fields

Learning area	Achievement goals in multidisciplinary departments/courses	Course considerations
V-E-1 Organic chemistry	For organic compounds, use IUPAC nomenclature to link structures to names.	
	Be able to describe the properties of typical functional groups and show their reactions and methods of introduction.	
	Be able to explain the properties and synthesis of typical polymeric compounds.	
V-E-2 Inorganic chemistry	Be able to explain the structure, types and properties of atoms.	
	Be able to describe the structure, bonding states and properties of elements and compounds.	
V-E-3 Analytical chemistry	Be able to calculate units as a way of expressing physical quantities.	
	Be able to describe changes of state due to chemical reactions (e.g. precipitation formation, complex formation, ionization) and physical phenomena, and perform the necessary quantitative calculations.	
	Understand the purpose and characteristics of standard instrumental analysis and be able to select according to the analytical target.	
V-E-4 Physical chemistry	Understand the properties of gases and be able to perform relevant calculations.	
	The molecular weight of a solute can be calculated from its freezing point depression, boiling point rise, osmotic pressure, etc.	
	Be able to explain the first, second, and third laws of thermodynamics and perform related calculations.	
	Chemical equilibrium can be explained and relevant calculations can be made.	
	Reaction rates can be explained and relevant calculations can be made.	
	Be able to describe typical chemical batteries.	
	Understand the significance of quantum chemistry and be able to explain its role.	
V-E-5 Chemical engineering	Understand the basic content of chemical engineering stoichiometry (units, mass balance, etc.) and unit operations, and be able to perform various calculations.	Not required in biological departments.
	Be able to explain the basics of understanding basic equipment and unit operations in chemical plants, including fluid transport and reactors.	
V-E-6 Biochemistry.	Be able to explain carbohydrates, proteins, nucleic acids and lipids, linking their function in vivo to their chemical structure and properties.	

	Understand the role and properties of enzymes and their role in vivo, and be able to determine K_m and V_{max} based on enzyme reaction kinetics.	
	Be able to explain the relationship between metabolic changes and energy input/output.	
V-E-7 Biotechnology.	Understand the types and characteristics of cell organelles and be able to describe cell structures.	Not required in chemistry departments.
	Understand the mechanisms for maintaining homeostasis in living organisms and be able to describe the techniques applied.	
	Understand the growth of micro-organisms and be able to describe culture methods.	
	Be able to explain the use of micro-organisms, animal and plant cells, etc.	
	Understand the principles of genetic engineering technology and be able to explain how it can be applied.	
VI-E Chemical and biological sciences (experimental and practical skills)	Understand the content of the experiment and be able to carry out the experiment in a safe manner.	
	Understand experimental manipulation and be able to carry out synthesis experiments using appropriate glassware etc.	
	Learn how to handle micro-organisms, biological samples and enzymes.	Not required in chemistry departments.
	Understand the mechanism of the experimental apparatus, learn how to handle it, and be able to analyze the data obtained.	

3-3.6 Construction sector

Learning area	Achievement goals in multidisciplinary departments/courses	Course considerations
V-F-1 Surveying	Be able to explain angular surveying methods and perform calculations from survey results.	
	Be able to explain distance surveying methods and perform calculations from survey results.	
	Be able to explain the method of level surveying and perform calculations from survey results.	
V-F-2 Materials	Explain terms and definitions relating to mechanical and physical properties required of materials.	
	Be able to describe the types and shapes of steel.	
	Explain the mechanical properties of steel with regard to stress-strain relationships, yield stress, tensile strength and modulus of elasticity.	
	Be able to describe the physical and chemical properties of cement.	
	Be able to explain the characteristics and uses of various types of cement.	
	Be able to describe the water content, density, grain size and actual volume fraction of aggregates.	
	Be able to describe the types and characteristics of aggregates.	
	Be able to describe the types and characteristics of admixtures and admixtures.	
	Explain the advantages and disadvantages of concrete.	
	Explain the workability, slump and air content of fresh concrete.	
	Explain the compressive strength, stress-strain curve, modulus of elasticity and drying shrinkage of hardened concrete.	

	<p>Be able to explain frost damage, alkali-silica reaction, neutralization and salt damage with regard to the durability of hardened concrete.</p> <p>Understand and be able to calculate formulation design procedures.</p> <p>Be able to describe the structure and features with regard to reinforced and prestressed concrete.</p> <p>Be able to explain the allowable stress design method and limit state design method, which are typical design methods for concrete structures.</p> <p>Be able to describe the failure modes of members subjected to bending moments and consider their safety against sectional failure.</p> <p>Calculation of cross-sectional stresses in members subjected to bending moments and safety against cracking can be considered.</p> <p>Be able to describe the failure modes of members subjected to shear forces and consider their safety against shear forces.</p> <p>Explain the basics of maintenance, non-destructive testing, repair and reinforcement of concrete structures.</p>	
V-F-3 Structure	<p>Be able to explain the definition of cross-sectional quantities (e.g. primary moment of section, figure center, secondary moment of section) and calculate them.</p> <p>The system is able to calculate the fulcrum reaction forces for simple, cantilevered, overhanging and gerber shear beams, and to calculate and illustrate the sectional forces occurring in these beams.</p> <p>Be able to describe trusses and their member types and calculate member forces.</p> <p>Be able to explain differential equations of deflection and calculate deflections and deflection angles.</p>	
V-F-4 Ground	<p>Be able to explain the formation, basic physical quantities and structure of soil.</p> <p>Be able to explain the different types of foundations and their bearing capacity formulae and apply them to the calculation of bearing capacity of earth structures.</p> <p>Be able to explain the classification and content of geotechnical investigations.</p>	
V-F-5 Hydraulics	<p>Be able to explain the system of units used in hydraulics.</p> <p>Be able to explain hydrostatic and total water pressure and calculate the magnitude and point of action of total water pressure acting on planar and curved surfaces.</p> <p>Be able to explain Bernoulli's theorem (total head and each head) and apply it to calculations (Torricelli's theorem, Pitot tube, Venturi meter).</p> <p>Be able to explain the law of conservation of momentum and apply it to calculations (forces acting from the fluid).</p>	
V-F-6 Environment	<p>Be able to explain the relationship between pollution and human health, the environment and human health, and the relationship between each.</p> <p>Be able to calculate water pollution expressed in terms of loadings and explain transfer processes and water quality transformation processes.</p> <p>Understand water supply planning and unit operations for water purification and be able to perform calculations related to these.</p> <p>Be able to explain sewerage planning and sewerage system configuration and perform calculations relating to these.</p>	

V-F-7 Planning	Be able to explain the historical evolution of urban planning in Japan and the rest of the world.	
	Be able to explain urban planning zones, zoning and zoning districts.	
	Be able to explain the concept of land readjustment projects and urban redevelopment projects as a method of urban development.	
V-F-8 Construction and legislation	Be able to explain each process of construction execution.	
	Be able to explain basic construction planning and control items.	
	Be able to explain the purpose of earthworks and construction methods.	
	Be able to explain the purpose and construction methods for each type of foundation works.	
V-F-9 Drafting	Explain line types, text, drawing content and drawing methods.	
	Be able to explain the functions and use of CAD software.	
	The designs can be drawn and used in CAD software.	
VI-F Construction (laboratory and practical skills)	Be able to handle equipment used in construction site surveying.	
	Understand and be able to test concrete for slump, air content and strength using equipment.	
	Official tests (JIS) to assess the physical or mechanical properties of soils can be carried out.	

3-3.7 Architectural fields

Learning area	Achievement goals in multidisciplinary departments/courses	Course considerations
V-G-1 Materials	Be able to describe the types of structural materials and their characteristics (e.g. mechanical properties, durability).	In knowledge, it is sufficient to be able to explain the most important items (bolded items in textbooks, etc.). In terms of calculation, the student should be able to solve simple problems using formulae. Structural materials may be included in the content of other fields of study.
	Describe the types, properties and use of finishing materials.	
V-G-2 Structure.	Calculate the stresses in static ramen and static trusses.	In knowledge, it is sufficient to be able to explain the most important items (bolded items in textbooks, etc.). In terms of calculation, the student should be able to solve simple problems using formulae. Stress calculations may be included in other areas of study.
	Be able to calculate cross-sectional parameters.	
	Be able to give an overview of timber, steel and reinforced concrete structures and their features and structural forms.	
V-G-3 Environment and equipment	Explain solar, light, thermal, air and sound environments.	In knowledge, it is sufficient to be able to explain the most important items (bolded items in textbooks, etc.). In terms of calculation, the student should be able to solve simple problems using formulae.
	Explain water supply and drainage systems, air conditioning systems and electrical installations.	
V-G-4 Planning and history	Be able to explain flow lines and modus operandi.	In knowledge, it is sufficient to be able to explain the most important items (bolded items in textbooks, etc.). In terms of calculation, the student should be able
	Be able to explain the basic dimensions involved in architectural design.	
	Be able to explain the planning of residential, educational and welfare, cultural and social, medical and business facilities.	

	Be able to describe the characteristics of architectural styles from ancient to early modern times.	to solve simple problems using formulae.
V-G-5 Construction and legislation	The construction process can be explained.	In knowledge, it is sufficient to be able to explain the most important items (bolded items in textbooks, etc.). In terms of calculation, the student should be able to solve simple problems using formulae. The five major control items may be included in the content of other areas of study.
	Explain the characteristics of the five major control items (quality, cost, process, safety and environment).	
	Provide an overview of the various types of construction works.	
	Be able to explain the system of law.	
	Be able to explain the content of stand-alone provisions.	
	Be able to explain the content of the collective provisions.	
V-G-6 Design and drafting	Understand the various types of architectural drawings and the scale and scale of drawings, and be able to reflect this in the drafting of drawings.	Issues should include housing.
	Based on the given conditions, the spatial configuration can be put together based on concepts, taking into account flow lines and zoning.	
	Be able to produce requested drawings (e.g. layout plans, floor plans for each floor).	
VI-G Architectural (laboratory and practical skills)	The physical properties of the structural materials used in construction or the physical properties of the environment surrounding the building can be determined by experimentation.	Have a basic knowledge of conducting experiments on architectural systems.
	Ability to handle surveying instruments.	

Chapter 4: Fundamental qualities and competencies engineers should acquire

4-1 VII Versatile generic skills

4-1.1 VII-A Communication skills

[Learning achievement goals]		
1 Goals Basic skills common to all areas are broadly classified into (1) Interpersonal Skills and (2) Personal Skills. (1) Interpersonal Skills include 'communication skills' and 'teamwork and leadership', while (2) Personal Skills include 'information gathering, use and dissemination', 'thinking skills' and 'problem finding skills and problem-solving skills'. The aim is to acquire and develop these skills through academic learning and other activities.		
2 Concept of instructional design In all subjects it is envisaged that achievement goals and learning content will be set by combining the knowledge and skills specific to each field with the skills included in this area, and that students' achievement will be measured and evaluated through their learning activities and reflection on their learning outcomes. In particular, the Courses of Study for Senior High Schools identify three elements of academic ability: "knowledge and skills", "the ability to think, make judgement and express" and "motivation to learn". Instruction design in each subject is expected to promote the development of these abilities. Based on this, KOSENs are also required to design classes that promote the development of each element "basic skills" and "field-specific specialized skills" as well as the general transferable skills indicated in this area.		
Learning contents	Achievement goals	Keywords
Communication skills	Be able to show an attitude of respect and consideration toward others in order to understand their ideas and arguments.	Listening (empathy, response, attitude), questioning, consideration for others, understanding and respecting diversity, etc.
	Be able to communicate their ideas and arguments in a manner appropriate to their purpose.	Claims, assertive communication, logical explanations, claims and arguments, presentations, use of charts, etc., networking, social networking, etc.
	Be able to take action to form good relationships with diverse others.	Trust, civility, anger management, respect and consideration for diversity, cross-cultural, intergenerational and social interaction.

4-1.2 VII-B Teamwork and leadership

Learning contents	Achievement goals	Keywords
Teamwork and leadership	Be able to take action towards building consensus in team activities, taking into account disagreements and conflicts.	Respect for different opinions and ideas, understanding and sharing the background and purpose of discussions and work, organizing issues, negotiation, etc.
	Be able to take action to encourage the formation, maintenance and improvement of collaborative team relationships.	Team building, understanding and respecting diversity, building trust, understanding members' characteristics and strengths.
	Be able to share goals for team activities, implement actions to achieve those goals and also to promote team collaboration.	Understanding and sharing team goals and principles, understanding roles within the team, promoting effective collaboration to achieve goals, (presenting team goals, principles and direction)

4-1.3 VII-C Ability to collect, use and disseminate information

Learning contents	Achievement goals	Keywords
Information gathering, utilization and dissemination skills	Be able to use a variety of means, including digital tools and various media, to gather information.	Gathering information using a variety of media and tools, and understanding the characteristics of media and tools.
	Be able to verify and evaluate information, taking into account its reliability, validity and effectiveness.	Understanding the characteristics of the media and the nature of information, bias, verifying the reliability and validity of information and discarding information.
	Be able to use and effectively disseminate information using appropriate methods, taking into account the rights of self and others.	Knowledge of copyright and human rights, recognition of wrongdoing, appropriate use of information, appropriate dissemination of information and effective use of information.

4-1.4 VII-D Thinking skills

Learning contents	Achievement goals	Keywords
Ability to think	Be able to analyze complex events and occurrences.	Analytical thinking, relationships between elements, etc.
	Be able to critically examine information and claims.	Critical thinking, elimination of bias, evidence and conclusions, etc.
	Be able to consider how to present information and arguments persuasively.	Reasonable explanations, claims and evidence, evidence, illustrations, etc.

4-1.5 VII-E Problem-finding and problem-solving skills

Learning contents	Achievement goals	Keywords
Problem-finding and problem-solving skills	Be able to analyze the events and occurrences faced and identify the issues that need to be addressed.	Application of analytical thinking, purpose-measure (rational) thinking, application of knowledge and information, cost-effectiveness, etc.
	Be able to grasp the issues contained in the gap between the current situation and the ideal to be achieved, based on an analysis of the current situation.	Future orientation, grasping the gap between the ideal and the current situation, application of analytical thinking, application of critical thinking, etc.
	Be able to set goals to be achieved in order to solve problems and realize ideals, and also to consider specific action plans.	Prioritization, development of action plans (including targets, deadlines, etc.), setting of action goals (quantitative targets, KGIs, KPIs, etc.), etc.

4-2 VIII Fundamental qualities and competencies

4-2.1 VIII-A Self-understanding

[Learning achievement goals]		
1 Goals		
This section presents areas relating to the values, attitudes, characteristics and tendencies of the learner that underlie not only knowledge, but also judgements and behavior. This section covers "independence", "self-understanding", "self-management and responsible behavior", "ethics", "career design" and "continuous learning and the purpose of learning." Through various study activities, the goal is to understand one's own values, attitudes, characteristics and tendencies, and to achieve transformation through learning and self-reflection.		
2 Concept of instructional design		
As with versatile generic skills, it is envisaged that in all subjects, in addition to knowledge and skills in the field, learning content should be set up to facilitate this by presenting desirable behavioral characteristics, etc. as achievement goals. It is desirable to design classes that support and promote the students' reflective recognition of their learning activities and achievements, and their orientation towards a desirable state based on an understanding of their own characteristics.		
In particular, the Courses of Study for Senior High Schools identify three elements of academic ability: "knowledge and skills", "the ability to think, make judgement and express" and "motivation to learn".		
Instruction design in each subject is expected to promote the development of these abilities.		
Based on this, KOSEs are also required to design classes that promote the development of each element "basic skills" and "field-specific specialized skills" as well as the general transferable skills indicated in this area.		
Learning contents	Achievement goals	Keywords
Self-understanding	Be able to reflect on their own experiences and activities and recognize their own ideas and values.	Reflective thinking, portfolios, objectivity, stress perception, traits, strengths, resilience, wellbeing, etc.
	Be able to consider necessary responses and actions based on self-understanding.	Adaptation, interpretation and evaluation of experiences, stress coping, stress management, etc.

4-2.2 VIII-B Initiative

Learning contents	Achievement goals	Keywords
Independence	Be able to recognize their own roles and behaviors.	Recognition and understanding of one's role, understanding of the significance and purpose of one's role, proactively thinking about one's role, etc.
	Be able to put into practice the roles and actions they are expected to fulfil.	Practicing assigned roles in group work, etc., practicing roles voluntarily, thinking about the roles expected of them autonomously, etc.

4-2.3 VIII-C Self-management and responsible behavior

Learning contents	Achievement goals	Keywords
Self-management and responsible behavior	To be able to grasp and identify the roles and behaviors expected of them.	Recognition and understanding of roles and responsibilities, understanding of the meaning and purpose of roles and responsibilities, understanding of the impact of decisions and actions, responsibility as a duty and responsibility at will, etc.
	Be able to think of specific actions and plans to carry out what needs to be done.	Task management, scheduling, planning and checking, stress coping, stress management, etc.
	Be able to practice the roles and behaviors expected of them and reflect on the process and results.	Understanding the consequences of decisions and actions, reflective thinking, etc.

4-2.4 VIII-D Ethics

Learning contents	Achievement goals	Keywords
Ethics	Be able to consider and evaluate their decisions and actions, and their consequences and impacts, from an ethical perspective.	Understanding of social rules and manners, understanding of the meaning, purpose and value of norms, ethically valid decisions, accountability to third parties, etc.
	Be able to reflect on and express their ethical foundations for decision-making and behavior.	Values, ethics, self-understanding, etc.

4-2.5 VIII-E Career design

Learning contents	Achievement goals	Keywords
Career design	Be able to reflect on their own experiences and behaviors and identify their own characteristics and strengths.	Identification of external and internal careers, identification of one's strengths and characteristics, and actions based on strengths and characteristics.
	Be able to plan for their future careers.	Thinking about a career as a professional (e.g. engineer), designing a career that makes use of your characteristics and strengths, planning for the realization of your career design, etc.
	Be able to consider the roles required of professionals (e.g. engineers) in the context of society, the environment and their impact on people.	Thinking about the role and contribution of professionals (e.g. engineers) to solving society's problems and achieving the challenges, considering their own ideals and goals as professionals (e.g. engineers), etc.
	Be able to describe the work of professionals (e.g. engineers).	Understanding of the work and practices of professionals (e.g. engineers), understanding of the roles and practices of professionals (e.g. engineers) in corporate activities, etc.
	Be able to explain the social significance and responsibilities of various industries, professions and companies.	Understanding of sector, industry, etc., corporate activities and the social role of companies, Social Responsibility (SR), Socially Responsible Investment (SRI), etc.

4-2.6 VIII-F Ongoing learning and learning objectives

Learning contents	Achievement goals	Keywords
Continuous learning and learning objectives	To be able to assess the learning situation and learning outcomes and consider learning plans according to their characteristics, needs and objectives.	Portfolio, consideration of learning and working purpose, metacognition of learning, content of learning, consideration of learning styles, understanding and consideration of different ways of learning
	Be able to inspect their own learning activities and learning content and consider improvements in order to realize independent and continuous learning.	Reflecting on one's learning, understanding learning, learning activities and learning outcomes, planning and implementing learning

Chapter 5: Creativity and design competencies that engineers should acquire

5-1 IX Creativity and design skills

5-1.1 IX-A Creativity

[Learning achievement goals]		
1 Goals The students are able to tackle problems for which no answers have been given in advance, define the problems to be addressed and create solutions after examining them from various perspectives, making full use of the knowledge and skills in their respective fields of expertise. They are also able to define engineering requirements from the perspective of clients and users, and to think about and implement processes to realize these requirements.		
2 Concept of instructional design In subjects that aim to develop creativity and engineering design skills, for example, the design of learning activities that aim to solve problems and achieve tasks based on complex events (e.g. real-life problems and first-hand examples) is envisaged. It is required to be developed and evaluated through learning activities such as group activities, collaborative education with local communities and companies, and social implementation education. It is assumed that through these learning activities incorporating 'creativity' and 'engineering design', the learning objectives in the specialized fields of each technical college will reach Level 4.		
Learning contents	Achievement goals	Keywords
Creativity	Be able to recognize and accept the importance of diverse ways of perceiving things and perspectives outside their field of expertise.	Humanities and social science perspectives, economic and business perspectives, artistic thinking, liberal arts, etc.
	Be able to analyze events from multiple perspectives and define the issues to be addressed.	Analytical thinking, critical thinking, value conflicts (e.g. efficiency, rationality, safety, quality, cost, ethics), defining problems and setting issues
	Be able to consider solutions to problems for which no answers are given in advance, using a variety of knowledge in an integrated way.	Integrated thinking, safety considerations, multiple values, creating solutions, etc.

5-1.2 IX-B Engineering design capability

Learning contents	Achievement goals	Keywords
Engineering design capability	Be able to grasp the requirements of clients and users and the functions to be implemented as engineering requirements.	Design thinking, empathic attitude, client/user orientation, understanding needs, defining requirements, social implementation, etc.
	Be able to examine multiple solutions under various constraints and propose the optimal solution based on engineering perspectives.	Design thinking, QCD (quality, cost and delivery), multidimensional thinking, optimal solutions under constrained conditions, social implementation, etc.
	Be able to plan concretely about the process of implementing engineering problem-solving methods and carry it out while monitoring progress.	Project management, process design and management, teamwork, leadership, social implementation, etc.

Part 3:

Advancing and distinguishing KOSEN education
with MCC Plus

Chapter 1: Advancing and distinguishing KOSEN education with MCC and MCC Plus

The MCC defines the minimum standards for KOSEN education and plays a key role in ensuring educational quality by being incorporated into each KOSEN's curriculum. However, education at each KOSEN is not limited to the MCC. Each KOSEN is expected to define its own vision for the type of human capital it aim to develop, establish a Diploma Policy that embodies this vision, and independently structure its curriculum to realize it. To do so, each KOSEN must continuously enhance its educational content to meet the evolving needs of local communities and industries while also fostering future leaders in society and industry. NIT supports and promote the and distinction of KOSEN education through various large-scale initiatives by utilizing its economies of scale. Each KOSEN can leverages the outcomes of these initiatives to further advance and differentiate its educational programs.

To support and promote the expansion and of each KOSEN's distinctive education, the MCC, which was made public in 2023, decided to present a set of achievement goals called MCC Plus. These goals in the MCC Plus are based on the outcomes of various projects that NIT has been studying and implementing (Fig.1). The learning areas shown in the diagram below are examples and are not limited; MCC Plus continues to study and incorporate educational contents and methods relevant to the evolving need of society and industry and share them.

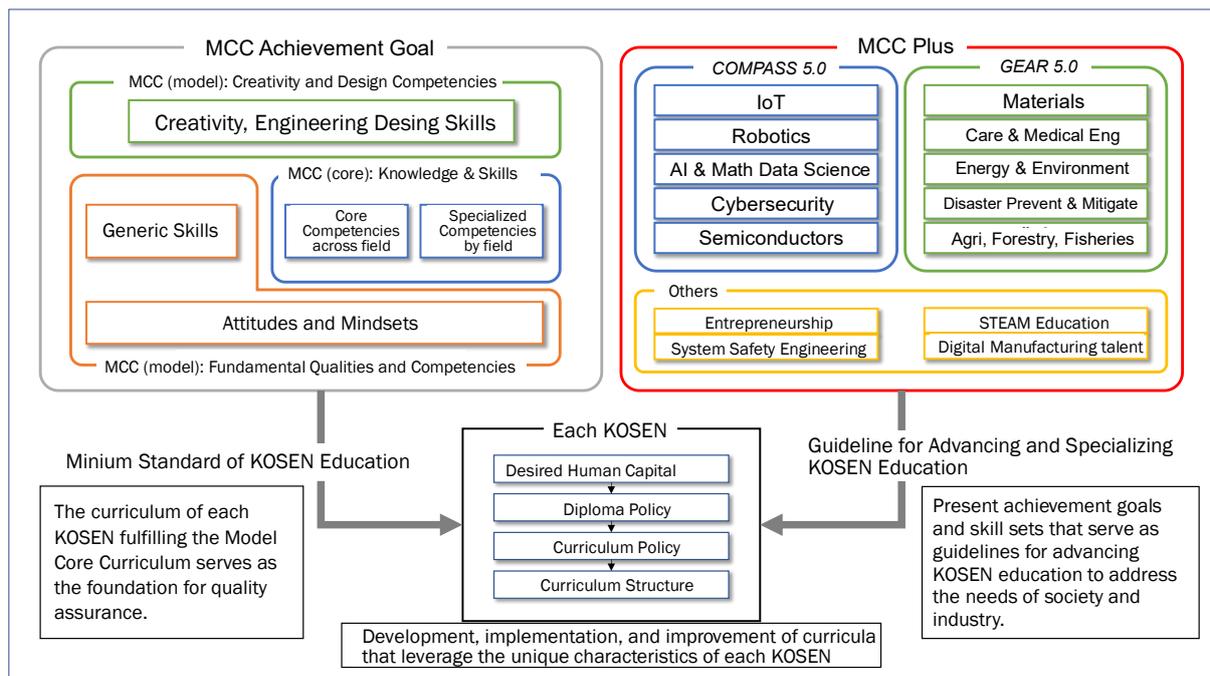


Figure 1: MCC achievement goals and MCC Plus

1-1 Relationship between curriculum management, MCC and MCC Plus at each KOSEN

While MCC defines the minimum standard for KOSEN education – the essential learning content and achievement levels – MCC Plus is a set of achievement goals that organizes the learning content and objectives expected to be actively introduced by each KOSEN. This includes the knowledge and skills that students should acquire to become the human capital expected by society and industry. Therefore, when organizing the curriculum, each KOSEN is not required to include all the content outlined MCC Plus. However, it is expected that each KOSEN will use MCC Plus as a reference guideline when designing its curriculum, leveraging its own unique characteristics, rather than simply following the learning content and achievement levels outlined as the minimum standards in the MCC.

The MCC achievement goals define the minimum standards for KOSEN education and are scheduled to be revised approximately every five years. These serve as guidelines that will be referred to for a certain period when designing the curriculum at each KOSEN. In contrast, the learning content included in the MCC Plus is reviewed and organized as needed, in response to changes in social conditions and trends in academic progress. As a result, MCC Plus may play a complementary role to MCC, which serves as a foundation valid for a certain period. The learning content contained in MCC Plus may also be considered when revising the MCC.

As indicated in Part 1, each KOSEN establish its Diploma Policy by leveraging its unique characteristics while incorporating the MCC achievement goals as a tangible representation of the human capital it aims to develop. The distinctive features of each KOSEN reflect its regional characteristics, history, and areas of specialization, while also striving to enhance educational quality in response to increasingly diverse and complex social and industrial needs. To achieve this, it is beneficial to upgrade the educational content of each KOSEN by utilizing the outcomes of projects conducted by NIT, leveraging its economies of scale. In these projects, the knowledge and skills expected of human capital by society are identified, and effective teaching materials and educational methods are developed and shared to help students acquire these competencies. By leveraging these resources, NIT aims to improve the overall educational level of all KOSENs while also advancing the education at each KOSEN (Fig.2).

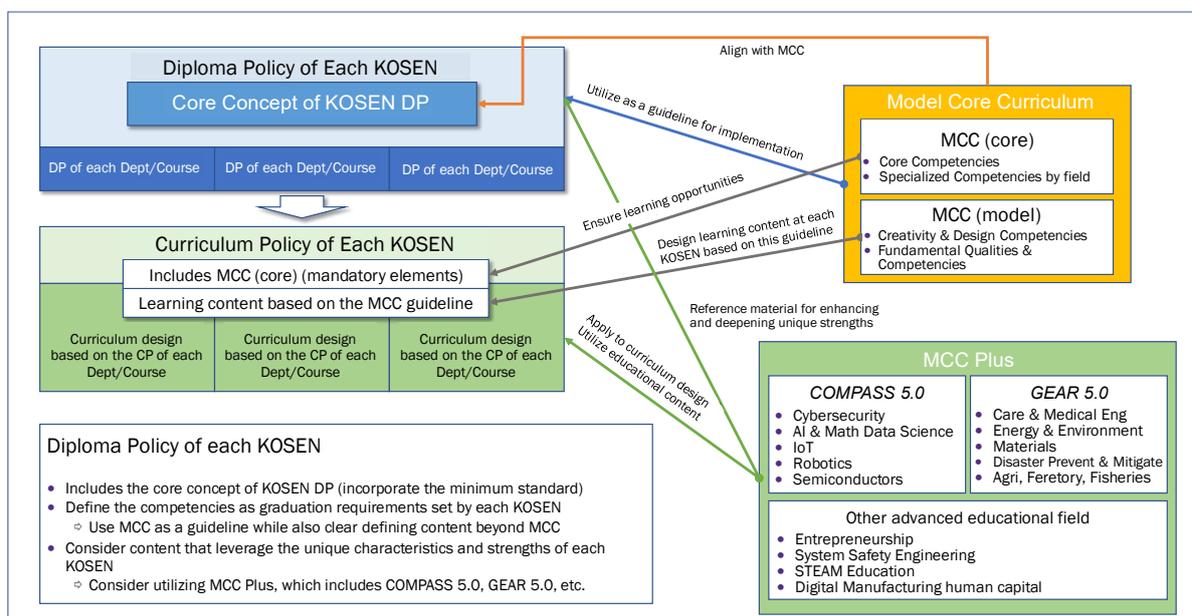


Figure 2: Relationship between the Diploma Policy and Curriculum Policy of each KOSEN, MCC and MCC Plus

1-2 Core concepts of MCC Plus content and its implementation

MCC Plus presents learning content and achievement goals that are not covered by the MCC achievement goals, addressing various social needs. However, not all learning content outside the scope of MCC achievement is considered part of MCC Plus.

MCC Plus will be examined and organized by leveraging the advantages of scale at all national KOSENs, positioning it as a guideline for the direction of education. For this reason, the learning content to be included in MCC Plus is primarily determined based on the results of projects conducted by the NIT in cooperation with national KOSENs, with the aim of enhancing education. As of 2022, NIT is working with each KOSEN on several key projects (Table 1), including: [KOSEN-Originated! “Society 5.0-Aligned Future Technological Human Capital” Development Project: COMPASS 5.0], [KOSEN-Originated! “Society 5.0-Aligned Future Technological Human Capital” Development Project: GEAR 5.0], [Early Identification of Science and Engineering Talent and Enhancement of Diversity-Oriented STEAM Education], [Shifting toward Human Capital Education for Innovation-Driven Manufacturing and Design].

Based on the progress of the project, the outcomes of the [KOSEN-Originated! “Society 5.0-Aligned Future Technological Human Capital” Development Project COMPASS 5.0] (hereafter referred to as “COMPASS 5.0”) will be presented in the MCC Plus, alongside the MCC 2023 achievement goals. Additional content may be included incorporated depending on the progress of various ongoing projects. Unlike the MCC achievement goals, MCC Plus is designed to be dynamic, allowing for additions, revisions, or deletions as needed, in response to changes in social conditions, trends in academic development, and the progress of projects at each KOSEN.

Table 1: Examples of major educational projects undertaken by NIT

<p>As of 2022, the following are examples of projects of NIT aimed at supporting and promoting the enhancement and of educational programs at each KOSEN. We plan to organize these projects as MCC Plus and present them as a reference guideline for curriculum management at each KOSEN, while monitoring their progress in the future.</p> <ul style="list-style-type: none"> ○ <u>KOSEN-Originated! “Society 5.0-Aligned Future Technological Human Capital” Development Project: COMPASS 5.0</u> This project aims to identify and organize the knowledge and skills required in industrial fields for the realization of Society 5.0 and to support and promote their introduction and implementation in KOSEN education nationwide. <ul style="list-style-type: none"> • AI and Mathematical Data Science • Cybersecurity • Robotics • IoT • Semiconductors ○ <u>KOSEN-Originated! “Society 5.0-Aligned Future Technological Human Capital” Development Project: GEAR 5.0</u> Aiming to develop human capital who will be at the heart of future technologies, this project seeks to create an educational curriculum for next-generation basic technologies through research and development in collaboration with companies, local governments and universities. Since 2022, activities have been conducted in the following five areas: <ul style="list-style-type: none"> • GEAR Material • GEAR Care and Medical engineering • GEAR Disaster Prevention and Mitigation • GEAR Agriculture, Forestry and Fisheries • GEAR Energy and Environment ○ <u>Early Identification of Science and Engineering Talent and Enhancement of Diversity-Oriented STEAM Education</u> The project, lunched in 2022, aims to explore, develop, and implement STEAM education at KOSEN to help develop human capital through early STEAM education. ○ <u>Shifting toward Education that Fosters Human Capital Capable of Driving Innovation through ‘Mono-zukuri’</u> The project, launched in 2022, aims to develop education that fosters human capital capable of driving innovation through product manufacturing and service innovation (<i>Mono-zukuri</i>), as well as human capital for the digital transformation of society, by enhancing entrepreneurship education and shifting towards digital manufacturing education, while leveraging the strengths of KOSEN education.
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The specific ideas and guidelines for curriculum organization, along with specific and materials – such as content applicable to individual class design – will be presented separately as the results of the COMPASS 5.0 projects.

Chapter 2: MCC Plus: COMPASS 5.0 (Achievement goals in Next-generation fundamental technology fields)

MCC Plus, developed alongside the MCC achievement goals, defines the achievement goals and skill sets identified and structured in COMPASS 5.0. An overview of COMPASS 5.0, and outline of the achievement goals and skill sets in each area are describe below.

2-1 About the COMPASS 5.0 project

COMPASS 5.0 is a project aimed at advancing KOSEN education in five key fields: AI and Mathematical Data Science, Cybersecurity, Robotics, IoT and Semiconductors (hereinafter referred to as “Next-Generation Fundamental Technology Fields”) to develop human capital for innovation. Studies and educational practices are being conducted through collaboration between KOSENs that serve as hubs for each field of study and KOSENs responsible for practical studies, with the outcomes of these efforts shared through various opportunities. To advance KOSEN education in the Next-Generation Fundamental Technology Fields, COMPASS 5.0 is developing an educational package that includes the following content:

① Achievement goals and skill sets

Organized targets for acquiring the knowledge and competencies required in Next-Generation Fundamental Technology Fields.

② Teaching materials

Education resources designed to support the achievement goals and skill sets.

③ Teacher training and examples of educational practices

A collection of case studies on educational practices primarily conducted at hub KOSENs and KOSENs responsible for practical studies within the COMPASS 5.0 project.

The “Achievement Goals and Skill Sets” will be provided as the MCC Plus 2023. The complete COMPASS 5.0 deliverables, including teaching materials and case studies, are provided by relevant project leaders of the COMPASS 5.0.

The “Achievement Goals and Skill Sets” set in each of the COMPASS 5.0 project areas have been organized in consultation with industry associations and consortia in related fields, as well as with reference to qualification examinations. Many of the achievement goals and skill sets are not minimum standards for KOSEN education; instead, they provide guidelines for enhancing and deepening the unique characteristics and strengths of each KOSEN. However, the Next-Generation Fundamental Technology Fields targeted by COMPASS 5.0 are areas that will shape the future social infrastructure of Japan and the world. Therefore, it is highly beneficial to actively incorporate these fields into the curriculum of each KOSEN. In this context, alongside the quality assurance of the Model Core Curriculum as a minimum standard for KOSEN education, the achievement goals and skill sets in the Next-Generation Fundamental Technology Fields should serve as a guideline for the specialization and enhancement of education at each KOSEN.

2-2 MCC Plus 2023 : Achievement goals in Next-generation fundamental technology fields (Skill sets)

The set of achievement goals (skill sets) presented as MCC Plus will follow the same format as the MCC (core) field-specific professional competencies. MCC Plus 2023 will consist of a set of achievement goals aligned to the four COMPASS 5.0 fields (AI and Mathematical Data Science, Cybersecurity, Robotics and IoT). In each of these fields, the “profile of human capital to be developed” is defined based on an understanding of the needs of the relevant industrial field. The qualities and

competencies required for these human capital are organized accordingly. Some of the achievement goals in each field will overlap with those included in the MCC achievement goals. The content from the MCC achievement goals is also presented in a way that provides a clear overall profile of the human capital to be developed in each field (Fig.3).

Learning Content	Achievement Goals	Reference Learning Items	MCC Compliant
Fundamentals of Information Technology	Understand that information technology is advancing rapidly and be aware of the social changes and challenges that come with it.	Society 5.0, Digitalization, Internet addiction, Gaming addiction, Cyberbullying, Impact of system downtime, Technology obsolescence	IV-C
	Understand about typical information systems and their forms of use.	Information terminals, Groupware, Cloud (SaaS, IaaS, PaaS), On-premises, Public Systems and services (Financial, Weather, Disaster Management), Virtualization	IV-C
	Understand the structure of a computer and the role of the operating system (OS), and be able to handle the basics.	Data, File management, Accounts (ID, Passwords), Storage media (e.g. External storage devices, Cloud), Operating systems, Application software, Computer components	IV-C
	Be able to operate office applications (e.g. document creation, spreadsheets, presentations).	Office applications, Tabular data, Spreadsheet functions (e.g. SUM, AVERAGE)	-

Indicate the achievement goals that students should

Use these as a reference when designing specific learning content in classes.

Show the alignment with MCC Achievement Goals:

- If aligned, specify the corresponding MCC achievement goal code
- If not aligned, indicate with “ - ”

※ The expressions of achievement goals in MCC Plus may not always match those in MCC. Alignment is determined by reviewing relevant items, such as “Reference items for learning”

Figure 3: MCC Plus description format

2-2.1 COMPASS 5.0: AI and Mathematical Data Science

[Project summary]

To realize Society 5.0, it is essential for society as a whole to accelerate digital transformation (DX) and further promote the social implementation of AI. To achieve this, developing and securing human capital with expertise in AI and Mathematical Data Science is an urgent priority. In particular, fostering KOSEN students who can apply their ICT hardware and software skills through early specialized education starting at age 15, as well as through problem-identification and problem-solving education, is crucial. This project focuses on developing educational content and methods to foster such KOSEN students.

[The human capital to be developed and the goals to be achieved (skill sets)]

Based on the foundation that human capital in all fields has acquired basic knowledge and competencies in AI and Mathematical Data Science, the system defines a set of achievement goals (skill sets) for individuals who can utilize AI and mathematical data in their fields of expertise, as well as for top-level professionals such as researchers and entrepreneurs.

[Details]

KOSEN-Originated! “Society 5.0-Aligned Future Technological Human Capital” Development Project
COMPASS 5.0: AI and Mathematical Data Science Field. <https://k-dash.nc-toyama.ac.jp/>

[AI and Mathematical Data Science : A set of achievement goals (skill sets)]

Learning Content	Achievement Goals	Reference Learning Items	MCC Compliant
Fundamentals of Information Technology	Understand that information technology is advancing rapidly and be aware of the social changes and challenges that come with it.	Society 5.0, Digitalization, Internet addiction, Gaming addiction, Cyberbullying, Impact of system downtime, Technology obsolescence	IV-C
	Understand about typical information systems and their forms of use.	Information terminals, Groupware, Cloud (SaaS, IaaS, PaaS), On-premises, Public Systems and services (Financial, Weather, Disaster Management), Virtualization	IV-C
	Understand the structure of a computer and the role of the operating system (OS), and be able to handle the basics.	Data, File management, Accounts (ID, Passwords), Storage media (e.g. External storage devices, Cloud), Operating systems, Application software, Computer components	IV-C
	Be able to operate office applications (e.g. document creation, spreadsheets, presentations).	Office applications, Tabular data, Spreadsheet functions (e.g. SUM, AVERAGE)	-
	Explain the difference between analogue and digital information and how data (such as numerical and text data) is represented in computers.	Continuous values, Discrete values, A/D conversion, D/A conversion, Sampling, Quantization, Sampling theorem, Quantization error, Binary numbers, Hexadecimal numbers, Radix Conversion, Significant figures, Integer and decimal representations, Bits, Bytes, Character codes.	IV-C
	Be able to use basic knowledge to collect and acquire information appropriately.	Data acquisition, Open data, Statistical portals, Big Data, Sensors	IV-C
	Be able to explain the significance and overview of databases.	Relational databases, Database management systems (DBMS), Database operations (e.g. SQL)	IV-C
	Be able to provide a third party an overview of the system they want to build.	Analysis of the problem/issue, and consideration and expression of a systemic solution.	-

Programming and Algorithms	Basic programs can be created.	Programming, Variables, Control syntax, Efficient programming (using libraries or APIs etc.)	IV-C
	Can perform mathematical operations using a computer.	Processing using spreadsheet software or programming languages, etc., Numerical calculations, Formula processing, Functions (quadratic, trigonometric, exponential, logarithmic functions, etc.)	IV-C
	Understand basic algorithms and be able to implement them using any programming language.	Representation by flowcharts or pseudo-code, etc., Sorting algorithms, Search algorithms	V-D-1 V-D-2
	Understand that there can be more than one algorithm to solve the same problem.	Differences in efficiency (e.g. computation time) depending on the algorithm.	IV-C
Media	Understand how to evaluate the truth or falsity of information based on evidence.	Source, Reliability and Credibility of data, Fakes (hoaxes, information manipulation, information dissemination), Scientific evidence, Logical judgement, Cross-checking	IV-C
	Be able to select the appropriate means of representing and communicating information, and to send and receive information appropriately.	Abstraction, Visualization, s, Diagrams, graphs, Selection of appropriate software (e.g. Word, Excel, PowerPoint), Communication tools (e.g. email, SNS), Media literacy, Content (text, images)	IV-C
Network	Explain the role of information and communication networks in society.	Fiber optic networks, Submarine cables, Mobile communications (4G, 5G), Internet	IV-C
	Understand how information and communication networks work, including their structure and components, as well as the role of protocols and technologies (such as the OSI reference model).	Servers, Clients, Protocols (HTTP, HTTPS, etc.), IP addresses, Routers, Hubs, Wi-Fi, LAN, URI, DNS, DHCP, OSI reference models	IV-C
	Be able to configure common network devices (e.g. PCs, home routers, etc.).	Personal device network settings.	-
Fundamentals of Information Security	Be able to explain the need for information security and the countermeasures against it.	Cybercrime, Cyber-attacks, Personal data protection, Information leaks, Security software, OS and Application updates	IV-C
Elements of Information Security	Be able to explain the three elements of information security (confidentiality, integrity, and availability).	CIA (confidentiality, integrity and availability)	IV-C
	Be able to explain access restrictions and authentication schemes for information.	Access control, Passwords, IC cards, Multi-factor authentication	IV-C
	Be able to explain basic cryptographic techniques and their necessity (e.g. HTTPS, VPNs).	HTTPS, VPN, Cryptography (encryption), Decryption	IV-C
Cyber-Attacks and Defenses	Be able to describe the main forms and examples of cyber-attacks and know how to defend against them.	Phishing scams, Malware, Ransomware, Targeted attacks, Intrusions, Security software	IV-C
Laws, Regulations and Policies	Understand the official rules (e.g. laws, guidelines) relating to information and communications, as well as the rules of the to which one belongs and the need for such rules.	Cybersecurity Basic Law, Unauthorized Computer Access Prohibition Law, Personal Information Protection Law, Copyright Law, Security Policy (basic policy, standards for countermeasures, implementation details, operational rules)	IV-C.
	Understand that each category (or rating) of information handled needs to be managed appropriately.	Ratings (e.g. confidential, confidential outside the department, confidential outside relevant parties, publicly available, information requiring protection)	IV-C

	Understand the importance of manners and morals (ethics) in living in an information society.	Information ethics, Information morality and Netiquette	IV-C
Risk and Security Management	Understand the threats (intentional and accidental) and risks involved in handling information, and know their hazards as well as how to counter and respond to them.	Ten major information security threats, Risks (tampering, loss, leakage, human error), Risk and hazard assessment.	IV-C
	Be able to explain the actions to be taken in the event of an incident.	Initial actions (reporting, maintenance)	IV-C
Data Science and AI	Be able to explain that data science and AI technologies are deeply involved in changes in society and daily life, and that they are closely linked to individuals' own lives.	Big Data, IoT, AI, Human intellectual activity and AI technologies.	IV-C
	Be able to explain, using application examples, that data science and AI technologies are useful tools for solving problems in society and daily life, and that they create value when combined with knowledge from various specialized areas.	Open data, Expansion of data science and AI application areas, Examples of data science and AI utilization and problem solving.	IV-C
	Understand the morals and ethics required when using data science and AI technologies, and be able to explain what is necessary to protect data.	Privacy laws, Data ethics (fabrication, falsification, plagiarism), Data bias	IV-C.
	Be able to use the basic skills (data acquisition, visualization and analysis) required for utilizing data science and AI technologies.	Diagrammatic representation of data (bar, line and scatter plots), Distribution of data (histograms) and representative values (mean, median, mode), Variation of data (variance, standard deviation), Data analysis (basic statistics, correlation and causality, regression analysis)	IV-C
	Be able to explain an overview of the basic methods used in data science and AI technologies.	Machine learning, Supervised learning, Unsupervised learning, Deep learning, Neural networks	IV-C
	Be able to explain the relationship between data science, AI technology, society, daily life, and the analytical methods in their own field of expertise.	Data-driven society, PDCA cycle, Examples of use of AI technology	IV-C
	Data Engineering	Be able to estimate the data required for analysis and learning while considering the conditions under which the data are used.	Data collection, Open data sets, Data privacy, Copyright, data, Comprehensiveness, Sampling bias, Scraping
Be able to respond appropriately to outliers, missing values, other irregularities and their characteristics.		Outliers, Anomalies, Missing values, Detection, Removal, Data cleansing	-
Be able to verify where there are any problems with the processed data.		Collation of totals, Checking distribution	-
Be able to produce high-quality data by clarifying criteria and controlling accuracy according to the task at hand.		Annotation, Data augmentation, Semi-supervised learning, Active learning	-
Depending on the task, appropriate features can be designed based on the characteristics of the data.		Features, Similarity, Dissimilarity, Characterization of mathematical and categorical data, Trends, Domain knowledge	-
Be able to transform various types of data into a form suitable for analyzing and learning, depending on the task.		Dimensional compression, Databases, Logging, Data formats	-
Be able to visualize data using appropriate techniques based on its characteristics.		Data compression, Cluster analysis, Sampling, Statistics, Heat maps, Diagrammatic representation	-

	Be able to analyze the nature and relationships of complex factors by appropriately selecting and applying the necessary data, analytical methods based on the issue.	Analytical processes, Data analysis (e.g. principal component analysis, cluster analysis, decision tree analysis, regression analysis), Self-organizing maps, Mixed distribution models, Factor analysis	-
	Be able to investigate and explain, using appropriate language, the factors contributing to the characteristics derived from data analysis.	Meaning extraction, Singularity, Difference, Trend, Association, Statistical value, Verbalization	-
Machine Learning and Learning Theory	Be able to describe the basic theories of supervised learning and the characteristics of learning models.	Linear regression, Logistic regression, Random forests, Boosting, Support vector machines (SVM), Neural networks, Autoregressive modelling (AR), Simple perceptron, Multilayer perceptron, Activation functions, Sigmoidal functions, Soft max functions, Error back propagation	-
	Be able to describe the basic theories of unsupervised learning and the characteristics of various learning models.	k-means method, Principal component analysis (PCA), Clustering, Dimensionality reduction, Dimensionality compression	-
	Be able to describe the basic theory of reinforcement learning and the characteristics of various learning models.	Discount rate, ϵ -greedy measures, Markovianity, State value function, Behavioral value function, Q-learning, Policy gradient method, Actor-Critic, A3C	-
	Be able to explain the characteristics of gradient descent methods and optimization techniques for learning, based on the convergence of the learning process.	Local optimal solution, Globally optimal solution, Saddle point, Plateau, Momentum, AdaGrad, AdaDelta, RMSprop, Adam, AdaBound, AMSBound, Hyperparameters, Random search, Grid search, Stochastic gradient descent, Steepest descent, Batch learning, Mini-batch learning	-
	Be able to design or select a learning model that aligns with the task at hand.	Analysis and problem requirements, Modelling methods (e.g. regression, decision trees, neural networks, SVM, ensemble learning)	-
	Be able to describe methods and metrics for assessing the accuracy of learning models.	Accuracy, Precision, Recall and F-score, ROC curves and AUC, Cross-validation, Hold-out validation, k-division cross-validation, Training error, Generalization error, Learning rate, Error function.	-
	Be able to describe methods for visualizing the basis for decisions and approximating learning models to interpret learning results.	CAM, LIME, SHAP	-
AI Utilization	Be able to determine the applicability of data science and AI techniques based on the specific issue.	Analytical approach, Issue formulation	-
	Be able to describe the structure and learning characteristics of neural network models for handling various types of data.	CNNs, Convolutional layers, Pooling layers, All-join layers, CNN evolutions, Transition learning and fine tuning, Skip joins, Recurrent neural networks, LSTM, Seq2Seq, Attention, Variational autoencoders, Adversarial generative networks (GANs).	-
	Be able to describe applications and typical network configurations used for image recognition tasks.	Object identification task, Object detection task, Segmentation task, Pose estimation task, AlexNet, Inception module, GoogLeNet, VGG, ResNet, EfficientNet, YOLO, Open Pose	-

	Be able to explain the concept of generative models and describe typical models used in applications such as image generation.	Variable Auto Encoder (VAE), DCGAN, Pix2Pix, CycleGAN	-
	Be able to describe neural network models for handling time series data, such as speech and language.	RNN, LSTM, Attention, One-hot vector, Local representation, Distributed representation, word2vec, Seq2Seq, Transformer, BERT, GPT-n	-
	Be able to explain the concept and applications of deep reinforcement learning.	DQN, Monte Carlo tree search, AlphaGo, AlphaGo Zero, Alpha Zero, Multi-agent reinforcement learning, OpenAI Five, games, Real-system applications	-
	Be able to describe learning techniques that enhance the accuracy of deep learning.	Drop-outs, Early termination, Data normalization, Batch normalization	-
	Be able to describe lightweight training models and methods for optimizing trained models.	Distillation, Model compression, Quantization, Pruning	-
	Be able to assess whether the results of data analysis and learning contribute to the creation of business value.	Business models, Inception decks and project design	-
	Be able to understand what to consider in real-world situations where AI is utilized as a service or product.	Protection and management of users and data, Copyright, Deepfakes, Fake news, Algorithmic bias	-
	Be able to build an environment for implementing and running machine learning and neural networks on GPUs using various frameworks and other tools.	CUDA, OpenCL, Parallel programming, Virtualization, Docker	-
	Be able to implement machine learning algorithms, including supervised learning, unsupervised learning, and reinforcement learning.	Linear regression, Logistic regression, Random forests, Boosting, Support vector machines (SVM), Neural networks, Autoregressive models (AR), Simple perceptrons, Multilayer perceptrons, Activation functions, Sigmoid functions, SoftMax functions, Error back propagation, k-means method, Principal component analysis (PCA), Clustering, Dimensionality reduction, Dimensionality compression, Discount factor, ϵ -greedy measures, Markovianity, State value function, Action value function, Q-learning, Policy gradient method, Actor-Critic, A3C, Local optimal solution, Global optimal solution, Saddle point, Plateau, Momentum, AdaGrad, AdaDelta, RMSprop, Adam, AdaBound, AMSBound, Hyperparameters, Random search, Grid search, Stochastic gradient descent, Steepest descent, Batch learning, Mini-batch learning	-

	Be able to select and implement deep learning models, such as those for image recognition, generation, time series processing, and reinforcement learning, depending on the task.	CNN, Convolutional layer, Pooling layer, All-coupling layer, CNN evolutions, Transition learning and fine tuning, Skip coupling, Recurrent neural networks, LSTM, Seq2Seq, Attention, Variational autoencoder, Adversarial generative network (GAN), Object identification task, Object Detection Task, Segmentation Task, Pose Estimation Task, AlexNet, Inception Module, GoogLeNet, VGG, ResNet, EfficientNet, YOLO, Open Pose, Variational Autoencoder (VAE), DCGAN, Pix2Pix, CycleGAN, RNN, LSTM, Attention, One Hot Vector, Local Representation, Distributed Representation, word2vec, Seq2Seq, Transformer, BERT, GPT-n, DQN, Monte Carlo tree search, AlphaGo, AlphaGo Zero, Alpha Zero, Multi-agent reinforcement learning, OpenAI Five, Games, Real system applications	-
	Be able to implement lightweight training models and methods for trained models suitable for use on edge devices.	Distillation, Model compression, Quantization, Pruning	-
	Be able to design and appropriately tune the parameters of the learning model.	Hyper parameterization, Grid search, Random search, Model-based optimization	-
	Be able to use various learning techniques to improve the accuracy of deep learning.	Drop-outs, Early termination, Data normalization, Batch normalization	-
	Be able to select the appropriate loss function and model selection criteria for the task and evaluate the model accordingly.	Model selection, Model evaluation, Correctness/Fitness/Reproducibility/F-value, ROC curves and AUC, Cross-validation, Hold-out validation, k-division cross-validation, Training error, Generalization error, Learning rate, Error function	-
	Be able to interpret the learning results by visualizing the basis for decisions and approximating the learning model.	CAM, LIME, SHAP.	-

2-2.2 COMPASS 5.0: Cybersecurity

[Project summary]

Internet technology (IT) forms the foundation for all areas of personal and corporate activities, as well as administrative services. However, cyber-attacks targeting this social infrastructure have evolved in various ways, and their impact has become increasingly severe. To protect IT and social infrastructure from malicious attacks and threats, human capital with advanced Cybersecurity skills are essential. This project focuses on developing educational content and methods to foster such KOSEN students.

[The human capital to be developed and the goals to be achieved (skill sets)]

Based on the foundation that human capital in all fields have acquired security awareness and basic skills, a set of achievement goals (skill sets) is defined for the following: human capital who can apply security technology in their respective fields of specialization; information technology engineers who have acquired the Cybersecurity technology required by society; and security specialist engineers as top-level human capital.

[Details]

NIT Cybersecurity Human Resource Development Project: <https://k-sec.kochi-ct.ac.jp/index.html>

[Cybersecurity : A set of achievement goals (skill sets)]

Learning Content	Achievement Goals	Reference Learning Items	MCC Compliant
Fundamentals of Information Technology	Understand that information technology is advancing rapidly and be aware of the social changes and challenges that come with it.	Society 5.0, Digitalization, Internet addiction, Gaming addiction, Cyberbullying, Impact of system downtime, Technology obsolescence	IV-C
	Understand about typical information systems and their forms of use.	Information terminals, Groupware, Cloud (SaaS, IaaS, PaaS), On-premises, Public Systems and services (Financial, Weather, Disaster Management), Virtualization	IV-C
	Understand the structure of a computer and the role of the operating system (OS), and be able to handle the basics.	Data, File management, Accounts (ID, Passwords), Storage media (e.g. External storage devices, Cloud), Operating systems, Application software, Computer components	IV-C
	Be able to operate office applications (e.g. document creation, spreadsheets, presentations).	Office applications, Tabular data, Spreadsheet functions (e.g. SUM, AVERAGE)	-
	Explain the difference between analogue and digital information and how data (such as numerical and text data) is represented in computers.	Continuous values, Discrete values, A/D conversion, D/A conversion, Sampling, Quantization, Sampling theorem, Quantization error, Binary numbers, Hexadecimal numbers, Radix Conversion, Significant digits, Integer and decimal representations, Bits, Bytes, Character codes.	IV-C
	Be able to use basic knowledge to collect and acquire information appropriately.	Data acquisition, Open data, Statistical portals, Big Data, Sensors	IV-C
	Be able to explain the significance and overview of databases.	Relational databases, Database management systems (DBMS), Database operations (e.g. SQL)	IV-C
	Be able to provide a third party an overview of the system they want to build.	Analysis of the problem/issue, and consideration and expression of a systemic solution.	-
Programming and Algorithms	Basic programs can be created.	Programming, Variables, Control syntax, Efficient programming (using libraries or APIs etc.)	IV-C

	Can perform mathematical operations using a computer.	Processing using spreadsheet software or programming languages, etc., Numerical calculations, Formula processing, Functions (quadratic, trigonometric, exponential, logarithmic functions, etc.)	IV-C
	Understand basic algorithms and be able to implement them using any programming language.	Representation by flowcharts or pseudo-code, etc., Sorting algorithms, Search algorithms	V-D-1 V-D-2
	Understand that there can be more than one algorithm to solve the same problem.	Differences in efficiency (e.g. computation time) depending on the algorithm.	IV-C
Media	Understand how to evaluate the truth or falsity of information based on evidence.	Source, Reliability and Credibility of data, Fakes (hoaxes, information manipulation, information dissemination), Scientific evidence, Logical judgement, Cross-checking	IV-C
	Be able to select the appropriate means of representing and communicating information, and to send and receive information appropriately.	Abstraction, Visualization, Tables, Diagrams, graphs, Selection of appropriate software (e.g. Word, Excel, PowerPoint), Communication tools (e.g. email, SNS), Media literacy, Content (text, images)	IV-C
Network	Explain the role of information and communication networks in society.	Fiber optic networks, Submarine cables, Mobile communications (4G, 5G), Internet	IV-C
	Understand how information and communication networks work, including their structure and components, as well as the role of protocols and technologies (such as the OSI reference model).	Servers, Clients, Protocols (HTTP, HTTPS, etc.), IP addresses, Routers, Hubs, Wi-Fi, LAN, URI, DNS, DHCP, OSI reference models	IV-C
	Be able to configure common network devices (e.g. PCs, home routers, etc.).	Personal device network settings.	-
Fundamentals of Information Security	Be able to explain the need for information security and the countermeasures against it.	Cybercrime, Cyber-attacks, Personal data protection, Information leaks, Security software, OS and Application updates	IV-C
Elements of Information Security	Be able to explain the three elements of information security (confidentiality, integrity, and availability).	CIA (confidentiality, integrity and availability)	IV-C
	Be able to explain access restrictions and authentication schemes for information.	Access control, Passwords, IC cards, Multi-factor authentication	IV-C
	Be able to explain basic cryptographic techniques and their necessity (e.g. HTTPS, VPNs).	HTTPS, VPN, Cryptography (encryption), Decryption	IV-C
Cyber-Attacks and Defenses	Be able to describe the main forms and examples of cyber-attacks and know how to defend against them.	Phishing scams, Malware, Ransomware, Targeted attacks, Intrusions, Security software	IV-C
Laws, Regulations and Policies	Understand the official rules (e.g. laws, guidelines) relating to information and communications, as well as the rules of the to which one belongs and the need for such rules.	Cybersecurity Basic Law, Unauthorized Computer Access Prohibition Law, Personal Information Protection Law, Copyright Law, Security Policy (basic policy, standards for countermeasures, implementation details, operational rules)	IV-C
	Understand that each category (or rating) of information handled needs to be managed appropriately.	Ratings (e.g. confidential, confidential outside the department, confidential outside relevant parties, publicly available, information requiring protection)	IV-C

	Understand the importance of manners and morals (ethics) in living in an information society.	Information ethics, Information morality and Netiquette	IV-C
Risk and Security Management	Understand the threats (intentional and accidental) and risks involved in handling information, and know their hazards as well as how to counter and respond to them.	Ten major information security threats, Risks (tampering, loss, leakage, human error), Risk and hazard assessment.	IV-C
	Be able to explain the actions to be taken in the event of an incident.	Initial actions (reporting, maintenance)	IV-C
Data Science and AI	Be able to explain that data science and AI technologies are deeply involved in changes in society and daily life, and that they are closely linked to individuals' own lives.	Big Data, IoT, AI, Human intellectual activity and AI technologies.	IV-C
	Be able to explain, using application examples, that data science and AI technologies are useful tools for solving problems in society and daily life, and that they create value when combined with knowledge from various specialized areas.	Open data, Expansion of data science and AI application areas, Examples of data science and AI utilization and problem solving.	IV-C
	Understand the morals and ethics required when using data science and AI technologies, and be able to explain what is necessary to protect data.	Privacy laws, Data ethics (fabrication, falsification, plagiarism), Data bias	IV-C
	Be able to use the basic skills (data acquisition, visualization and analysis) required for utilizing data science and AI technologies.	Diagrammatic representation of data (bar, line and scatter plots), Distribution of data (histograms) and representative values (mean, median, mode), Variation of data (variance, standard deviation), Data analysis (basic statistics, correlation and causality, regression analysis)	IV-C
	Be able to explain an overview of the basic methods used in data science and AI technologies.	Machine learning, Supervised learning, Unsupervised learning, Deep learning, Neural networks	IV-C
	Be able to explain the relationship between data science, AI technology, society, daily life, and the analytical methods in their own field of expertise.	Data-driven society, PDCA cycle, Examples of use of AI technology	IV-C
Cybersecurity	Understand and be aware of common attack techniques at the network layer.	Denial of Services (DoS) attacks, DNS reflection attacks	-
	Understand and be familiar with investigative techniques related to digital forensics, including tools and implementation methods.	Hardware, Operating systems, Networks, Forensics, Forensic support tools (e.g. VMWare, Wireshark), Footprint in digital forensics, Binary analysis, Non-volatile data types and collection	-
	Understand the role of security products provided by major vendors.	Security suites (e.g. antivirus and firewall software)	-
	Be able to explain the role of firewalls and intrusion detection/prevention systems (IDS/IPS) and operate them.	Firewalls, Routers, IDS/IPS, Demilitarized zone (DMZ), Single authentication point/audit/policy enforcement, Malicious content message scanning, PCI/PII-compliant data anonymization, Data loss protection scanning, Faster encryption processing, SSL security, REST/JSON Processing	-
	Be able to explain how various types of information, such as logs, can be used to identify the cause of a security incident when it occurs.	System logs, Correlation tools, Situation identification and categorization, Resolution studies, Incident detection	-

Be able to explain the actions an organization should take when a security incident is reported.	CSIRT, Reporting, PoC, Informing, Alerting, Triage	-
Understand how to implement system development while considering the necessary security measures for the system.	Security architecture, Enterprise architecture, Implementation of system development processes with security measures in mind (e.g. requirements definition, design, security testing), Security goals, Operational goals and trade-offs, Network design process	-
Be able to explain the systematic methods recommended for achieving secure system construction.	Security Technical Implementation Guide (STIG), Companies' security advisories, Bell-LaPadula model, Biba integrity model, Clark-Wilson integrity model.	-
Understand knowledge of security threats, how to analyze them, and how to take appropriate countermeasures based on their principles and content.	Malware, Malware analysis, Phishing, Baiting, Tailgating, Ethical hacking	-
Understand the vulnerabilities in the network,	Jamming techniques, Vulnerabilities in wireless applications, Network equipment and applications and potential vulnerabilities	-
Be able to explain the factors to consider when creating an appropriate security policy for the organization,	Personally Identifiable Information Data Security Standard (PII DSS), Credit Card Information Data Security Standard (PCI DSS)	-
Understand encryption algorithms and secure coding techniques.	Wireless LAN encryption algorithms (e.g. WEP, WPA), Secure coding (secure programming), Data confidentiality (e.g. steganography), Encryption algorithms (e.g. AES, RSA cipher, ElGamal cipher, elliptic curve cipher)	-
Be able to control access to networks and systems.	Access control (authentication, authorization, auditing), Types and models of access control schemes (voluntary access control, mandatory access control, role-based access control)	-
Be able to describe hardening techniques that reduce system vulnerabilities and enhance security.	Hardening, SELinux, Least privilege, Password policy, Network segmentation, Removal of unnecessary services, Enabling logging	-
Be able to explain the need of education on security and the training method applied to the members of the organization.	Practical experience in simulated real-life situations, Cyber competitions as a way of developing skills, Best practices learned from external organizations on cyber issues, Cybersecurity curriculum and training, Ability to explain and deliver on research, development, education and awareness raising	-
Understand the existence and content of security standards in various industries.	IT security assessment, Monitoring, Detection, Remediation tools, Assessment of procedures, Implementation, Current industry methodologies for the promotion, Industry-standard security models	-

	Be able to operate in accordance with the security measures and rules for handling information established by the organization.	Operational information control (user query response, monitoring alert response, improvement requests, incident management, problem management, change management, release management, configuration management, knowledge management), Operational maintenance management (service level management, capacity management, availability management, information security management IT service continuity management, operational personnel training).	-
	Understand the risks associated with security incidents and the changes and impacts on information systems when such incidents occur.	Cyber resilience, Dependability, Impact on system operations	-
	Understand the Cybersecurity workforce framework, including the required job role assignments and associated tasks, knowledge and skills.	SecBok, iCompetency Dictionary, NICE Framework	-
	Understand the importance of Cybersecurity and be able to explain the need to respond appropriately to changes in technology and social conditions, as well as to comply with information security policies and similar guidelines.	Diversification of threats and attack methods, 10 major information security threats, Cyber-terrorism, Import/Export regulations for cryptography and security technologies, Incident response (recovery, recurrence prevention measures)	-
	Understand secure communication methods and the ways to establish a basic environment,	Encryption protocols (TLS, HTTPS, etc.), Issuing, creating, using and validating certificates, Firewalls, WAFs	-
	Understand network operating conditions and communication trails, and be able to use basic methods to obtain and analyze them.	Network traffic analysis, Packet analysis, Detection of suspicious access, Analysis and root cause investigation of security events, Port scanning	-
	Understand the vulnerabilities that can occur in systems connected to network and be able to diagnose them and implement appropriate countermeasures.	Vulnerability assessment (e.g. penetration testing), System vulnerabilities (e.g. buffer overflows, XSS, SQL injection)	-
	Be able to provide an overview of software reverse engineering.	Reverse engineering, Decompiling	-
Software Engineering	Be able to explain the process of software-focused system development (including security-related aspects).	Configuration management, Project management, Tests on security	-
Computer System	Be able to explain typical system configurations that improve the reliability and functionality of computer systems, along with their operation and maintenance for secure and stable performance.	Multi-server configurations (redundancy, load balancers, etc.), System reliability, Backup and recovery, Power supplies (backup power, emergency power, UPS, etc.), Secure operation and maintenance	-
System Design	Be able to explain that system design involves allocating requirements and making system configuration decisions, including how to achieve the required functionality in both hardware and software. Additionally, understand how to measure its performance and availability, as well as the relevant indicators.	Allocation of requirements, System configuration, System performance (e.g. number of concurrent accesses, throughput, database access speeds), Availability measurements (e.g. availability calculations).	-
Fundamentals of Operating System	Be able to explain the basic concepts of memory management and be familiar with typical file systems.	FAT, NTFS, EXT, etc.	-
	Be able to use command-line tools.	Command-line tool	-

	Understand the overview of system files.	Log files, Registry files, Configuration files, etc.	-
Local Area Networks and Internet	Be able to explain the concept of Local Area Networks and the understand the identification of physical and logical layers.	LAN, VLAN	-
Network Applications	Be able to explain the structure and standards of telecommunications (wireless and wired communications).	Standards for wireless communication (IEEE 802.11x), Standards for wired communication (IEEE 802.3x)	-
	Be able to analyze communication situations using basic network-related tools.	ping, traceroute, nslookup, etc.	-

2-2.3 COMPASS 5.0: Robotics

[Project summary]

Japan, which has developed in a robotics leader, a labor shortage is predicted for the future. At the same time, the complexity of robotics technology, which forms the foundation of production, is increasing due to the shift toward high-mix, low-volume production and the expanding range of robotics applications. This makes the developing human capital to support these changes an urgent issue. This project focuses on developing educational content and methods to foster System Integrator (Sler) who will play a key role in addressing these social demands.

[The human capital to be developed and the goals to be achieved (skill sets)]

The knowledge and skills required for human capital capable of digital manufacturing (DX) and the social implementation of robotics (RX) are structured, and achievement goal groups (skill sets) are defined.

[Details]

(under development)

[Robotics : A set of achievement goals (skill sets)]

<<Common to the Robotics field>>

Learning Content	Achievement Goals	Reference Learning Items	MCC Compliant
Fundamentals of Information Technology	Understand that information technology is advancing rapidly and be aware of the social changes and challenges that come with it.	Society 5.0, Digitalization, Internet addiction, Gaming addiction, Cyberbullying, Impact of system downtime, Technology obsolescence	IV-C
	Understand about typical information systems and their forms of use.	Information terminals, Groupware, Cloud (SaaS, IaaS, PaaS), On-premises, Public Systems and services (Financial, Weather, Disaster Management), Virtualization	IV-C
	Understand the structure of a computer and the role of the operating system (OS), and be able to handle the basics.	Data, File management, Accounts (ID, Passwords), Storage media (e.g. External storage devices, Cloud), Operating systems, Application software, Computer components	IV-C
	Be able to operate office applications (e.g. document creation, spreadsheets, presentations).	Office applications, Tabular data, Spreadsheet functions (e.g. SUM, AVERAGE)	-
	Explain the difference between analogue and digital information and how data (such as numerical and text data) is represented in computers.	Continuous values, Discrete values, A/D conversion, D/A conversion, Sampling, Quantization, Sampling theorem, Quantization error, Binary numbers, Hexadecimal numbers, Radix Conversion, Significant figures, Integer and decimal representations, Bits, Bytes, Character codes.	IV-C
	Be able to use basic knowledge to collect and acquire information appropriately.	Data acquisition, Open data, Statistical portals, Big Data, Sensors	IV-C
	Be able to explain the significance and overview of databases.	Relational databases, Database management systems (DBMS), Database operations (e.g. SQL)	IV-C
	Be able to provide a third party an overview of the system they want to build.	Analysis of the problem/issue, and consideration and expression of a systemic solution.	-
Programming and Algorithms	Basic programs can be created.	Programming, Variables, Control syntax, Efficient programming (using libraries or APIs etc.)	IV-C

	Can perform mathematical operations using a computer.	Processing using spreadsheet software or programming languages, etc., Numerical calculations, Formula processing, Functions (quadratic, trigonometric, exponential, logarithmic functions, etc.)	IV-C
	Understand basic algorithms and be able to implement them using any programming language.	Representation by flowcharts or pseudo-code, etc., Sorting algorithms, Search algorithms	V-D-1 V-D-2
	Understand that there can be more than one algorithm to solve the same problem.	Differences in efficiency (e.g. computation time) depending on the algorithm.	IV-C
Media	Understand how to evaluate the truth or falsity of information based on evidence.	Source, Reliability and Credibility of data, Fakes (hoaxes, information manipulation, information dissemination), Scientific evidence, Logical judgement, Cross-checking	IV-C
	Be able to select the appropriate means of representing and communicating information, and to send and receive information appropriately.	Abstraction, Visualization, Tables, Diagrams, Graphs, Selection of appropriate software (e.g. Word, Excel, PowerPoint), Communication tools (e.g. email, SNS), Media literacy, Content (text, images)	IV-C
Network	Explain the role of information and communication networks in society.	Fiber optic networks, Submarine cables, Mobile communications (4G, 5G), Internet	IV-C
	Understand how information and communication networks work, including their structure and components, as well as the role of protocols and technologies (such as the OSI reference model).	Servers, Clients, Protocols (HTTP, HTTPS, etc.), IP addresses, Routers, Hubs, Wi-Fi, LAN, URI, DNS, DHCP, OSI reference models	IV-C
	Be able to configure common network devices (e.g. PCs, home routers, etc.).	Personal device network settings	-
Fundamentals of Information Security	Be able to explain the need for information security and the countermeasures against it.	Cybercrime, Cyber-attacks, Personal data protection, Information leaks, Security software, OS and Application updates	IV-C
Elements of Information Security	Be able to explain the three elements of information security (confidentiality, integrity, and availability).	CIA (confidentiality, integrity and availability)	IV-C
	Be able to explain access restrictions and authentication schemes for information.	Access control, Passwords, IC cards, Multi-factor authentication	IV-C
	Be able to explain basic cryptographic techniques and their necessity (e.g. HTTPS, VPNs).	HTTPS, VPN, Cryptography (encryption), Decryption	IV-C
Cyber-Attacks and Defenses	Be able to describe the main forms and examples of cyber-attacks and know how to defend against them.	Phishing scams, Malware, Ransomware, Targeted attacks, Intrusions, Security software	IV-C
Laws, Regulations and Policies	Understand the official rules (e.g. laws, guidelines) relating to information and communications, as well as the rules of the to which one belongs and the need for such rules.	Cybersecurity Basic Law, Unauthorized Computer Access Prohibition Law, Personal Information Protection Law, Copyright Law, Security Policy (basic policy, standards for countermeasures, implementation details, operational rules)	IV-C.
	Understand that each category (or rating) of information handled needs to be managed appropriately.	Ratings (e.g. confidential, confidential outside the department, confidential outside relevant parties, publicly available, information requiring protection)	IV-C

	Understand the importance of manners and morals (ethics) in living in an information society.	Information ethics, Information morality, Netiquette	IV-C
Risk and Security Management	Understand the threats (intentional and accidental) and risks involved in handling information, and know their hazards as well as how to counter and respond to them.	Ten major information security threats, Risks (tampering, loss, leakage, human error), Risk and Hazard assessment.	IV-C
	Be able to explain the actions to be taken in the event of an incident.	Initial actions (reporting, maintenance)	IV-C
Data Science and AI	Be able to explain that data science and AI technologies are deeply involved in changes in society and daily life, and that they are closely linked to individuals' own lives.	Big Data, IoT, AI, Human intellectual activity and AI technologies.	IV-C
	Be able to explain, using application examples, that data science and AI technologies are useful tools for solving problems in society and daily life, and that they create value when combined with knowledge from various specialized areas.	Open data, Expansion of data science and AI application areas, Examples of data science and AI utilization and problem solving.	IV-C
	Understand the morals and ethics required when using data science and AI technologies, and be able to explain what is necessary to protect data.	Privacy laws, Data ethics (fabrication, falsification, plagiarism), Data bias	IV-C
	Be able to use the basic skills (data acquisition, visualization and analysis) required for utilizing data science and AI technologies.	Diagrammatic representation of data (bar, line and scatter plots), Distribution of data (histograms) and representative values (mean, median, mode), Variation of data (variance, standard deviation), Data analysis (basic statistics, correlation and causality, regression analysis)	IV-C
	Be able to explain an overview of the basic methods used in data science and AI technologies.	Machine learning, Supervised learning, Unsupervised learning, Deep learning, Neural networks	IV-C
	Be able to explain the relationship between data science, AI technology, society, daily life, and the analytical methods in their own field of expertise.	Data-driven society, PDCA cycle, Examples of use of AI technology	IV-C

<<Robot designer, Robot system integrator>>

Project Management	Understand how to manage projects and be able to apply this knowledge in practice through group work.	Project management methods, After-sales service, Specification documentation, Sales engineering, Production engineering, Costing, Mass production effectiveness, Pricing, Quality assurance, Quality management, W-model process systems for robotic systems, Documentation systems, Planning, Estimation, Risk management, Design reviews, Development processes, Requirements engineering, Production planning, Process control	-
Task Verification	Understand how to examine issues and be able to apply this knowledge in practice through group work.	Project management methods, Problem identification using the 7 IE tools, FTA analysis methods, Quality stability using the 7 QC tools, Visualization, Production efficiency analysis, Requirements definition, Gentrification, Test design, Design review, Safety design, STAMP/STPA, Characteristic factor analysis, FMEA	-

Process Analysis	Understand the analysis of production processes and be able to propose new ones.	Production technology, Production engineering, Simple process analysis, Operator process analysis, Product process analysis, Motion analysis, Federated operation analysis, Line organization analysis, Operation analysis, Transport control, Machining, Assembly, Inspection, Shipping, Layout, Productivity, Set-up changes, Cycle time verification, Time charting	-
Production Process	Understand the processes of production and be able to propose new processes.	Production processes, Production engineering, Production engineering and manufacturing technology, Process design, Design BOM and manufacturing BOM, Process preparation, Machining, Assembly, Inspection, Shipping, Layout, Productivity, Set-up changes, Cycle time verification, Time charting	-
Design and Calculation of Safe Structural Mechanism	Understand examples of safe structural mechanisms and be able to perform design calculations	Mechanical design, Structural analysis, Safety standards, Seismic design, Risk assessment	-
Mechanical Design and Drafting	Be able to design calculations for robot hands, mounts, winches, and similar devices, and be able to create the drawings for them.	Mechanical design and drafting, CAD, Robot sliders, Robot jigs, Safety fences	-
CAD Design	Be able to create drawings using 3D CAD.	Mechanical design and drafting, CAD	V-A-1
Drive Unit Design	Be able to perform design calculations for mechanical systems that incorporate drive equipment.	End-effectors, Appropriate drive equipment, Drive systems, Actuators, Servomotors and stepper motors, Hydraulic and pneumatic actuators, Power transmission mechanisms direct drive units, Reduction mechanisms	-
Sensor Design	Be able to perform design calculations for sensor-based mechanical systems.	Appropriate sensors, Force sensors, Appropriate sensors, Human senses and external sensors, Acceleration sensors, Internal sensors, Force sensors, Photoelectric sensors, Proximity sensors, Fiber sensors	-

<<Mechanical designer>>

Material Mechanics Application Skills	Understand the formulas of material mechanics and be able to perform strength calculations.	Representation of forces, Moments and even forces, Stress and strain, Tension and compression, Torsion, Bending, Combined stress, Strain energy, Metallic materials, Non-ferrous metals, Non-metallic materials	V-A-3 V-A-6
Mechanical Drawings	Be able to explain to other people the elements and notation of drafting based on industrial standards.	Mechanical design and drafting, CAD, Fundamentals of mechanical drafting, Production drawings, Drafting of machine elements, Design and drafting of machines	V-A-1
Mechanical Mechanics Application Skills	Understand mechanical mechanics formulas and be able to design components.	Centre of gravity, Velocity and acceleration, Laws of force and motion, Rotational motion, Fundamentals of vibration, Vibration of single-degree-of-freedom systems, Free vibration of undamped systems, Free vibration of damped systems, Forced vibration of damped systems due to harmonic external forces, Harmonic vibration of damped systems due to harmonic displacement	V-A-3

Thermodynamics Application Skills	Understand thermodynamic formulas and be able to perform thermal design.	Fundamentals of thermodynamics, First law of thermodynamics, Properties and changes of state of ideal gases, Second law of thermodynamics	V-A-4
Mechanical Elements and Mechanical Components Application Skills	Be able to produce component drawings of robotic machine parts.	Screws, Bolts and nuts, Shafts and shaft couplings, Bearings, Gears, Link mechanisms, Cam mechanisms, Belts, Motors, Casting technology, Machining (NC machines), Reduction gears, Prime movers, Heat and surface treatment, Component processing (can manufacturing, welding, machining, casting)	V-A-2 V-A-5
Robotics Engineering Application Skills (Kinematics)	Understand forward and inverse kinematics formulas and be able to perform design calculations.	Forward kinematics, Inverse kinematics, Homogeneous transformation matrices, Quaternions, Euler angles, coordinate transformations.	-
CAE Utilization Skill	Understand and be able to use Mechanical CAE functions.	CAE	-
CAD Unitization Skills	Understand and be able to use Mechanical CAD functions.	CAD	V-A-1
Materials Mechanics Application Skills	Understand the formulas of material mechanics and be able to perform strength calculations.	Representation of forces, Moments and even forces, Stress and strain, Tension and compression, Torsion, Bending, Combined stress, Strain energy, Metallic materials, Non-ferrous metals, Non-metallic materials	V-A-3 V-A-6
Mechanical Drawings	Be able to explain to others the elements and notation of drawing based on industrial standards.	Mechanical design and drafting, CAD, Fundamentals of mechanical drafting, Production drawings, Drafting of machine elements, Design and drafting of machines	V-A-1
Mechanical Mechanics Application Skills	Understand mechanical mechanics formulas and be able to design components,	Centre of gravity, Velocity and acceleration, Laws of force and motion, Rotational motion, Fundamentals of vibration, Vibration of single-degree-of-freedom systems, Free vibration of undamped systems, Free vibration of damped systems, Forced vibration of damped systems due to harmonic external forces, Harmonic vibration of damped systems due to harmonic displacement	V-A-3
Thermodynamics Application Skills	Understand thermodynamic formulas and be able to perform thermal design,	Fundamentals of thermodynamics, First law of thermodynamics, Properties and changes of state of ideal gases, Second law of thermodynamics	V-A-4
Mechanical Elements and Mechanical Parts Application Skills	Be able to produce component drawings of robotic machine parts	Screws, Bolts and nuts, Shafts and shaft couplings, Bearings, Gears, Link mechanisms, Cam mechanisms, Belts, Motors, Casting technology, Machining (NC machines), Reduction gears, Prime movers, Heat and surface treatment, Component machining (can manufacturing, welding, machining, casting)	V-A-2 V-A-5

<<Electrical designer>>

Electrical Circuit Design Skills (Motor Circuits)	Have knowledge of applying electrical circuit (motor circuit) formulas.	Three-phase AC, Rotating machines, DC machines, Induction machines, Synchronous machines, Transformers, High power design, Low power design, Analogue circuit design, Digital circuit design, AC servo motors, Absolute encoder circuit (position detection), Brake circuit, Pulse generator, Encoder, Potentiometer, Torque margin, Rated torque, Maximum torque, Three-phase AC, Power devices, Rectifier circuits, Inverter circuits, AC servo motors, Servo control	-
Electrical Circuit Design Skills (Power Circuits)	Have knowledge of applying electrical circuit (power circuit) formulas.	Static machines, Power systems, High power design, Analogue circuit design, Digital circuit design, Power circuits, Power electronics, Voltage type inverters, Power devices (IGBT, MOSFET), Gate drive circuits, Current detection circuits, Rectifier circuits, Power regenerative circuits, Resistance regenerative circuits, DB (dynamic braking) circuits, Main circuit capacitor circuits, Control power circuits, Inrush current suppression circuits, DCDC chopper circuits, CPU, SoC, FPGA, Noise immunity, EMC technology, Isolation design, Functional safety, Machine safety, Inverters, Power consumption, Regulators, Electrical circuits (three-phase AC), Power measurement, Power devices, Rectifier circuits, Servo control	-
Electrical Circuit Design Skills (Electronic Circuits)	Have knowledge of applying electrical circuit (electronic circuit) formulas.	Components of electronic circuits, Amplification circuits, Arithmetic amplifiers, Oscillation, Modulation and demodulation circuits, Waveform observation (testers, digital oscilloscopes, HiCoders, etc.), Output circuits (PNP, NPN), A/D conversion, D/A conversion	-
Network Utilization Skills	Have knowledge of using Ethernet, Fieldbus and Safety Fieldbus.	Fieldbus communication standards, Wireless standards, Understanding of communication methods and protocols (Ethernet, RS422, RS485, RS232C, PCI, PCIe, I2C), Transmission line design, Characteristic impedance and S-parameters, Measurement techniques, Network analyzers, Wiresharks, PLCs, Computer network basics, Network protocols, TCP/IP, UDP, Socket communication, Serial communication, ORiN, Middleware, Ethernet	-
CAD Utilization Skills	Have knowledge of using Electrical CAD systems.	Electrical drafting, Electrical CAD, Circuit design CAD, Board design CAD, 3D modelling, Surface machining, Polygon machining, CAE, CAM, Offline teaching	-
Sensors and Sensing Utilization Skills	Have knowledge of using sensors (e.g. force, ultrasonic, distance, vision sensors).	Fundamentals of measurement, Systems of units and standards, Measurement of voltage and current, Measurement of resistance and impedance, Measurement of power and power lines, Waveform observation	-

Understanding Safety Standards	Understand residual risks in robotic systems.	IEC standards, ISO standards, EMC, Safeguards, Residual risk, JIS standards, Occupational health and safety regulations, Risk assessment, Functional safety, Intrinsic safety, Safe circuit performance, Ergonomics	-
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«Software designer»

Embedded Software Development Skills	Have knowledge of using C, C++, C#, and other programming languages used in embedded software development.	Elements of programming, Software creation, Practical programming, Algorithms, Data structures, Software engineering, Program analysis, Computer systems, System design, Operating system fundamentals, Compilers, Open-source software, Commercial software, Safety design, STAMP/STPA	-
PC Software Development Skills	Have knowledge of using C, C++, C #, XML, HTML, and other programming languages used in PC software development.	Elements of programming, Software creation, Practical programming, Algorithms, Data structures, Software engineering, Program analysis, Computer systems, System design, Operating system fundamentals, Compilers, Open-source software, Commercial software, Python	-
Network Development Skills	Have knowledge of using networks for Factory Automation (FA), including fieldbus networks, PC-to-PC networks, and higher-level information networks.	Hierarchical protocols, Local area networks and the Internet, Network applications	-
Robotics Engineering Application Skills (Kinematics, Dynamics)	Have knowledge of applying robotics engineering formulas (forward and inverse kinematics).	Dynamics, Linear algebra, C, C++, Python, Matlab, Forward kinematics, Inverse kinematics, Sensor engineering, Forward kinematics, Inverse kinematics, Homogeneous transformation matrices, Quaternions, Euler angles, Coordinate transformation, Jacobi matrices, Numerical processing and errors, Numerical computing, Mechatronics, control systems	-
Control Theory Application Skills	Be able to explain control theory (classical and modern approaches).	Control engineering, Mechanical dynamics, Vibration engineering, Classical control theory, Modern control theory, Matlab, Machine learning (supervised learning, unsupervised learning, etc.), PID control, State estimation observer, Kalman filter, System identification, Model predictive control, Nonlinear control, Adaptive control, Sliding mode control, Systems and transfer Functions, Poles, Zeros and stability, Impulse and step responses, Frequency response and Bode diagrams, Feedback control systems, Laplace transforms	-
AI Software Application and Development Skills	Have knowledge of JavaScript, Python, and other programming languages. used in machine learning and neural networks.	Overview of machine learning, Deep learning, Elements of programming, Software creation, Practical programming, Algorithms, Data structures, Computational modelling, Media information processing, Python, UX design	-
IoT-related Application and Development Skills	Have knowledge of using IoT systems, including edge computing, cloud computing, 5G, and other technologies.	Communications, Cloud computing, Computer systems, System design, Operating system fundamentals, Compilers, Security	-

Robot Simulator Development Skills	Have knowledge of using and/or programming robot simulators.	Numerical processing and errors, Numerical computing, Programming languages, Physics engines, Unity, Image processing, Experience operating simulators for robot manufacturers, Physics engines, URDF, Robot description language, Offline teaching, Interference avoidance, GUI	-
Embedded Software Development Skills	Have knowledge of using C, C++, C#, and other programming languages used for embedded software development.	Elements of programming, Software creation, Practical programming, Algorithms, Data structures, Software engineering, Program analysis, Computer systems, System design, Operating system fundamentals, Compilers, Open-source software, Commercial software, Safety design, STAMP/STPA	-
PC Software Development Skills	Have knowledge of using C, C++, C #, XML, HTML, and other programming languages used in PC software development.	Elements of programming, Software creation, Practical programming, Algorithms, Data structures, Software engineering, Program analysis, Computer systems, System design, Operating system fundamentals, Compilers, Open-source software, Commercial software, Python	-

2-2.4 COMPASS 5.0: IoT

[Project summary]

The IoT is a crucial technology for delivering high-value-added services to society by utilizing stored data. Efforts are being made to develop human capital who understand Cyber-Physical Systems (CPS) – where data analysis from cyberspace are fed back into physical space – based on the premise that IoT data can be effectively utilized. Additionally, educational content and teaching materials are being developed to foster professionals with both technical expertise and a business mindset.

[The human capital to be developed and the goals to be achieved (skill sets)]

Based on the acquisition of basic knowledge and skills related to the IoT in all fields, the skills that human capital in the electrical, electronic and information fields should acquire include the ability to collect, visualize, analyze and feedback IoT data, the ability to use the IoT to solve problems, the ability to apply the IoT in each specialized field, the ability to compete and apply the IoT in the CPS, and the perspective and practical ability to apply the IoT in each specialized field. The objectives (skill sets) are set by organizing them into perspectives and practical skills that can be applied to the CPS.

[Details]

KOSEN-Originated! “Society 5.0-Aligned Future Technological Human Capital” Development Project, Curriculum development of next-generation fundamental technology education, IoT field
<https://www.sendai-nct.ac.jp/compass5/>

[IoT : A set of achievement goals (skill sets)]

Learning Content	Achievement Goals	Reference Learning Items	MCC Compliant
Fundamentals of Information Technology	Understand that information technology is advancing rapidly and be aware of the social changes and challenges that come with it.	Society 5.0, Digitalization, Internet addiction, Gaming addiction, Cyberbullying, Impact of system downtime, Technology obsolescence	IV-C
	Understand about typical information systems and their forms of use.	Information terminals, Groupware, Cloud (SaaS, IaaS, PaaS), On-premises, Public Systems and services (Financial, Weather, Disaster Management), Virtualization	IV-C
	Understand the structure of a computer and the role of the operating system (OS), and be able to handle the basics.	Data, File management, Accounts (ID, Passwords), Storage media (e.g. External storage devices, Cloud), Operating systems, Application software, Computer components	IV-C
	Be able to operate office applications (e.g. document creation, spreadsheets, presentations).	Office applications, Tabular data, Spreadsheet functions (e.g. SUM, AVERAGE)	-
	Explain the difference between analogue and digital information and how data (such as numerical and text data) is represented in computers.	Continuous values, Discrete values, A/D conversion, D/A conversion, Sampling, Quantization, Sampling theorem, Quantization error, Binary numbers, Hexadecimal numbers, Radix Conversion, Significant figures, Integer and decimal representations, Bits, Bytes, Character codes.	IV-C
	Be able to use basic knowledge to collect and acquire information appropriately.	Data acquisition, Open data, Statistical portals, Big Data, Sensors	IV-C
	Be able to explain the significance and overview of databases.	Relational databases, Database management systems (DBMS), Database operations (e.g. SQL)	IV-C

	Be able to provide a third party an overview of the system they want to build.	Analysis of the problem/issue, and consideration and expression of a systemic solution.	-
Programming and Algorithms	Basic programs can be created.	Programming, Variables, Control syntax, Efficient programming (using libraries or APIs etc.)	IV-C
	Can perform mathematical operations using a computer.	Processing using spreadsheet software or programming languages, etc., Numerical calculations, Formula processing, Functions (quadratic, trigonometric, exponential, logarithmic functions, etc.)	IV-C
	Understand basic algorithms and be able to implement them using any programming language.	Representation by flowcharts or pseudo-code, etc., Sorting algorithms, Search algorithms	V-D-1 V-D-2
	Understand that there can be more than one algorithm to solve the same problem.	Differences in efficiency (e.g. computation time) depending on the algorithm.	IV-C
Media	Understand how to evaluate the truth or falsity of information based on evidence.	Source, Reliability and Credibility of data, Fakes (hoaxes, information manipulation, information dissemination), Scientific evidence, Logical judgement, Cross-checking	IV-C
	Be able to select the appropriate means of representing and communicating information, and to send and receive information appropriately.	Abstraction, Visualization, Tables, Diagrams, graphs, Selection of appropriate software (e.g. Word, Excel, PowerPoint), Communication tools (e.g. email, SNS), Media literacy, Content (text, images)	IV-C
Network	Explain the role of information and communication networks in society.	Fiber optic networks, Submarine cables, Mobile communications (4G, 5G), Internet	IV-C
	Understand how information and communication networks work, including their structure and components, as well as the role of protocols and technologies (such as the OSI reference model).	Servers, Clients, Protocols (HTTP, HTTPS, etc.), IP addresses, Routers, Hubs, Wi-Fi, LAN, URI, DNS, DHCP, OSI reference models	IV-C
	Be able to configure common network devices (e.g. PCs, home routers, etc.).	Personal device network settings.	-
Fundamentals of Information Security	Be able to explain the need for information security and the countermeasures against it.	Cybercrime, Cyber-attacks, Personal data protection, Information leaks, Security software, OS and Application updates	IV-C
Elements of Information Security	Be able to explain the three elements of information security (confidentiality, integrity, and availability).	CIA (confidentiality, integrity and availability)	IV-C
	Be able to explain access restrictions and authentication schemes for information.	Access control, Passwords, IC cards, Multi-factor authentication	IV-C
	Be able to explain basic cryptographic techniques and their necessity (e.g. HTTPS, VPNs).	HTTPS, VPN, Cryptography (encryption), Decryption	IV-C
Cyber-Attacks and Defenses	Be able to describe the main forms and examples of cyber-attacks and know how to defend against them.	Phishing scams, Malware, Ransomware, Targeted attacks, Intrusions, Security software	IV-C
Laws, Regulations and Policies	Understand the official rules (e.g. laws, guidelines) relating to information and communications, as well as the rules of the to which one belongs and the need for such rules.	Cybersecurity Basic Law, Unauthorized Computer Access Prohibition Law, Personal Information Protection Law, Copyright Law, Security Policy (basic policy, standards for countermeasures, implementation details, operational rules)	IV-C.

	Understand that each category (or rating) of information handled needs to be managed appropriately.	Ratings (e.g. confidential, confidential outside the department, confidential outside relevant parties, publicly available, information requiring protection)	IV-C
	Understand the importance of manners and morals (ethics) in living in an information society.	Information ethics, Information morality and Netiquette	IV-C
Risk and Security Management	Understand the threats (intentional and accidental) and risks involved in handling information, and know their hazards as well as how to counter and respond to them.	Ten major information security threats, Risks (tampering, loss, leakage, human error), Risk and hazard assessment.	IV-C
	Be able to explain the actions to be taken in the event of an incident.	Initial actions (reporting, maintenance)	IV-C
Data Science and AI	Be able to explain that data science and AI technologies are deeply involved in changes in society and daily life, and that they are closely linked to individuals' own lives.	Big Data, IoT, AI, Human intellectual activity and AI technologies.	IV-C
	Be able to explain, using application examples, that data science and AI technologies are useful tools for solving problems in society and daily life, and that they create value when combined with knowledge from various specialized areas.	Open data, Expansion of data science and AI application areas, Examples of data science and AI utilization and problem solving.	IV-C
	Understand the morals and ethics required when using data science and AI technologies, and be able to explain what is necessary to protect data.	Privacy laws, Data ethics (fabrication, falsification, plagiarism), Data bias	IV-C
	Be able to use the basic skills (data acquisition, visualization and analysis) required for utilizing data science and AI technologies.	Diagrammatic representation of data (bar, line and scatter plots), Distribution of data (histograms) and representative values (mean, median, mode), Variation of data (variance, standard deviation), Data analysis (basic statistics, correlation and causality, regression analysis)	IV-C
	Be able to explain an overview of the basic methods used in data science and AI technologies.	Machine learning, Supervised learning, Unsupervised learning, Deep learning, Neural networks	IV-C
	Be able to explain the relationship between data science, AI technology, society, daily life, and the analytical methods in their own field of expertise.	Data-driven society, PDCA cycle, Examples of use of AI technology	IV-C
IoT in Society	Understand the changes occurring in society and the Cyber-Physical Systems (CPS) enabled by the IoT, and be able to explain the significance of learning about the IoT.	Society5.0, 4th Industrial Revolution, Industry 4.0, DX, Cyber space, Virtual space, Physical space, Real space, Workplace reform, RPA, CPS, AI, Artificial intelligence, Big Data, IoT, M2M, Workforce shortage, Declining population, Aging society with fewer children, Healthcare disparities	-
	Be able to explain the process of using IoT to enhance operations and develop new businesses opportunities.	Five Forces Analysis, Product innovation, Process innovation, Design thinking, Service design	-
	Be able to explain the evolution (maturity model) and utilization of future IoT systems, as well as the perspectives that engineers should adopt.	Waterfall development, Prototype development, Agile development, PoC Capability (visibility control, automation, optimization, autonomy), IoT ecosystem	-

	Be able to explain new businesses and services that utilize IoT technology.	Smart XX, Smart products, Blockchain, RPA, Virtual currency, Sharing economy, MaaS, Fintech, Connected cars, Drones, Care, Preventive medicine, Predictive detection, Operational status	-
	Be able to explain the need for and provide examples of IoT applications in their respective fields of expertise.	Case studies in various specializations	-
Technology Elements of the IoT	Be able to provide an overview of the basic configuration of an IoT system.	Edge computing, Cloud servers, Gateways, Area networks, Wide area communication networks, Service applications	-
	Be able to explain the role of IoT devices in bridging physical and cyber space	End devices, Edge devices, AD/DA conversion, Actuators (motors, solenoids, hydraulics, pneumatics), Sensors (Temperature, humidity, barometric, pressure, light, flow, pressure, acceleration, gyro, geomagnetic, LiDAR, magnetic, pH, Air, quality, biometrics, position)	-
	Be able to explain an overview of the various communication schemes that connect sensor devices to the cloud systems.	PAN (Bluetooth, Zigbee, BLE, NFC), LAN (Wi-Fi 4/5/6), MAN (LoRa, LoRaWAN, Sigfox, NB-IoT, Wi-SUN, LPWA), WAN (4G, 5G), Communication protocol (HTTP, HTTPS, MQTT, AMQP, CoAP, WebSocket, TCP/ IP, UDP), Network devices (repeaters, bridges, hubs, routers, gateways, coordinators)	-
	Be able to explain an overview of various platforms and applications in IoT servers.	Cloud (public cloud, private cloud), On-premises, Virtualization, SaaS, PaaS, HaaS, IaaS, BaaS, Distributed processing, Data formats (CSV, XML, JSON), Node-RED, No-code, Low-code, Database (RDB, NoSQL), Pay-as-you-go, API	-
Considerations for the Utilization of IoT	Be able to explain an overview of IoT-specific security threats and their corresponding countermeasures.	Encryption, Decryption, Symmetric key cryptography, Public key cryptography, Digital signature, TLS, SSH, Authentication, Cyber-attacks, IDS, IPS, Security risks, Security policy	-
	Be able to explain an overview of the laws, regulations, and ethical considerations related to the IoT.	Radio Law, Specified low-power radio stations Law, On Law Conformity Mark, PL Law, Product Liability Law, Electrical Appliance and Material Safety Law, Drone Regulation Law, RoHS Directive Telecommunications Business Law, GPL, Copyright Personal Data Protection Law, General Data Protection Regulation, Cybersecurity Basic Law	-
IoT Data Handling	Be able to explain the appropriate processes required for conducting data analysis.	Business intelligence, PPDAC (Problem Plan Data Analysis Conclusion), Issue tree, Data type (numerical, quality), Data scale (interval, ratio, nominal, ordinal)	-
	Be able to explain data analysis methods.	Statistics, Probability, Prediction, Correlation analysis, Regression analysis, Classification, AI (machine learning, deep learning, supervised learning, unsupervised learning, reinforcement learning), Data visualization, Data mining	-

IoT Network Technology	Be able to explain the considerations involved in the use of radio waves.	Verification, Accreditation, Certification, MRA (Mutual Recognition Agreement), License-free stations, Frequency, Frequency management, Radio wave characteristics (frequency, propagation loss, linearity, information transmission capacity, antenna, reflection, multipath, shielding), License, ISM, Band, Radio station, Radio operator, Collision avoidance, Hidden terminal, Exposed terminal, Telecommunications, Business Act, Revised Civil Aeronautics Act	-
	Be able to explain the IoT communication traffic in quantitative terms.	Data volume, Communication speed, Load balancing, Bandwidth utilization, Data retransmission, Delay	-
IoT Information Security	Be able to explain the development guidelines for IoT system development.	Safety and security policy, Risk analysis, Safe and secure design, Safe and secure construction and connection, Safe and secure operation and maintenance, Development guidelines for a connected world, IoT security guidelines	-
Design, Development and Operational Verification	Be able to design, develop and verify the operation of systems in accordance with the requirements specification using standard methods.	Software development models, V-shaped models of development processes, System development techniques, Software development management techniques, Hearing, Design thinking, Testing techniques, Test management techniques, Review, Agile, Bottom-up, Top-down, PoC, Prototyping, Mass production, UX/UI	-
System Maintenance and Operation	Be able to describe the maintenance and operation of IoT systems.	Initial costs, Running costs, Maintenance, Risks of IoT maintenance and operation, Power supply disconnection, Missing, Failure, Disturbance, Poor maintenance, Installation location, Unattended operation, Stray devices, Fail-soft, Fail-safe	-
Analysis of IoT Data Utilization	Be able to perform analytical processing procedures on the collected data.	Data pre-processing, Data cleansing, Cleaning, Elimination of outliers, Real-time processing, Bayesian analysis, Down sampling, Resampling, Timing of data generation	-
	Be able to effectively utilize the data.	Statistical analysis (prediction, correlation analysis, regression analysis, decision tree analysis, classification, principal component analysis, cluster analysis), Machine learning (supervised learning, Bayesian models, SVM, random, forests, unsupervised learning, reinforcement learning, deep learning, CNN, RNN, Autodencoder, DQN, data pre-processing, learning model evaluation), Spectral analysis, SAS, SPSS, R Python, Julia, Data mining	-
Utilization of Cloud Servers	Be able to effectively utilize typical cloud services.	AWS, Microsoft Azure, Google Cloud IoT Core, Cloud-native, API-first, Fully Managed Service	-

	Be able to effectively utilize database on server technologies.	RDB, NoSQL database, Memory database, Key-value database, Document-oriented database, Column-oriented database, Graph database, JSON, Application server, WEB server, Structured data, Unstructured data, XML, JSON, ACID characteristics, BASE characteristics	-
Application Development	Be able to select software (web servers, databases, programming languages and libraries).	Apache, nginx, MySQL, NoSQL, PostgreSQL, PHP, Python, Ruby, Node-RED	-
	Be able to program applications (server-side and browser-side environments).	HTML, PHP, JavaScript, SQL, Program structures, Data types, Syntax notation, Development tools, Open source, No-code, Low-code, Native application, Web application, Responsive design	-
Utilization of IoT Devices	Be able to utilize the operations, principles, basic performance, and applications of typical sensors, as well as utilization of typical peripheral circuits, such as analog-to-digital (AD) conversion amplifiers.	Sensors (Temperature, humidity, pressure, gyro, image, optical, acceleration, geomagnetism, infrared, ultrasound, enzymes, immunity, DNA, Bio), GPS, Millimeter wave radar, Laser scanners, Thermistors, Photo interrupters, Photocouplers, AD/DA conversion circuits (resolution, accuracy, conversion time, sampling, quantization), MEMS, Interfaces (SPI, I2C, UART), GPIO	-
	Be able to utilize the power source and operational principle of typical actuators.	Hydraulic, Pneumatic, Electrical, Motor (DC servo, stepper, DC brushless), Solenoid	-
Development of IoT Devices	Be able to select the appropriate power source for the device.	Batteries, Solar panels, AC/DC conversion, Controllers	-
	Be able to select hardware components (such as sensors, actuators, microprocessors).	Microcontroller board (Arduino, Raspberry Pi, M5Stack ,IoT-Engine, Jetson, AVR, PIC), Device characteristics and limitations	-
	Understand the characteristics of IoT wired and wireless area networks and apply this knowledge to solve real-world issues.	Congestion control, Notification information, Inactivity_Timer, Intermittent reception, Protocol, Signal strength, Communication distance, Communication frequency, Communication error, Topology, Radio communication, Traffic handling capacity, Number of simultaneous connections, Reliability, Communication speed, Low latency, ISM band, MQTT, WebSocket	-
	Be able to program IoT devices (control of sensors and other components using microcontrollers).	Arduino_IDE, Node-RED, Python, C Program structures, Data types, Syntax notation, Development tools, System development techniques, Software development management techniques, Timers, Interruptions, Real-time processing, Sleep, Intermittent, Edge computing, Batch processing	-

Part 4:
Reference materials

Chapter 1: Comparison of MCC achievement goals with other standards

In developing MCC 2017, the alignment between the standards set by the *Japan Accreditation Board for Engineering Education* (hereinafter referred to as “JABEE”), international accreditation standards for engineering education, and the *Courses of Study Guideline for Upper Secondary Schools in Japan* was reviewed and confirmed. The same process was followed in the revision MCC 2023, where we have reviewed and confirmed the alignment with various criteria for engineering education and the *Courses of Study Guideline for Upper Secondary Schools in Japan* (notified in 2008). The alignment with these standards and criteria is presented here as reference material.

However, there are a few important points that need to be considered when examining how the MCC aligns with these standards:

(1) Correspondence with other standards relating to engineering education

The standards and other documents related to engineering education that were reviewed include the JABEE Accreditation Standards (2019 onwards), ABET 2022-2023 EAC-Criteria, IEA (International Engineering Alliance) Graduate Attribute 2021, and the CDIO Syllabus V.3. Of these, the JABEE Accreditation Standards, ABET 2022-2023 EAC-Criteria and IEA Graduate Attribute 2021 are applicable to engineering education programs under the Washington Accord. KOSEN education is a unique system in Japan that accepts students from the age of 15 and provides a five-year integrated education for engineers. While it offers professional education comparable to university undergraduate program, the standards of the Washington Accord cannot be applied directly to this system. Therefore, when each KOSEN seeks JABEE accreditation, it is necessary to design a four-year education program, including the two-year curriculum of the KOSEN Advanced Course, rather than satisfying the accreditation criteria solely with a curriculum that meets the MCC. Each KOSEN is required to demonstrate that its curriculum includes the MCC and that its four-year education program including the two-year KOSEN Advanced Course, fully meets the accreditation criteria.

In addition, the CDIO Syllabus does not represent accreditation standards for engineering education; rather, it outlines the student achievement goals set by the CDIO Initiative, a framework designed to promote quality improvement in engineering education. Therefore, the MCC, positioned as the minimum standard for KOSEN education, does not fully align with the CDIO Syllabus. When organizing the curriculum, each KOSEN aims to leverage its own unique characteristics and strengths to enhance its education. It seeks to build a curriculum and education system by referring to resources like MCC Plus, while ensuring compliance with MCC as the minimum standard for KOSEN education. The CIDO Syllabus is also considered as a reference.

Although the MCC does not directly correspond to these standards, it is important to confirm that its content considering the areas emphasized by these standards and that it has been developed in alignment with international trends in engineering education.

(2) Correspondence with the Course of Study Guideline for Upper Secondary Schools

In developing MCC 2017, which is a revision of the MCC Draft, the *Course of Study Guidelines for Upper Secondary Schools* (notified in 2008) (hereinafter referred to as the “Courses of Study”) were taken into consideration during the discussion. The Courses of Study have been fully applied since 2022, and their alignment has been reconfirmed in the revision of the MCC, which forms the foundation of KOSEN education that accepts students from the later stages of secondary school education.

However, it should be noted that, unlike universities and other institutions which are structured as higher education courses after completion of the upper secondary education, KOSEN education needs to be organized as a five-year higher education program. This approach is fundamentally different from a design that simply adds a higher education component to the upper secondary school curriculum.

The Courses of Study outline the academic skills that should be developed and nurtured through the following three elements, and specify that each subject should foster these elements:

- (1) To ensure the acquisition of knowledge and skills.
- (2) To cultivate such as thinking ability, judgement, expression skills.
- (3) To foster the ability to engage in learning and developing human qualities.

On the other hand, the achievement goals of the MCC consist of the MCC (core), which primarily focuses knowledge and skills, and the MCC (model), which encompasses thinking, judgement, expression, attitude, humanity, as well as creativity and design competencies. Therefore, the following points should be considered when contrasting the MCC with the Courses of Study.

- The comparison table shows the alignment with the MCC (core), confirming the learning content primarily related to knowledge and skills. The fundamental concept of the Model Core Curriculum is that content related to thinking, judgement, expression, and attitude/mindset is included in the MCC (model). It is assumed that the actual curriculum organization and subject design will integrate elements from both the MCC (core) and MCC (model).
- The MCC (core) is set as the achievement level of Level 2 (Understand) or 3 (Apply) as defined by the MCC. It is assumed that Level 4 (Practice) will be achieved by graduation from the KOSEN five-year main course through curriculum organization and subject design, which combine MCC (core) with the MCC (model), including creativity and design competencies. Therefore, study contents listed in the Courses of Study that go beyond Level 3 do not necessarily align with the MCC (core); the goal is to achieve Level 4 (Practice) through curriculum organization that complies with the MCC and maximizes the unique characteristics of each KOSEN.

1-1 Correspondence with other standards for engineer education

1-1.1 Correspondence table for ABET, JABEE, IEA

The correspondence between the ABET (2022-2023 Criteria for Accrediting Engineering Programs), the JABEE - Japanese Accreditation Board for Professional Engineer Education (Common Criteria 2019-), and the IEA Graduate Attributes 2021 is shown in Table 1.

Table 1 Correspondence table with ABET CRITERIA FOR ACCREDITING ENGINEERING PROGRAMS, JABEE Japanese Accreditation Board for Engineering Education (Common Criteria 2019-), IEA Graduate Attributes 2021, and MCC achievement goals

ABET (Accreditation Board for Engineering and Technology)	JABEE (Japan Accreditation Board for Engineering Education)	IEA (International Engineering Alliance)	MCC 2023 Achievement Goals	
2022-2023 Criteria for Accrediting Engineering Programs	Japanese Accreditation Standards for Technical Education Common Criteria (from 2019)	Knowledge and Attitude Profile A Washington Accord program provides:	Graduate Attribute Profiles ... for Washington Accord Graduate	
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	(c) knowledge of mathematics, natural sciences and information technology and the ability to apply them (d) specialist knowledge required in the field and the ability to apply them	WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences WK2: Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to WK2: Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline. WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts WK6: Knowledge of engineering design and operations in a practice area WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline	Engineering Knowledge WA1: Apply knowledge of mathematics, natural science, computing and engineering fundamentals, and an engineering specialization as specified in WK1 to WK4 respectively to develop solutions to complex engineering problems Design/development of solutions WA3: Design creative solutions for complex engineering problems and design systems, components or processes to meet identified needs with appropriate WA4: Design creative solutions for complex engineering problems and design systems, components or processes to meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required (WK5)	I Mathematics II Natural Sciences (II -A Physics, II -B Physics Laboratory, II -C Chemistry, II -D Chemistry Laboratory, II -E Life Science and Earth Science) IV Fundamentals of Engineering (IV-C Information Literacy) V Specialized Engineering by Field (V -A Mechanical Engineering, V -B Materials Engineering, V -C Electrical and Electronics Engineering, V -D Information Engineering, V -E Chemical and IX Creativity and design competencies (IX-A Creativity, IX-B Engineering design skills)
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. 2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	(e) design capacity to use various types of science, technology and information to solve society's requirements		Problem Analysis WA2: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences with holistic considerations for sustainable development* (WK1 to WK4) Design/development of solutions WA3: Design creative solutions for complex engineering problems and design systems, components or processes to meet identified needs with appropriate WA4: Design creative solutions for complex engineering problems and design systems, components or processes to meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required (WK5)	IV Fundamentals of Engineering (IV-B Engineer Ethics, IV-E Globalization Cross-Cultural Multicultural Understanding) V Specialist engineering by field (V -A Mechanical engineering, V -B Materials engineering, V -C Electrical and electronics engineering, V -D Information engineering, V -E Chemical and biological engineering, V -F Construction engineering, V -G Architecture engineering) VII General skills (VII-D Thinking skills, VII-E Problem Identification and Solution skills) IX Creativity and design competencies (IX-A Creativity, IX-B Engineering design skills)
3. an ability to communicate effectively with a range of audiences.	(f) Communication skills, including logical writing, oral presentation and discussion.		Communication WA9: Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being WA8: Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, taking into account cultural, language, and learning differences.	III Humanities and Social Sciences (III -A Japanese, III -B English) VII Versatile Skills (VII-A Communication Skills)

<p>4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.</p>	<p>(a) the ability and aptitude to think multilaterally from a global perspective (b) an understanding of the impact and effects of technology on society and nature, and the contribution and responsibility of engineers to society (h) the ability to plan and organize work under given constraints</p>	<p>WK5: Knowledge, including efficient resource use, environmental impacts, whole-life costs, re-use of resources, net zero carbon, and similar concepts WK6: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and public safety and operations in a practice area WK8: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development WK9: Ethics, inclusive behavior and conduct. knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.</p>	<p>The Engineer and the World WA6: When solving complex engineering problems, analyze and evaluate sustainable development impacts* to: society, the economy, sustainability, health and safety, legal frameworks, and the environment (WK1, WK5, and WK7) Ethics WA7: Apply ethical principles and commit to professional ethics and norms of engineering practice and adhere to relevant national and international Demonstrate an understanding of the need for diversity and inclusion (WK9)</p>	<p>II Natural Sciences (II -E Life Sciences, Earth Sciences) III Humanities and Social Sciences (III-C Society) IV Fundamentals of Engineering (IV-B Engineer Ethics, IV-E Globalization Cross-Cultural Multicultural Understanding)</p>
<p>5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish 6. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.</p>	<p>(i) Ability to work in teams.</p>	<p>WK10: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own WK10: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.</p>	<p>Individual and Collaborative Team work WA8: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary, face-to-face, remote and distributed settings (WK9) Project Management and Finance WA10: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own WA11: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.</p>	<p>VII Versatile skills (VII-A Communication skills; VII-B Teamwork and leadership; VII -C Information gathering, utilization and dissemination skills; VII-D Thinking skills; VII-E Problem finding and problem solving skills)</p>
<p>6. an ability to develop and conduct appropriate experiments, analyze and interpret data, and use engineering judgment to draw conclusions.</p>	<p>(d) the specialist knowledge required in the field and the ability to apply it</p>	<p>WK2: Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to WK2: Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline</p>	<p>Investigation WA4: Conduct investigations of complex engineering problems using research methods including research-based knowledge, design of experiments, WA4: Conduct investigations of complex engineering problems using research methods including research-based knowledge, design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions (WK8) Tool Usage WA5: Create, select and apply, and recognize limitations of appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems (WK2 and WK6)</p>	<p>I Mathematics (probability, statistics) II Natural sciences (II -B physics experiments, II -D chemistry experiments) IV Fundamentals of engineering (IV-A engineering experimental techniques, IV- C information literacy) VI Field-specific engineering laboratory experiments and hands-on practices skills (VI-A mechanical fields, VI-B materials fields, VI-C electrical and electronic fields, VI-D information fields, VI-E chemical and biological fields, VI-F construction, VI-G Architecture)</p>
<p>7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.</p>	<p>(g) the ability to learn independently and continuously</p>	<p>WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative WK9: Engagement with selected knowledge in current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues WK11: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change (WK8)</p>	<p>Lifelong learning WA11: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change (WK8)</p>	<p>VIII Attitudes and mindsets (VIII-A Self-awareness, VIII-B Initiative, VIII-C Self-management and responsible behavior, VIII-E Career design, VIII-F Continuous learning and learning objectives)</p>

[Reference]

ABET (2022-2023 Criteria for Accrediting Engineering Programs) <https://www.abet.org/wp-content/uploads/2022/01/2022-23-EAC-Criteria.pdf>

JABEE (Japanese Accreditation Board for Engineering Education Common Criteria (from 2019)) https://jabee.org/about_jabee/accreditation_system

IEA (Knowledge and Attitude Profile, Graduate Attribute Profiles) <https://www.ieaagreements.org/assets/Uploads/IEA-Graduate-Attributes-and-Professional-Competencies-2021.1-Sept-2021.pdf>

1-1.2 Correspondence table with CDIO syllabus version 3

A correspondence table with CDIO Syllabus version 3 is presented in Table 2.

Table 2 Correspondence table with CDIO syllabus version 3 and MCC achievement goals

CDIO Syllabus Ver. 3	MCC 2023 Achievement goals
1 FUNDAMENTAL KNOWLEDGE AND REASONING	
1.1 KNOWLEDGE OF UNDERLYING MATHEMATICS AND SCIENCES	I Mathematics, II Natural sciences, IV Fundamentals of engineering (IV-C Information literacy)
1.2 CORE ENGINEERING FUNDAMENTAL KNOWLEDGE	IV Fundamentals of engineering V Specialized engineering by field (V-A Mechanical engineering, V-B Materials engineering, V-C Electrical and electronics engineering, V-D Information engineering, V-E Chemical and biological engineering, V-F Construction engineering, V-G Architecture engineering)
1.3 ADVANCED ENGINEERING FUNDAMENTAL KNOWLEDGE, METHODS AND TOOLS	V Specialist engineering by discipline (V-A Mechanical engineering, V-B Materials engineering, V-C Electrical and electronics engineering, V-D Information engineering, V-E Chemical and biological engineering, V-F Construction engineering, V-G Architecture engineering) VI Experimental and practical engineering skills by discipline (VI-A Mechanical engineering, VI-B Materials engineering, VI-C Electrical and electronics engineering, VI-D Information engineering, VI-E Chemical and biological fields, VI-F Construction fields, VI-G Architecture fields)
1.4 KNOWLEDGE OF SOCIAL SCIENCES AND HUMANITIES	III Humanities and social sciences
2 PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES	
2.1 ANALYTIC REASONING AND PROBLEM SOLVING	VII Versatile skills (VII-D Thinking skills, VII-E Problem finding and problem-solving skills) IX Creativity and design competencies (IX-A Creativity)
2.2 EXPERIMENTATION, INVESTIGATION AND KNOWLEDGE DISCOVERY	VI Field-specific engineering experiments and practical training skills (VI-A mechanical fields, VI-B materials fields, VI-C electrical and electronic fields, VI-D information fields, VI-E chemical and biological fields, VI-F construction fields, VI-G construction fields) VII General-purpose skills (VII-C information gathering, utilization and transmission skills, VII-D thinking skills)
2.3 SYSTEM THINKING	
2.4 ATTITUDES, THOUGHT AND LEARNING	VII Versatile skills (VII-D Thinking skills) VIII Attitudes and mindsets (VIII-A Self-awareness, VIII-C Self-management and responsible behavior, VIII-F Purpose of continuous learning and learning) IX Creativity and design competencies (IX-A Creativity)
2.5 ETHICS, EQUITY AND OTHER RESPONSIBILITIES	IV Fundamentals of engineering (IV-B Engineer ethics) VIII Attitudes and mindsets (VIII-C Self-management and responsible behavior, VIII-D Ethics, VIII-E Career design, VIII-F Continuous learning and learning objectives)
3 INTERPERSONAL SKILLS: COLLABORATION, TEAMWORK AND COMMUNICATION	
3.1 TEAMWORK AND COLLABORATION	VII Versatile skills (VII-A Communication skills, VII-B Teamwork and leadership) IX Creativity and design competencies (IX-B Engineering design skills)
3.2 COMMUNICATIONS.	III Humanities and Social Sciences (III-A Japanese, III-B English) IV Fundamentals of Engineering (IV-C Information Literacy) VII General Skills (VII-A Communication Skills)
3.3 COMMUNICATIONS IN FOREIGN LANGUAGES	III Humanities and Social Sciences (III-B English) VIII Attitudes and Mindsets (VIII-E Career Design)
4 CONCEIVING, DESIGNING, IMPLEMENTING AND OPERATING SYSTEMS IN THE ENTERPRISE, SOCIETAL AND ENVIRONMENTAL CONTEXT ? THE INNOVATION PROCESS	
4.1 EXTERNAL, SOCIETAL AND ENVIRONMENTAL CONTEXT	III Humanities and Social Sciences (III-C Society) IV Fundamentals of Engineering (IV-B Engineer Ethics, IV-D Globalization and Multicultural Understanding) VIII Attitudes and Mindsets (VIII-E Career Design)
4.2 ENTERPRISE AND BUSINESS CONTEXT	VIII Attitudes and mindsets (VIII-E Career design)
4.3 CONCEIVING, SYSTEM ENGINEERING AND MANAGEMENT	IX Creativity and design competencies (IX-A Creativity, IX-B Engineering design skills)
4.4 DESIGNING	V Specialist engineering by field (V-A Mechanical engineering, V-B Materials engineering, V-C Electrical and electronics engineering, V-D Information engineering, V-E Chemical and biological engineering, V-F Construction engineering, V-G Architecture engineering) IX Creativity and design competencies (IX-A Creativity, IX-B Engineering design skills)
4.5 IMPLEMENTING.	IX Creativity and design competencies (IX-A Creativity, IX-B Engineering design skills)
4.6 OPERATING	

1-2 Correspondence table with the Courses of Study Guideline for Upper Secondary Schools

The correspondence between the MCC and the Course of Study Guideline for Upper Secondary Schools in Japan (notified in 2008) is shown below.

I Mathematics

	Model Core Curriculum	Course of Study Guideline for Upper Secondary Schools
Objective	<p>[Learning achievement goals]</p> <p>To acquire the mathematical knowledge, computational techniques and applied skills necessary to solve fundamental engineering problems, and to develop the ability to use this knowledge, techniques, etc. in relation to phenomena in engineering.</p>	<p>The aim is to develop the following qualities and abilities to think mathematically through mathematical activities, using mathematical ways of seeing and thinking.</p> <p>(1) Ensure that students systematically understand the basic concepts, principles and laws in mathematics and develop skills in mathematising events, interpreting them mathematically, and expressing and processing them mathematically.</p> <p>(2) Cultivate the ability to consider events logically using mathematics, to recognize the essence of events and their relationships with other events and to consider them in an integrated and developed manner, and to express events concisely, clearly and precisely using mathematical expressions.</p> <p>(3) Cultivate an attitude of recognizing the good qualities of mathematics and actively trying to make use of mathematics, an attitude of thinking persistently and making decisions based on mathematical arguments, and an attitude of deepening reflection, evaluation and improvement of the problem-solving process, as well as a basis for creativity.</p>

Learning Content	Model Core Curriculum and Learning Content Achievement Goals	Course of Study Guideline for Upper Secondary Schools
Computing Numbers and Expressions	<ul style="list-style-type: none"> Can calculate addition, multiplication and division of integers and perform simple factorization using factor theorems, etc. Be able to calculate addition, multiplication and division of fractional expressions. Understand and be able to calculate the absolute value of real numbers. Able to calculate square roots, including rationalization of denominators. Understand the phase equality of complex numbers and be able to add, multiply and divide and calculate absolute values. 	<p>Mathematics I (1) Numbers and expressions</p> <p>ア(ア) Understand the significance of extending numbers to real numbers and perform simple four arithmetic operations on irrational numbers.</p> <p>ア(ウ) To develop an understanding of quadratic multiplication formulas and factorization formulas.</p> <p>Mathematics II (1) Various expressions</p> <p>ア(ア) Understand third-order multiplication and factorization formulas and use them to expand and factor expressions.</p> <p>ア(イ) Understand the division of polynomials and the four arithmetic rules for fractional expressions and perform calculations for simple cases.</p> <p>ア(ウ) Understand the significance of extending numbers to complex numbers and perform four arithmetical operations on complex numbers.</p> <p>ア(オ) Understand factor theorems and use factor theorems and other techniques to find solutions to simple higher-order equations.</p>
Equations and inequalities	<ul style="list-style-type: none"> Be able to solve quadratic equations using solution formulas etc. Be able to solve higher-order equations using factor theorems etc. Solving simultaneous equations. Solve irrational and fractional equations. Solve linear and quadratic inequalities. Be able to utilize the concept of the identity equation. 	<p>Mathematics I (1) Numbers and expressions</p> <p>ア(エ) Understand the meaning of solutions to inequalities and the properties of inequalities, and find solutions to linear inequalities.</p> <p>Mathematics II (1) Various expressions</p> <p>ア(エ) Discriminating between types of solutions to quadratic equations and understanding the relationship between solutions and coefficients.</p> <p>ア(オ) Understand factor theorems and use factor theorems and other techniques to find solutions to simple higher-order equations.</p>
Functions and graphs	<ul style="list-style-type: none"> Understand the properties and graphs of quadratic functions and be able to find the maximum and minimum values. Understand the properties and graphs of fractional and irrational functions and apply them to inequalities involving fractional and irrational functions. Find the inverse function of a given function and explain its properties. 	<p>Mathematics I (3) Quadratic functions</p> <p>ア(ア) Understand changes in the value of quadratic functions and the characteristics of their graphs.</p> <p>ア(イ) Finding the maximum and minimum of a quadratic function.</p> <p>ア(ウ) Understand the relationship between solutions to quadratic equations and the graphs of quadratic functions. Also, understand the relationship between solutions to quadratic inequalities and the graphs of quadratic functions and use the graphs of quadratic functions to find solutions to quadratic inequalities.</p> <p>Mathematics III (1) Extreme limits</p> <p>ア(ウ) Understand how simple fractional and irrational functions change in value and the characteristics of their graphs.</p> <p>ア(エ) Understand the meaning of composite and inverse functions and find them for simple cases.</p>
Exponential and logarithmic functions	<ul style="list-style-type: none"> Can perform calculations using power roots and exponential laws. Understand the properties and graphs of exponential functions and solve equations and inequalities involving exponential functions. Understand the properties of logarithms and be able to calculate logarithms. Understand the properties and graphs of logarithmic functions and solve equations and inequalities involving logarithmic functions. 	<p>Mathematics II (3) Exponential and logarithmic functions</p> <p>ア(ア) Understand the significance of extending exponents from positive integers to rational numbers and use exponential laws to calculate numbers and expressions.</p> <p>ア(イ) Understand changes in the value of an exponential function and the characteristics of its graph.</p> <p>ア(ウ) Understand the meaning of logarithms and their basic properties, and perform simple logarithmic calculations.</p> <p>ア(エ) Understand how logarithmic functions change in value and the characteristics of their graphs.</p>

<p>Trigonometric Function</p>	<ul style="list-style-type: none"> • Angles can be expressed using the arc degree method. • The values of trigonometric ratios of acute angles and trigonometric functions of general angles can be determined. • Understand the properties and graphs of trigonometric functions and solve equations and inequalities involving trigonometric functions. • Additive theorems are available. 	<p>Mathematics I (2) Figures and measurements ア(ア) Understanding the meaning of trigonometric ratios of acute angles and their interrelationships. ア(イ) Understand the significance of extending trigonometric ratios to obtuse angles and how to use values of trigonometric ratios of acute angles to find values of trigonometric ratios of obtuse angles. ア(ウ) To understand the sine and cosine theorems in relation to the triangle determinant and the theorem of the square, and to find the lengths of the sides and the magnitudes of the angles of a triangle.</p> <p>Mathematics II (4) Trigonometric functions ア(ア) Understand the significance of extending the concept of angles to general angles and how angles are expressed using the arc degree method. ア(イ) Understand how trigonometric functions change in value and the characteristics of their graphs. ア(ウ) Understand the basic properties of trigonometric functions, including their interrelationships. ア(エ) Understand the additive theorem for trigonometric functions, the double angle formula and the composition of trigonometric functions.</p>
<p>Figures and Expressions</p>	<ul style="list-style-type: none"> • Can find distances and end points from two given points. • Be able to find the equations of straight lines and circles. • For quadratic curves, explain the relationship between the equation and the approximate shape of the graph. • The area represented by the inequality can be illustrated. 	<p>Mathematics II (2) Figures and equations ア(ア) To express the position of a point that divides a line segment in a plane into interior and exterior points and the distance between two points using coordinates. ア(イ) Representing a line or circle on a coordinate plane by an equation. ア(ウ) Understand trajectories and find trajectories for simple cases. ア(エ) For simple cases, find the domain represented by an inequality or express a domain in terms of an inequality.</p> <p>Number C (2) Curves on planes and complex planes ア(ア) Understand that parabolas, ellipses and hyperbolas are represented by quadratic expressions and the basic properties of these quadratic curves.</p>
<p>Number of Cases</p>	<ul style="list-style-type: none"> • Be able to use the law of product and the law of sums to find the number of cases. • Understand the product and sum laws and be able to calculate permutations and combinations. 	<p>Mathematics A (2) Number of cases and probability ア(ア) Understand the basic relationships relating to the number of elements in a set and the principles of counting, including the law of sums and the law of products. ア(イ) Understand the meaning of permutations and combinations based on concrete events and determine the total number of permutations and combinations.</p>
<p>Sequence</p>	<ul style="list-style-type: none"> • Find the general terms of isoperimetric and isoperimetric sequences and their sums. • Represent the sum of a sequence of numbers using the sum sign and find the sum of the numbers. • Find the limit of a sequence of numbers. • Investigate the convergence and divergence of infinite geometric series and find their sum. 	<p>Mathematics B (1) Sequence ア(ア) Understand the isoperimetric and isoperimetric sequences and find their general terms and sums. ア(イ) Understand how to find the general terms and sums of various sequences of numbers.</p> <p>Mathematics III (1) Extreme limits ア(ア) Understand the limits of sequences of numbers and To find the limit of a simple number sequence, e.g. based on the limit of the ア(イ) Understand the convergence and divergence of infinite series and find the sum of simple infinite series such as infinite geometric series.</p>
<p>Vector</p>	<ul style="list-style-type: none"> • Can calculate vector sums, differences and real multiples and find magnitudes. • Be able to perform calculations using the component representation of vectors. • Finding the inner product of vectors. • Vectors can be used to determine parallelism and perpendicularity. • Can find equations for lines, planes and spheres in space. 	<p>Mathematics C (1) Vectors ア(ア) Understand the meaning of vectors in the plane, the meaning of the vectors in the plane, the homomorphisms, sums, differences, real multiples, position vectors and the representation of the components of vectors. ア(イ) Understand the inner product of vectors and its basic properties. ア(ウ) Understand that the ideas of coordinates and vectors can be extended from the plane to space.</p> <p>Mathematics A (1) Properties of figures ア(ア) Understand the basic properties related to triangles. ア(イ) Understand the basic properties of a circle. ア(ウ) Understand the basic properties related to spatial figures.</p>
<p>Matrix</p>	<ul style="list-style-type: none"> • Be able to calculate matrix sums, differences, real multiples and products. • Can determine the regularity of a matrix and find its inverse. • Understand the properties of determinants and be able to calculate the value of determinants. • Solve simultaneous linear equations using matrices. 	<p>(N/A)</p>
<p>Applications of Matrices</p>	<ul style="list-style-type: none"> • Understand that a matrix represents a linear transformation and be able to find the coordinates of a linearly transformed point. • The matrices representing the composite and inverse transformations can be obtained. • Understand that symmetrical translations and rotations in the plane are linear transformations and be able to find the matrix representing the linear transformation. • Be able to find the eigenvalues and eigenvectors of a matrix. 	<p>(N/A)</p>

Differentiation	<ul style="list-style-type: none"> • Be able to find the limit of a function. • Understand the meaning of differential coefficients and derivatives and be able to find the derivative of a power function. • Derivatives of products and quotients can be determined. • Can perform calculations using differential calculus of composite functions. • Find derivatives of functions including trigonometric, exponential, logarithmic and inverse trigonometric functions. 	<p>Mathematics II (5) Differential and integral ideas ア(ア) Understand the meaning of differential coefficients and derivatives, and find the derivatives of constant multiples, sums and differences of functions. ア(イ) Use derivatives to investigate increases and decreases, maxima and minima of the value of a function and understand how to outline a graph.</p> <p>Mathematics III (1) Extreme limits ア(オ) Understand the limits of the value of a function.</p> <p>Mathematics III (2) Differential methods ア(ア) Understand differentiability, products of functions and derivatives of quotients, and find the derivatives of the sum, difference, product and quotient of functions. ア(イ) Understand and find the derivatives of the composite function. ア(ウ) Understand the derivatives of trigonometric, exponential and logarithmic functions and find them. ア(エ) Use derivatives to find the equations of tangents to various curves, investigate the increase/decrease, maxima and minima of various function values and graph irregularities, and draw a rough sketch of a graph.</p> <p>Number C (2) Curves on planes and complex planes ア(イ) Understanding the mediating variable representation of curves.</p>
Applications of Differential Calculus	<ul style="list-style-type: none"> • Be able to use derivatives to get a general idea of the shape of a graph and to find the extremes, maximum and minimum values of a function. • The equation of the tangent line can be obtained. • Be able to use second derivatives to determine the concavity and convexity of a graph. • Derivatives can be calculated for functions displayed as mediating variables. 	
Integration	<ul style="list-style-type: none"> • Can use derivative formulas to find indefinite integrals. • Understand the fundamental theorem of differential and integral calculus and be able to use indefinite integrals to obtain definite integrals. • Use substitution integrals and partial integrals to find indefinite and definite integrals. • Calculate indefinite and definite integrals of functions, including trigonometric, exponential, logarithmic, fractional and irrational functions. 	<p>Mathematics II (5) Differential and integral ideas ア(ウ) To understand the meaning of indefinite and definite integrals and to find the values of indefinite and definite integrals of constant multiples, sums and differences of functions.</p> <p>Mathematics III (3) Integral methods ア(ア) Develop an understanding of the basic properties of indefinite and definite integrals and use them to find indefinite and definite integrals. ア(イ) Understand the methods of substitutive and partial integrals and use them to find indefinite and definite integrals for simple cases. ア(ウ) Use definite integrals to find the area of figures surrounded by various curves, the volume of a solid and the length of a curve.</p> <p>Number C (2) Curves on planes and complex planes ア(ウ) Understanding the meaning of polar coordinates and the fact that curves are represented by polar equations.</p>
Applications of the Integral Method	<ul style="list-style-type: none"> • Can use definite integrals to find areas. • The length of a curve can be determined using definite integrals. • Can use definite integrals to find volumes. 	
Progression	<ul style="list-style-type: none"> • Taylor expansions of univariate functions can be obtained. • Euler's formula can be used. 	(N/A)
Partial Differentiation	<ul style="list-style-type: none"> • Partial derivatives up to the second order can be obtained, e.g. by using partial differentiation of composite functions. • Find the extreme values of a bivariate function. 	(N/A)
Multiple Integral	<ul style="list-style-type: none"> • Be able to calculate double integrals by cumulative integration. • Can calculate double integrals using polar coordinate transformations. • Double integrals can be used to find volumes. 	(N/A)
Differential Equation	<ul style="list-style-type: none"> • Solve differential equations in variable separation form. • Solve first-order linear differential equations. • Solve constant coefficient second-order asymptotically linear differential equations. 	(N/A)

Probability	<ul style="list-style-type: none"> Understand the additive theorem of probability, the exhaustion event and the extra event, and be able to calculate probabilities. Understand conditional probability, the multiplication theorem of probability and independent events, and be able to calculate probabilities. Understand random variables and probability distributions and be able to explain the properties and characteristics of binomial and normal distributions. 	<p>Mathematics I (1) Numbers and expressions ア(イ) Understand basic concepts about sets and propositions.</p> <p>Mathematics A (2) Number of cases and probability ア(ア) Understand the basic relationships relating to the number of elements in a set and the principles of counting, including the law of sums and the law of products. ア(イ) Understand the meaning of permutations and combinations based on concrete events and find the total number of permutations and combinations. ア(ウ) Develop an understanding of the meaning of probability and the basic laws of probability and use them to find the probability or expected value of an event. ア(エ) Understanding the meaning of independent trials and determining the probability of independent trials. ア(オ) Understand the meaning of conditional probability and find the conditional probability for simple cases.</p> <p>Mathematics B (2) Statistical inference ア(イ) Understanding of random variables and probability distributions. ア(ウ) Understanding the properties and characteristics of binomial and normal distributions.</p> <p>Mathematics B (3) Mathematics and social life ア(イ) To mathematise daily and social events and other phenomena and to know how to solve problems mathematically.</p>
Statistics	<ul style="list-style-type: none"> Organize one-dimensional data and determine the mean, variance and standard deviation. Be able to organize two-dimensional data to create scatter plots and obtain correlation coefficients and regression lines. 	<p>Mathematics I (4) Analysis of data ア(ア) Understanding the meaning of variance, standard deviation, scatter plots and correlation coefficients and how they are used. ア(イ) Organizing data into tables and graphs and obtaining basic statistics such as variance and standard deviation, for example by using computers and other information equipment.</p> <p>Mathematics B (3) Mathematics and social life ア(イ) To mathematise daily and social events and other phenomena and to know how to solve problems mathematically.</p> <p>Mathematics C (3) Mathematical representation ア(ア) Understand the significance of using diagrams, tables and statistical graphs to express daily events and social phenomena in an ingenious way.</p>
(N/A)		<p>Mathematics I (4) Analysis of data ア(ウ) Understanding the concept of hypothesis testing in concrete events.</p> <p>Mathematics A (3) Mathematics and human activity ア(ア) Understanding of the relationship between concepts such as those relating to quantity and shape and human activity. ア(イ) To develop an understanding of the relationship between mathematics and culture through historical mathematical topics, mathematical games and puzzles.</p> <p>Mathematics B (1) Sequence ア(ウ) Understand reduction formulas and express changes in events in terms of reduction formulas and find the general term of a sequence of numbers expressed in terms of simple reduction formulas. ア(エ) Understanding of mathematical induction.</p> <p>Mathematics B (2) Statistical inference ア(ア) To develop an understanding of the concept of sampling surveys. ア(エ) Understand the methods of interval estimation and hypothesis testing using the normal distribution.</p> <p>Mathematics B (3) Mathematics and social life ア(ア) Understand the significance of using mathematics to solve problems in social life and other areas.</p> <p>Mathematics C (2) Curves in the plane and the complex plane ア(エ) Understand the complex number plane and polar forms of complex numbers, real multiples of complex numbers, and the graphic meaning of sums, differences, products and quotients. ア(オ) Understanding de Moivre's theorem.</p> <p>Mathematics C (3) Mathematical representation ア(イ) Understand the significance of using discrete graphs and matrices to devise and represent daily and social events.</p>

II-A Physics

	Model Core Curriculum	Course of Study Guideline for Upper Secondary Schools
Objective	<p>[Learning achievement goals]</p> <p>Acquire basic knowledge of physics and be able to apply it to their own engineering field. In the process, they also develop the ability to think about natural phenomena systematically and logically, and acquire a physical view and way of thinking to scientifically elucidate a wide range of natural phenomena.</p> <p>(1) perform basic calculations on the motion and energy of objects; and (2) perform basic calculations on the motion and energy of objects.</p> <p>(2) relate various phenomena related to heat, waves and electricity to the laws of physics.</p>	<p>[Fundamentals of Physics]</p> <p>Aim to develop the qualities and abilities required to scientifically explore the motion of objects and various energies through observation and experimentation with a viewpoint, using the viewpoint and thinking of science in relation to the motion of objects and various energies, as follows.</p> <p>(1) While making connections with daily life and society, ensure that students understand the motion of objects and various forms of energy, and acquire the basic skills in observation and experimentation necessary for scientific enquiry.</p> <p>(2) Develop the ability to explore scientifically through observation and experimentation.</p> <p>(3) Cultivate an attitude of proactive engagement with the motion of objects and various energies, and an attitude of scientific inquiry.</p> <p>[Physics]</p> <p>Aim to develop the qualities and abilities necessary for scientific exploration of physical things and phenomena, through engaging with physical things and phenomena, using a science perspective and thinking, and conducting observations and experiments with a view to the future, as follows.</p> <p>(1) Ensure that students deepen their understanding of the basic concepts, principles and laws of physics and develop the skills related to observation and experimentation necessary for scientific enquiry.</p> <p>(2) Develop the ability to explore scientifically through observation and experimentation.</p> <p>(3) Cultivate an attitude of proactive engagement with physical things and phenomena and an attitude of scientific inquiry.</p>

Learning Content	Model Core Curriculum and Learning Content Achievement Goals	Course of Study Guideline for Upper Secondary Schools
Motion of Bodies (field of mechanics)	<ul style="list-style-type: none"> Explain the concepts of velocity and acceleration. Calculations can be made on average velocity and average acceleration. In linear and planar motion, be able to view velocities as vectors and perform calculations on the synthesis and decomposition of velocities and relative velocities. Be able to perform calculations on the displacement, time and velocity of an object using the formula for iso-accelerative linear motion. The motion of a mass point moving in the plane can be treated as a change in the position vector. Calculate the displacement, velocity and acceleration of an object with respect to each other using derivatives and integrals. 	<p>[Fundamentals of Physics]</p> <p>(1) (7) ⑦ Understand how to measure and represent physical quantities and analyze methods for familiar physical phenomena. (This should cover, for example, methods that are common throughout the study of 'Fundamentals of Physics'.)</p> <p>(1) (7) ① Understand how to represent the motion of an object, with a focus on linear motion.</p> <p>(1) (7) ⑤ conduct experiments and other activities related to the linear motion of an object with varying speed, to find and understand the relationship between speed and time, and to understand the acceleration of an object in linear motion.</p> <p>[Physics]</p> <p>(1) (7) ⑦ Understand the motion of an object in motion in a plane. (Dealing with the fact that displacements, velocities and accelerations representing the motion of an object in a plane are represented by vectors.)</p>
Motion of Falling Bodies (field of mechanics)	<ul style="list-style-type: none"> Be able to perform calculations on the displacement, velocity and time of free-fall and vertically projected objects. Calculations on the displacement, velocity and time of horizontally and obliquely projected objects can be performed. 	<p>[Fundamentals of Physics]</p> <p>(1) (1) ⑤ Understand the characteristics of the motion of an object falling and the relationship between the forces acting on the object and its motion. (Free fall and vertical projection are dealt with, with qualitative exposure to horizontal projection.)</p> <p>[Physics]</p> <p>(1) (7) ① Understand the motion of horizontally and obliquely projected objects in relation to linear motion. (i.e. dealing with velocity, acceleration and the action of gravity in the horizontal and oblique projection of an object).</p>
	(N/A)	<p>[Fundamentals of Physics]</p> <p>(1) (1) ⑤ (Qualitative exposure to the existence of air resistance as well.)</p> <p>[Physics]</p> <p>(1) (7) ① (Touch also on falling motion in the presence of air resistance.)</p>
Various Forces (field of mechanics)	<ul style="list-style-type: none"> Be able to illustrate the forces acting on an object. Force synthesis and decomposition. Be able to perform calculations on the balance of forces acting on a mass point. Understand the concepts of gravity, elastic force, drag force and tension and be able to perform calculations relating to each of these forces. Explain pressure and buoyancy. 	<p>[Fundamentals of Physics]</p> <p>(1) (1) ⑦ Understand that various forces act on objects. (Frictional, elastic, pressure and buoyancy forces shall be dealt with. Also to be qualitatively exposed to forces acting across space.)</p> <p>(1) (1) ① Understand the equilibrium of forces acting on objects. (Focus should be on the equilibrium of forces acting in a plane.)</p>
Frictional Forces (field of mechanics)	<ul style="list-style-type: none"> Explain the balance of forces when static frictional forces are at work. Calculations on maximum frictional forces can be made. Be able to perform calculations on dynamic frictional forces. 	

Laws of Motion (field of mechanics)	<ul style="list-style-type: none"> • Be able to explain the three laws of motion. • The equations of motion can be used to determine the acceleration produced in an object and the forces acting on the object. 	<p>[Fundamentals of Physics]</p> <p>(1) (4) ⑦ Conduct experiments and other activities related to the motion of an object when a constant force is continuously applied to it, to find and understand the relationship between the mass of an object, the force acting on the object and the acceleration produced in the object, and to understand the three laws of motion. (Focus should be given to linear motion.)</p>
Mechanical Energy (field of mechanics)	<ul style="list-style-type: none"> • Set up equations of motion in the form of differential equations for simple motions and solve them as initial value problems. 	<p>(N/A)</p>
Momentum (field of dynamics)	<ul style="list-style-type: none"> • Be able to perform calculations on work and work rates. • Be able to perform calculations on the kinetic energy of an object. • Be able to perform calculations on potential energy due to gravity. • Be able to perform calculations on potential energy due to elastic forces. • Be able to explain the law of conservation of mechanical energy and use the law to determine the velocity and displacement of an object. 	<p>[Fundamentals of Physics]</p> <p>(1) (7) ⑦ Understand kinetic and potential energy in relation to work. (For 'potential energy', deal with potential energy due to gravity and potential energy due to elastic forces.)</p> <p>(1) (7) ④ Understand the law of conservation of mechanical energy in relation to work by conducting experiments and other activities related to mechanical energy. (Focus should be given to the conservation of mechanical energy in the absence of friction and air resistance.)</p>
Momentum (field of dynamics)	<ul style="list-style-type: none"> • The mass and velocity of an object can be used to determine its momentum. • Using the fact that the change in momentum of an object is equal to the force product, the magnitude of the force product, the change in velocity and the average force applied can be determined. • Be able to explain the law of conservation of momentum and use the law and the coefficient of repulsion to determine, for example, the change in velocity with respect to collisions, splitting and merging of objects. 	<p>[Physics]</p> <p>(1) (4) ⑦ Understand the relationship between momentum and force product. (Dealing with the fact that momentum and the force product are represented by vectors and that the change in momentum is equal to the force product.)</p> <p>(1) (4) ④ Understand the law of conservation of momentum through experiments on collisions and splitting of objects.</p> <p>(1) (4) ⑦ Understand the change in mechanical energy in a collision. (Also deal with rebound coefficients.)</p>
Circular Motion and Single Oscillations (field of mechanics)	<ul style="list-style-type: none"> • Be able to perform calculations on the velocity, angular velocity, period, acceleration and centripetal force of an object in constant velocity circular motion. • Explain the relationship between displacement, velocity, acceleration and restoring force in single vibration. • Various quantities characterizing single oscillations, such as period, frequency, etc., can be determined. 	<p>[Physics]</p> <p>(1) (7) ⑦ Understand how to describe an object in circular motion and the forces acting on it. (The velocity, period, angular velocity, centripetal acceleration and centripetal force of constant velocity circular motion shall be dealt with. Also, centrifugal forces shall be touched upon.)</p> <p>(1) (7) ④ To conduct experiments on pendulums, etc., to find out and understand the regularities of single oscillations, and to understand how to describe a single oscillating object and the forces acting on that object. (Dealing with the displacement, velocity, acceleration and restoring force of a single-vibrating object. For 'single oscillation', spring pendulums and single pendulums shall be dealt with.)</p>
Universal Gravitation (field of mechanics)	<ul style="list-style-type: none"> • The law of universal gravitation can be used to find the universal force of attraction acting between objects. • Be able to perform calculations on potential energy due to universal gravitation. • Be able to perform calculations on the motion of objects subject to universal gravitation. 	<p>[Physics]</p> <p>(1) (4) ⑦ Understand the laws of planetary motion based on observational data on the planets. (Kepler's laws shall be dealt with.)</p> <p>(1) (4) ④ Understand the law of universal gravitation and the motion of objects due to universal gravitation. (Also deal with potential energy due to universal gravitation.)</p>
Rigid bodies (field of mechanics)	<ul style="list-style-type: none"> • Be able to perform calculations on moments of force. • Be able to perform calculations on rigid body suspensions. • Able to perform calculations on the center of gravity. 	<p>[Physics]</p> <p>(1) (7) ⑦ To find and understand the conditions for the suspension of rigid bodies by conducting experiments on the suspension of objects of different sizes.</p> <p>(2) (7) ⑦ To deal with the equilibrium of moments of force. Also, to be exposed to the center of gravity of objects.)</p>
Temperature and Heat (thermal field) Work and Heat (thermal sector) Energy (thermal sector)	<ul style="list-style-type: none"> • Explain the relationship between the thermal motion of atoms and molecules and absolute temperature. • Explain that, over time, a state of thermal equilibrium is reached by the transfer of heat. • Be able to perform calculations on the heat capacity and specific heat of an object. • The law of conservation of heat capacity can be used to determine the heat capacity, specific heat and temperature of an object after thermal equilibrium. • Be able to determine the pressure, temperature and volume of a gas using Boyle-Charles' law and the equation of state of an ideal gas. • Explain the relationship between the kinetic energy and internal energy of molecules in an ideal gas. • Be able to use the first law of thermodynamics to perform calculations on changes of state of gases (constant volume change, constant pressure change, isothermal change and adiabatic change). • Explain, with specific examples, that there are many forms of energy and that they can be converted into each other. • Be able to explain irreversible change with specific examples. • Be able to perform calculations on the thermal efficiency of heat engines. 	<p>[Fundamentals of Physics]</p> <p>(2) (4) ⑦ Understand heat and temperature in terms of thermal motion of atoms and molecules. (The thermal phenomena should be viewed from a microscopic point of view and the relationship between the thermal motion of atoms and molecules and temperature should be treated qualitatively. It should also touch upon internal energy and the three states of matter.)</p> <p>(2) (4) ④ Understand heat transfer and the conversion of heat and work through experiments and other activities related to heat. (Also exposure to irreversibility in thermal phenomena.)</p> <p>[Physics]</p> <p>(1) (4) ⑦ Understand the relationship between the motion of gas molecules and pressure. (This should cover the equation of state of an ideal gas, the velocity of gas molecules and their average kinetic energy.)</p> <p>(1) (4) ④ Understand the internal energy of gases in relation to the motion of gas molecules. (Dealing with ideal gases.)</p> <p>(1) (4) ⑦ Understand the relationship between heat, work and internal energy through experiments and other activities relating to changes of state in gases. (Dealing with the first law of thermodynamics.)</p>

	(N/A)	[Fundamentals of Physics] (2) (±) ⑦ Understand, from a physics perspective, the characteristics and use of energy from sources such as hydropower, fossil fuels, nuclear power and sunlight available to mankind. (Focus should be given to the conversion to electrical energy. With regard to 'nuclear energy', students should be exposed to the fact that energy is generated by nuclear fission. In relation to this, the types and properties of radiation, the basic properties of radioactive materials and the uses of nuclear energy and their challenges should also be touched upon).
Wave Propagation and Types (wave fields).	<ul style="list-style-type: none"> Be able to perform calculations on the amplitude, wavelength, period, frequency and speed of waves. Explain how transverse and longitudinal waves propagate. The displacement of the medium in relation to time and position can be expressed by a sinusoidal equation. 	[Fundamentals of Physics] (2) (7) ⑦ Understand the properties of waves, focusing on the case of linear transmission. (The method of using a diagram should be dealt with in the main. Standing waves should also be dealt with and exposure to longitudinal and transverse waves should be given). [Physics] (2) (7) ⑦ Understand how waves propagate and how they are represented. (Huygens' principle, dealing with reflection and refraction of water surface waves and the wave equation.)
Principle of Superposition and Wave interference (wave field).	<ul style="list-style-type: none"> Explain the principle of wave superposition. Explain the independence of waves. Explain the conditions under which two waves can strengthen or weaken each other when they interfere. Explain the characteristics of standing waves (e.g. how they oscillate at nodes and bellies). 	(2) (7) ④ Understanding wave interference and diffraction. (Dealing with water surface waves.)
Reflection, Refraction and Diffraction of Waves (wave field)	<ul style="list-style-type: none"> Be able to explain Huygens' principle. Explain the laws of reflection, refraction and diffraction of waves. 	
Sound Waves and Sonic Bodies (wave field)	<ul style="list-style-type: none"> The length of the string and the speed of the waves travelling along the string can be used to determine the natural frequency of the string. Using the length of the air column and the sound velocity, the natural frequencies of open and closed tubes can be determined (without considering the opening end correction). Be able to explain buzzing and resonance and resonance phenomena with specific examples. The change in sound frequency due to the Doppler effect can be determined for motion on a straight line. 	[Fundamentals of Physics] (2) (7) ④ Understand the relationship between the resonance of an air column and the frequency of a sound source by conducting experiments on the resonance of air columns. Also, to understand the vibration of strings and the properties of sound waves. (Dealing with reflection, resonance and buzzing of waves, etc.) [Physics] (2) (1) ⑦ Understand sound interference and diffraction. (2) (1) ④ Understand the Doppler effect of sound. (Focus should be given to cases where the observer and the sound source move in the same straight line.)
Light waves (wave field)	<ul style="list-style-type: none"> Be able to explain the difference between natural light and polarized light. Be able to perform calculations on the angle of reflection and refraction of light. Explain that spectra are produced by dispersion phenomena due to differences in wavelength. Be able to explain diffraction and interference of light with specific examples. 	[Physics] (2) (7) ⑦ Understand how light travels. (This should deal with the speed, wavelength, reflection, refraction, dispersion and polarization of light, and should also touch on the fact that light is a transverse wave and the spectrum of light.) (2) (7) ④ To understand the diffraction and interference of light in relation to the properties of light waves by conducting experiments on the diffraction and interference of light. (Young's experiments, dealing with diffraction gratings and interference in thin films.)
	(N/A)	[Physics] (2) (7) ⑦ (The geometric optical properties of mirrors and lenses should be treated as basic.)
Electrostatic fields (electrical field)	<ul style="list-style-type: none"> Be able to explain the difference between conductors and non-conductors in relation to free electrons. Coulomb's law can be used to determine the electrostatic force acting between point charges. Be able to explain electric fields and potentials and perform calculations on electric fields and potentials created around point charges and simple shaped charged objects. Understand the properties of capacitors and be able to determine their electrical capacitance etc. 	[Fundamentals of Physics] (2) (7) ⑦ Conduct experiments and other activities related to electrical resistance, and find and understand that conductors made of the same substance have different electrical resistance depending on their length and cross-sectional area. Also, understand that resistivity differs depending on the substance. (Also deal with the fact that the current in metals is due to the flow of free electrons. Also to mention that there are semiconductors and insulators). [Physics] (3) (7) ⑦ Understand the forces that electric charges exert on each other. They shall also understand how electric fields are represented. (Electrostatic induction shall also be dealt with.) (3) (7) ④ Understand the relationship between electric fields and electric potential in relation to potential energy due to electrostatic forces. (3) (7) ⑦ Understand the properties of capacitors and relate electrical capacitance to electric fields and potential differences. (3) (7) ④ Understand the basic laws in electric circuits through experiments and other activities related to electric circuits.
Electric current (electrical field)	<ul style="list-style-type: none"> Use Ohm's law and Kirchhoff's law to find voltage, current and resistance. The composite resistance can be determined when the resistors are connected in series and parallel. Be able to perform calculations on Joule heat and power. 	
	(N/A)	[Physics] (3) (7) ⑦ (Touching also on condenser connections.) (3) (7) ④ (Temperature variation of resistivity and internal resistance shall also be dealt with. Also, exposure to semiconductors.)

Magnetism and Others	(N/A)	<p>[Fundamentals of Physics]</p> <p>(2) (7) Ⓢ Understand the basic mechanisms of electricity generation, transmission and use of electricity. (Conversion of alternating current to direct current and the use of electromagnetic waves shall also be touched upon.)</p> <p>[Physics]</p> <p>(3) (4) Ⓢ Understand the magnetic fields created by currents. (Focus should be on the magnetic fields created by linear and circular currents.)</p> <p>(3) (4) Ⓢ Understand the forces that an electric current receives from a magnetic field. (Exposure to Lorentz forces.)</p> <p>(3) (4) Ⓢ Conduct experiments and other activities related to electromagnetic induction to find and understand the relationship between changes in magnetic flux and the direction and magnitude of induced electromotive force, and to understand the laws of electromagnetic induction. Also, to understand the generation of alternating current. (The course shall focus on the laws of electromagnetic induction and shall deal with self-induction and mutual induction. Also to be exposed to the basic properties of alternating current circuits.)</p> <p>(3) (4) Ⓢ To understand the properties of electromagnetic waves and their use. (Exposure to electrical vibrations and the generation of electromagnetic waves.)</p>
Atom	(N/A)	<p>[Physics]</p> <p>(4) (7) Ⓢ Understand the charge and mass of the electron. (Ⓢ Students should be exposed to historical experiments on electrons.)</p> <p>(4) (7) Ⓢ Understand the particle and wave nature of electrons and light. (This should deal with the photoelectric effect, electron diffraction, etc., and should include exposure to X-rays.)</p> <p>(4) (4) Ⓢ Understand the relationship between the structure and spectrum of atoms and the energy levels of electrons. (Focus should be given to the structure of the hydrogen atom in relation to the spectrum.)</p> <p>(4) (4) Ⓢ Understand the composition of the atomic nucleus, nuclear decay and nuclear reactions. (Also touch upon the equivalence of mass and energy.)</p> <p>(4) (4) Ⓢ To know about the existence of elementary particles.</p>

II-C Chemistry

	Model Core Curriculum	Course of Study Guideline for Upper Secondary Schools
Objective	<p>[Learning achievement goals].</p> <p>Acquire basic knowledge of chemistry and be able to apply it to their own field of engineering. In the process, they also develop the ability to think about natural phenomena systematically and logically, and acquire a chemical view and way of thinking to scientifically elucidate a wide range of natural phenomena.</p>	<p>[Basic chemistry]</p> <p>The aim is to develop the qualities and abilities required to scientifically explore matter and its changes through engaging with matter and its changes, using a science perspective and thinking, and conducting observations and experiments with a view to the future, as follows.</p> <p>(1) To develop an understanding of materials and their changes in relation to daily life and society, and to acquire the basic skills in observation and experimentation necessary for scientific enquiry.</p> <p>(2) Develop the ability to explore scientifically through observation and experimentation.</p> <p>(3) Cultivate an attitude of independent engagement with matter and its changes, and an attitude of scientific enquiry.</p> <p>[Chemistry]</p> <p>The aim is to develop the qualities and abilities required for scientific exploration of chemical things and phenomena by engaging with chemical things and phenomena, using a science perspective and thinking, and conducting observations and experiments with a view to the future, as follows.</p> <p>(1) Ensure that students deepen their understanding of the basic concepts, principles and laws of chemistry and develop the skills related to observation and experimentation necessary for scientific enquiry.</p> <p>(2) Develop the ability to explore scientifically through observation and experimentation.</p> <p>(3) Cultivate an attitude of independent involvement and scientific enquiry into chemical things and phenomena.</p>

Learning Content	Model Core Curriculum and Learning Content Achievement Goals	Course of Study Guideline for Upper Secondary Schools
The Relationship between Chemistry and Human life	<ul style="list-style-type: none"> Explain the relevance of chemistry to contemporary social issues. 	<p>[Basic chemistry]</p> <p>⑦ Chemistry Features.</p> <p>To understand the characteristics of chemistry, the science of matter, through activities to investigate the properties of familiar substances that support daily life and society.</p> <p>⑦ The world opened up by chemistry</p> <p>To understand that the matters studied in this subject are linked to the science and technology that support daily life and society. <Explanation: to take up specific examples of science and technology used in daily life and society.></p> <p>[Chemistry]</p> <p>⑦ Various substances and human life</p> <p>To understand the role that chemistry has played in the use of inorganic substances, organic compounds and macromolecular compounds in human life, taking advantage of their respective characteristics. To deal with typical substances used in human life.</p> <p>① The future that chemistry is building.</p> <p>To understand that the results of chemistry are used in various fields and form the basis for new science and technology that will build the future. To highlight achievements that stimulate interest in the development of chemistry and the progress of science and technology.</p>
Composition of Substances	<ul style="list-style-type: none"> Explain that matter is made up of atoms. Be able to describe monads and compounds. Be able to explain isotopes. Be able to explain the distinction between pure substances and mixtures. Understand the separation methods for mixtures and be able to select an appropriate separation method. 	<p>[Basic chemistry]</p> <p>↗ Understand the following about the constituent particles of matter. Also, through observation and experimentation on substances and chemical bonds, understand the following and acquire skills related to such observation and experimentation.</p> <p>[Basic chemistry]</p> <p>⑦ Units and compounds</p> <p>To understand the elements in terms of units and compounds by carrying out experiments to identify the elements. To deal with flame color reactions and precipitation reactions.</p> <p>[Basic chemistry]</p> <p>① Separation and purification of substances</p> <p>To learn basic operations and methods of exploring substances in experiments, including experiments in the separation and purification of substances. To deal with filtration, distillation, extraction, recrystallisation and chromatography.</p>

The Three Phases of Matter	<ul style="list-style-type: none"> • Explain that the molecules and atoms that make up matter are in constant thermal motion. • Be able to explain changes in the state of water. • Be able to explain the three states of matter and their changes of state. 	<p>[Basic chemistry]</p> <p>⊕ Heat motion and the three states of matter</p> <p>To understand the relationship between the thermal motion of particles and temperature, and the relationship between the thermal motion of particles and the three modes of change of matter. To be exposed to the difference between physical and chemical changes.</p> <p>[Chemistry]</p> <p>⑦ Change of status</p> <p>To understand the boiling and melting points of substances in relation to intermolecular forces and chemical bonds. In addition, to understand the energy transfer in and out of a change of state and the equilibrium between states and its relationship to temperature and pressure. Melting and evaporation heat shall be dealt with. Equilibrium between states should deal with vapor-liquid equilibrium and vapor pressure.</p>
Equation of State for Gases	<ul style="list-style-type: none"> • Be able to explain Boyle-Charles' law and perform the necessary calculations. • Be able to explain the equation of state of gases and perform the necessary calculations. 	<p>[Chemistry]</p> <p>① Properties of gases</p> <p>To understand the relationship between the volume of a gas and its pressure and temperature. To deal with the Boyle-Charles law and the equation of state of an ideal gas. In doing so, the molecular weight measurement should also be touched upon. Mixtures of gases, the law of partial pressure and real gases should also be dealt with. The energy distribution and absolute temperature of gaseous molecules should also be touched upon.</p>
Atomic Structure	<ul style="list-style-type: none"> • Explain the structure of the atom (nucleus and electrons), atomic number and mass number. • Explain isotopes and radioisotopes. 	<p>[Basic chemistry]</p> <p>⑦ Atomic structure</p> <p>To understand the structure of the atom and the properties of protons, neutrons and electrons. To deal with atomic number, mass number and isotopes. In doing so, radioactive isotopes and their use shall be touched upon.</p>
Electron Configuration	<ul style="list-style-type: none"> • Be able to write about the electron configuration of an atom using electron shells. • Be able to explain the function of valence electrons. 	<p>[Basic chemistry]</p> <p>① Electron configuration and periodic table</p> <p>To understand the periodic law of the elements and the relationship between the electron configuration of atoms and the families and periods of the periodic table. To deal with typical elements. For the 'periodic law of the elements', the changes in ionization energies should also be touched upon.</p>
Ion	<ul style="list-style-type: none"> • Explain ionization energy and electron affinity. • Representative ions can be represented by chemical formulas. 	<p>[Basic chemistry]</p> <p>⑦ Ions and ionic bonding</p> <p>To understand the formation of ions in relation to their electron configuration. Also, to understand ionic bonding and the properties of substances formed by ionic bonding. Polyatomic ions shall also be dealt with. 'Substances formed by ionic bonding' shall be treated as representative examples and their uses shall be touched upon.</p>
Periodic Law of the Elements	<ul style="list-style-type: none"> • Be able to consider the relationship between atomic number and the number of valence electrons. • Be able to consider the properties of elements in terms of valence electrons and the periodic law. 	<p>[Basic chemistry]</p> <p>① Electron configuration and periodic table</p> <p>To understand the periodic law of the elements and the relationship between the electronic configuration of atoms and the families and periods of the periodic table. To deal with typical elements. For the 'periodic law of the elements', the changes in ionization energies should also be touched upon.</p>
Ionic Bond	<ul style="list-style-type: none"> • Explain the chemical formulas of ions and the names of ions. • Explain ionic bonding. • Be able to explain the properties of ionic crystals. 	<p>[Basic chemistry]</p> <p>⑦ Ions and ionic bonding</p> <p>To understand the formation of ions in relation to their electron configuration. Also, to understand ionic bonding and the properties of substances formed by ionic bonding. Polyatomic ions shall also be dealt with. 'Substances formed by ionic bonding' shall be treated as representative examples and their uses shall be touched upon.</p>
Covalent Bond	<ul style="list-style-type: none"> • Explain covalent bonds. • Explain polarity and hydrogen bonding. • Be able to write down molecules by means of structural and electronic formulas. 	<p>[Basic chemistry]</p> <p>① Molecular and covalent bonds</p> <p>To understand covalent bonds in relation to their electronic configuration. Also, to understand the properties of substances composed of molecules. Typical inorganic substances and organic compounds shall be dealt with and their uses shall be touched upon. The polarity and coordination bonds of molecules shall also be touched upon, as well as the structure of covalent crystals and polymeric compounds such as plastics.</p>
Metallic Bonding and Metal Crystals	<ul style="list-style-type: none"> • Be able to explain free electrons and metal bonds. • Be able to explain the properties of metals. 	<p>[Basic chemistry]</p> <p>⊕ Metal and metal bonding</p> <p>To understand the properties of metals and metallic bonding. To deal with representative metals and to be exposed to their uses.</p>
Atomic, Molecular and Formula Quantities and Amount of Substance	<ul style="list-style-type: none"> • Explain the relative mass and atomic weight of atoms. • The amount of substance (mol) can be used to express the amount of substance. • Explain molecular and formula weights. • Explain the relationship between the volume of a gas and the amount of substance. 	<p>[Basic chemistry]</p> <p>⑦ Atomic structure</p> <p>To understand the structure of the atom and the properties of protons, neutrons and electrons. To deal with atomic number, mass number and isotopes. In doing so, radioactive isotopes and their use shall be touched upon.</p> <p>⑦ Substance quantity</p> <p>To understand the relationship between the quantity of matter and the number of particles, mass and volume of gas. Molar mass and molar concentration of solutions should also be addressed.</p>

Reaction Formula	<ul style="list-style-type: none"> Understand and construct reactants, products and coefficients for chemical reaction formulas. Be able to perform stoichiometric calculations using chemical reaction equations. 	<p>[Basic chemistry]</p> <p>① Chemical reaction formula</p> <p>To conduct experiments and other activities related to chemical reactions, and to find and understand that chemical reaction formulas describe the substances involved in a chemical reaction and their quantitative relationships.</p>
Concentration of Solution	<ul style="list-style-type: none"> Be able to explain ionization and distinguish between electrolytes and non-electrolytes. Be able to explain mass percent concentration and calculate mass percent concentration. Be able to explain molar concentration and calculate molar concentration. 	<p>[Chemistry]</p> <p>② Ionization equilibrium</p> <p>To understand the ionic product of water, pH and the ionization equilibrium of weak acids and weak bases. To be exposed to salt hydrolysis and buffer solutions.</p> <p>[Basic chemistry].</p> <p>⑦ Substance quantity</p> <p>To understand the relationship between the quantity of matter and the number of particles, mass and volume of gas. Molar mass and molar concentration of solutions should also be addressed.</p>
Acids and Bases	<ul style="list-style-type: none"> Explain the definitions of acids and bases (Arrhenius' and Bronsted Lowry's definitions). Explain the chemical formulas of acids and bases and the valence of acids and bases. Explain the degree of ionization and the strength of acids and bases. 	<p>[Basic chemistry]</p> <p>⑦ Acids, bases and neutralization</p> <p>Experiments on acids and bases should be carried out to understand the quantitative relationships between the properties of acids and bases and the substances involved in neutralization reactions. The relationship between the strength of acids and bases and the degree of ionization should also be dealt with. For acids and bases, the relationship between the concentration of hydrogen ions and pH should also be touched upon. For 'neutralization reactions', the properties of the salts produced should also be touched upon.</p>
pH (measure of acidity) Neutralization	<ul style="list-style-type: none"> Be able to explain pH and calculate pH and hydrogen ion concentrations. The neutralization reaction can be represented by a chemical equation. Be able to calculate neutralization titrations. 	<p>[Chemistry]</p> <p>② Ionization equilibrium</p> <p>To understand the ionic product of water, pH and the ionization equilibrium of weak acids and weak bases. To be exposed to salt hydrolysis and buffer solutions.</p>
Oxidation and Reduction	Be able to explain redox reactions.	<p>[Basic chemistry]</p> <p>① Oxidation and reduction</p> <p>To understand that oxidation and reduction are due to the transfer of electrons. Typical oxidizing and reducing agents shall be dealt with. Also to be exposed to the ionization tendencies of metals and the reactions of the Daniel battery.</p>
Ionization Tendency of Metals and Batteries	<ul style="list-style-type: none"> Ionization tendency can be explained. The reactivity of metals can be explained on the basis of their ionization tendency. Primary batteries can be described in terms of their reactions. Be able to describe the rechargeable battery and its reactions. 	<p>[Chemistry]</p> <p>① Battery</p> <p>To understand the mechanism of batteries that extract electrical energy in relation to redox reactions. To deal with typical practical batteries used in daily life and society.</p>
electrolysis	<ul style="list-style-type: none"> Explain electrolysis reactions. Able to perform calculations according to Faraday's law. 	<p>[Chemistry]</p> <p>② Electrolysis</p> <p>To understand that electrolysis occurs due to externally applied electrical energy, in relation to redox reactions. Also, to understand the relationship between the amount of change in the substance involved in the reaction and the amount of electricity. The focus should be on electrolysis of aqueous solutions.</p>
(N/A)		<p>[Chemistry]</p> <p>② Structure of solids</p> <p>The concept of the crystal lattice and the structure of crystals shall be understood. For 'crystal structure', the body-centered cubic lattice, face-centered cubic lattice and hexagonal close-packed structure shall be dealt with. Amorphous shall also be touched upon.</p> <p>⑦ Solubility equilibrium</p> <p>To understand the mechanism of dissolution. Also, to understand solubility in relation to dissolution equilibrium. To deal with solubility in solids and gases.</p> <p>① Solutions and their properties</p> <p>To understand the differences between the properties of solvents and solutions through familiar phenomena, including experiments on solutions and their properties. Vapor pressure drop, boiling point rise, freezing point drop and osmotic pressure shall be dealt with. Colloidal solutions shall also be dealt with.</p> <p>⑦ Chemical reactions, heat and light</p> <p>To understand that the generation and absorption of heat and light in chemical reactions result from the difference in chemical energy possessed by substances before and after the reaction, through experiments on chemical reactions and heat and light. Hess's law shall be dealt with. The binding energy should also be touched upon, as well as qualitatively touching on the factors that cause endothermic reactions to proceed spontaneously.</p> <p>⑦ Reaction rate</p> <p>To understand how reaction rates are expressed and the factors affecting reaction rates. Simple reactions shall be dealt with. 'Factors' shall deal with concentration, temperature and the presence or absence of a catalyst.</p> <p>① Chemical equilibrium and its transfer</p> <p>To understand reversible reactions, chemical equilibrium and transfer of chemical equilibrium. To deal mainly with Le Chatelier's principle.</p> <p>② Typical elements</p>

		<p>To understand that the properties of typical elements can be organized on the basis of the periodic table through experiments and other activities on typical elements. To focus on units and compounds of homologous elements with similar properties.</p> <p>⊕ Transition elements To understand the properties of the transition elements alone and in compounds. To deal with chromium, manganese, iron, copper, zinc and silver.</p> <p>⊕ Hydrocarbons To understand the properties and reactions of aliphatic hydrocarbons in relation to their structure.</p> <p>⊕ Compounds with functional groups To understand the structure, properties and reactions of aliphatic compounds with functional groups through experiments and other activities. To cover alcohols, ethers, aldehydes, ketones, carboxylic acids and esters and to deal with the fact that their properties are characterized by their carbon skeleton and functional groups. Mirror-image isomers shall also be touched upon.</p> <p>⊕ Aromatic compounds To understand the structure, properties and reactions of aromatic compounds. To deal with aromatic hydrocarbons, phenols, aromatic carboxylic acids and aromatic amines.</p> <p>⊕ Synthetic polymer compounds To understand the structure, properties and synthesis of synthetic polymer compounds. To deal with typical synthetic fibers and plastics.</p> <p>⊕ Natural polymer compounds To understand the structure and properties of natural polymer compounds. To deal with the typical natural macromolecular compounds that make up fiber and food. In doing so, monosaccharides, disaccharides and amino acids shall also be dealt with.</p>
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II-E Life sciences, Earth sciences

	Model Core Curriculum	Course of Study Guideline for Upper Secondary Schools
Objective	<p>[Learning achievement goals].</p> <p>Acquire the basic knowledge in life and earth sciences necessary to build a sustainable society that considers the global and biological environment, which is essential in the future as an engineering or science engineer.</p> <p>(1) The commonality and diversity of life To understand the diversity and commonality of life on Earth and to understand the origins of life.</p> <p>(2) Biological life and ecosystems To understand that the global environment is closely related to human activities, not only by understanding the life activities of living organisms on Earth, but also by understanding the components of ecosystems.</p> <p>(3) The Earth as a planet. To understand that the Earth is one of the planets in the solar system and that its activity is driven by the sun's radiant energy.</p> <p>(4) Earth's history and the global environment To understand the history of the Earth and the geological events found on the Earth's surface and inside.</p> <p>(5) Human activity and the global environment Consider ways in which human activities can improve the global environment.</p>	<p>The aim is to develop the qualities and abilities required for scientific exploration of natural things and phenomena through involvement in natural things and phenomena, the use of science perspectives and ideas, and observation and experimentation with a sense of perspective, as follows.</p> <p>(1) To deepen students' understanding of the relationship between nature and human life and between science and technology and human life, and to develop the skills in observation and experimentation necessary for scientific enquiry.</p> <p>(2) Develop the ability to conduct observations and experiments, and to relate them to human life and explore them scientifically.</p> <p>(3) Develop an attitude of willingness to get involved in natural things and phenomena and to explore them scientifically, while at the same time increasing interest in science.</p>

Learning Content	Model Core Curriculum and Learning Content Achievement Goals	Course of Study Guideline for Upper Secondary Schools
Commonality and Diversity of Living Organisms	<ul style="list-style-type: none"> Explain the diversity of life on Earth. Understand the common characteristics of organisms and explain the relationship between commonality and evolution of organisms. Be able to explain the origins of life on Earth. 	<p>[Science and human life]</p> <p>(㉞) Science of life.</p> <p>㉞ Human life phenomena.</p> <p>To understand human life phenomena in relation to human life by making observations and conducting experiments on human life phenomena.</p>
Biological Life and Ecosystems	<ul style="list-style-type: none"> Explain that energy is necessary for life activities. Understand the components of ecosystems (producers, consumers and decomposers) and explain that decomposers in ecosystems are closely related to human life. Understand vegetation succession and biome and be able to explain how they work and their distribution. 	<p>㉞ Microorganisms and their uses.</p> <p>To understand the function of micro-organisms in relation to human life through observations and experiments on micro-organisms.</p>
Earth as a Planet.	<ul style="list-style-type: none"> Understand that the Earth is among the planets that make up the solar system and be able to explain the motion and periodicity of celestial bodies. Understand the general circulation of the atmosphere and be able to explain meteorological phenomena such as wind flows in the atmosphere. Explain global warming in relation to solar radiation energy and heat transport by the atmosphere and oceans. 	<p>[Science and human life]</p> <p>(㉞) Science of space and earth.</p> <p>㉞ Sun and Earth</p> <p>To understand the motion of the sun and other familiar celestial bodies and the sun's radiant energy in relation to human life, through observations and experiments on celestial bodies.</p>
Earth's History and the Global Environment	<ul style="list-style-type: none"> Be able to describe the evolution of the primordial earth. Understand magma formation and volcanic activity on the Earth and explain its impact on human life. Understand earthquake generation and fault movement and relate seismic activity to plate movement. 	
Human Activity and the Global Environment	<ul style="list-style-type: none"> Explain tropical deforestation and biodiversity loss due to human activities. Understand the bioaccumulation of toxic substances and explain pollution problems in bioaccumulation. Be able to explain the problems of global warming and countermeasures. 	<p>[Science and human life]</p> <p>(㉞) Science of space and earth.</p> <p>㉞ Natural landscapes and natural hazards</p> <p>To understand the origins of familiar natural landscapes and natural disasters in relation to human life, through observations and experiments on natural landscapes and natural disasters.</p>

(N/A)		<p>*1 [Science and human life]</p> <p>(1) Scientific and technological developments Guidance on the development of science and technology to enable students to acquire the following</p> <ul style="list-style-type: none"> ア To understand how developments in science and technology have contributed to human life today. イ Scientific consideration and expression of the relationship between the development of science and technology and human life. <p>(2) Science in human life The course focuses on familiar natural objects and phenomena, as well as science and technology used in daily life and society, and teaches students to acquire the following through observation and experiments on these objects and phenomena.</p> <ul style="list-style-type: none"> ア To develop an awareness of the relationship between the science of light and heat, the science of matter, the science of life, the science of space and the earth and human life, and to acquire skills related to their observation and experimentation. イ To find problems and conduct observations and experiments with a perspective on the science of light and heat, the science of matter, the science of life, the science of the universe and the earth, and to consider and express these scientifically in relation to human life. <p>(3) Science and human life in the future Guidance is given to enable students to acquire the following through setting and exploring issues based on their study of the relationship between nature and human life and between science and technology and human life.</p> <ul style="list-style-type: none"> ア To develop an awareness of the future relationship between science and human life. イ Scientific consideration and expression of the future relationship between science and human life.
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*1 Through classes and experiments in this subject and in physics, chemistry and specialized subjects, students observe and experiment with natural things and phenomena, develop a view and way of thinking about nature and learn how to proceed with inquiry.

III-A Japanese language

	Model Core Curriculum	Course of Study Guideline for Upper Secondary Schools
Objective	<p>[Learning achievement goals].</p> <p>By acquiring the linguistic and cultural education that forms the basis of humanity, and by practicing effective and interactive communication on their own initiative, students aim to develop a deep understanding of diverse others and improve their linguistic ability to respond flexibly to changing situations and their ability to use the Japanese language in relation to their field of specialization.</p> <p>(1) Express their own opinions on the ideas expressed in logical texts (editorials and reviews), based on their judgement of the validity of the arguments.</p> <p>(2) Be able to use terminology related to their field of expertise in their thinking and expression.</p> <p>(3) Have a broad interest in linguistic and cultural education and be able to use the knowledge and ideas gained in this area to express themselves effectively.</p> <p>(4) Appreciate literary works (novels, essays, poetry, classics, etc.) in context and, based on an understanding of the characters and perspectives depicted in them, be able to view themselves objectively and express their own opinions.</p> <p>(5) Be able to collect, analyze and organize information, structure and prepare reports and papers, and give oral presentations.</p> <p>(6) Be able to discuss issues on the basis of evidence, strive to understand new ideas and the perspectives of others, and summarize their thoughts and ideas as a group.</p>	<p>Section 1. National Language (Japanese)</p> <p>Subsection 1 Objectives</p> <p>The aim is to develop the following qualities and abilities to use verbal ways of seeing and thinking, and to accurately understand and effectively express themselves in the Japanese language through language activities.</p> <p>(1) To understand the characteristics of the national languages necessary for lifelong social life and to be able to use them appropriately.</p> <p>(2) To enhance the ability to communicate in relation to others in lifelong social life and to develop thinking and imaginative skills.</p> <p>(3) To deepen awareness of the value of language, to develop a sense of language, to be aware that they are the bearers of our country's language culture, and to develop a lifelong attitude of respect for the national language and the improvement of their ability to use it.</p>

Learning Content	Model Core Curriculum and Learning Content Achievement Goals	Course of Study Guideline for Upper Secondary Schools
Logical Sentence	Can accurately grasp the structure and development of logical texts (editorials and reviews) and summarize the gist and main points.	<p>[Modern Japanese C Reading (1)]</p> <p>ア To accurately grasp the content, structure and logical development of a text based on its narrative, taking into account the type of text, and to grasp the gist and main points of the text.</p> <p>[Modern Japanese C Reading (2)]</p> <p>ア Activities in which students read logical and practical texts and discuss and critique their content and form, quoting and summarizing them.</p> <p>[Logic National Language A Writing (2)]</p> <p>ア Activities that summarize, for example, an overview of a particular material from various perspectives.</p> <p>[Logic National Language B Reading (1)]</p> <p>ア To accurately grasp the content, structure and logical development of a text, based on the type of text, and to grasp the gist of the text while clarifying the point of the argument.</p> <p>イ To understand the relationship between the material and the text, based on the type of text, and to accurately capture the content and structure of the text.</p> <p>ウ Interpreting the content by critically examining the evidence that supports the claims and the arguments that lead to the conclusions, and by examining the validity and reliability of the text and materials.</p> <p>オ Deepen the interpretation of the content based on relevant texts and materials, considering the writer's position and purpose.</p>
	Express their own opinions on the ideas expressed in logical texts (editorials and reviews), based on their judgement of the validity of the arguments.	<p>[Modern Japanese A Speaking and Listening (1)]</p> <p>ニ Listening while anticipating the development of the logic, evaluating the content and structure of the story, the development of logic and expression, and organizing the information they have heard to expand and deepen their own thinking.</p> <p>[Modern Japanese B Writing (2)]</p> <p>ア Activities in which students read logical and practical texts and discuss their opinions and ideas, citing the text and materials.</p> <p>[Logic National Language B Reading (1)]</p> <p>ニ Evaluate the structure of the text, the development of logic and expression from multiple and multifaceted perspectives in relation to the writer's intentions.</p> <p>カ deepen their own thinking from new perspectives on human beings, society and nature by linking the content and interpretation of texts to a variety of issues and different values.</p>

		<p>キ Expanding and deepening their thinking by relating the necessary information on the basis of several texts and materials related to the set subject matter. [Logic National Language B Reading (2)]</p> <p>ア Activities in which students read logical and practical texts and critique and discuss their content and form.</p> <p>イ Activities in which students read editorial texts on social topics and related materials and, on the basis of their contents, discuss and debate their own ideas.</p> <p>ウ Activities in which students read short articles on matters related to the foundations of academic learning and discuss and present their ideas.</p>
	To increase vocabulary used in social life (including colloquialisms and idiomatic phrases) and use it in thinking and expression.	<p>[Modern Japanese [knowledge and skills] (1)]</p> <p>エ To increase the quantity of words and phrases necessary for understanding and expressing themselves in the real world, and to refine their sense of language and enrich their vocabulary through understanding the structure, characteristics, usage and notation of words and vocabulary and using them in speech and writing.</p> <p>[Language and culture [knowledge and skills] (1)]</p> <p>ウ To increase the number of words and phrases characteristic of the country's language and culture, to deepen understanding of their cultural backgrounds, and to refine word sense and enrich vocabulary through their use in writing.</p> <p>[Logic national language [knowledge and skills] (1)]</p> <p>イ To increase the number of words and phrases needed to make arguments and learn the basics of academic study, and to refine their word sense and enrich their vocabulary through their use in writing.</p>
	Be able to use terminology related to their field of expertise in logical thinking and expression.	<p>[Language and culture A Writing (1)]</p> <p>イ To devise the type, structure and development of the text, and the style, description and wording of the text, so that their experiences and thoughts are effectively conveyed.</p> <p>[Logic national language [knowledge and skills] (1)]</p> <p>イ To increase the number of words and phrases needed to make arguments and learn the basics of academic study, and to refine word sense and enrich vocabulary through their use in writing.</p> <p>[Japanese language expression [knowledge and skills] (1)]</p> <p>ウ To increase the number of words and phrases needed to express their thoughts and ideas in a variety of ways, and to refine their sense of language and enrich their vocabulary through using them in stories and sentences.</p>
Language and Culture	Be able to appreciate literary works (novels, essays, poetry, classics, et ウ) in context and explain the view of things depicted in them and the feelings of the characters.	<p>[Language and culture Target]</p> <p>(1) To enable students to acquire the knowledge and skills in the national language necessary for life-long social life and to deepen their understanding of the language and culture of our country.</p> <p>[Language and culture Objectives]</p> <p>(3) To deepen awareness of the value of language, to improve oneself through a lifelong love of reading, to develop an awareness of oneself as a bearer of our country's language and culture, and to develop an attitude of trying to relate to others and society through language.</p> <p>[Language and culture B Reading (1)]</p> <p>ア To accurately capture the content, structure and development of a text based on its narrative, taking into account the type of text.</p> <p>イ Capturing the way of seeing, feeling and thinking about what is expressed in the work or text and interpreting the content.</p> <p>ウ Evaluating the structure and development of the text, the way it is expressed and the features of expression.</p> <p>エ Deepen the interpretation of the content of the work or text, taking into account the context in which it was established and its relationship to other works, etc.</p> <p>オ To deepen one's own way of seeing, feeling and thinking about things based on the content and interpretation of the work, and to have one's own ideas about the language and culture of our country.</p> <p>[Literature Language Objectives]</p> <p>(2) To develop the ability to empathize deeply and imagine richly, to think creatively, to communicate in relation to others and to broaden and deepen one's thoughts and ideas.</p> <p>[Literature Japanese B Reading (1)]</p> <p>イ Interpreting the content through evaluating the narrator's point of view, the way the scene is set and the characteristics of the expression.</p> <p>オ To capture the way of seeing, feeling and thinking about what is represented in the work, as well as to deepen the interpretation of the work, taking into account the context in which it was established and its relationship with other works, etc.</p> <p>[Classical exploration Target]</p> <p>(1) To enable students to acquire the knowledge and skills in the national language necessary for lifelong social life and to deepen their understanding of Japan's traditional language and culture.</p> <p>(2) To develop the ability to think logically, to empathize deeply and to imagine richly, and to communicate in relation to the ways of seeing, feeling and thinking of our predecessors through the classics, etc., so that they can broaden and deepen their own thoughts and ideas.</p> <p>[Classical Explorations A Reading (1)]</p>

		<p>ア To accurately capture the structure and development of the text, based on the type of text.</p> <p>㇗ Reading classics and other works, taking into account the context in which the work was established and its relationship with other works, etc., to deepen the interpretation of its content and to consider the value of the work.</p> <p>㇘ broadening and deepening one's ideas about our country's language and culture through evaluating classical works and texts from multiple and different perspectives.</p>
	Have a broad interest in linguistic and cultural education (vocabulary, knowledge, etc.) and can use the knowledge and ideas gained in this area to express themselves effectively.	<p>[Modern Japanese [knowledge and skills] (1)]</p> <p>㇗ To increase the quantity of words and phrases necessary for understanding and expressing themselves in the real world, and to refine their sense of language and enrich their vocabulary through understanding the structure, characteristics, usage and notation of words and vocabulary and using them in speech and writing.</p> <p>[Language and culture Objectives].</p> <p>(1) To enable students to acquire the knowledge and skills in the national language necessary for life-long social life and to deepen their understanding of the language and culture of our country.</p> <p>[Language and culture [knowledge and skills] (1)]</p> <p>ア Understanding that language has a function in supporting the transmission, development and creation of culture.</p> <p>㇘ To increase the number of words and phrases characteristic of the country's language and culture, to deepen understanding of their cultural backgrounds, and to refine word sense and enrich vocabulary through their use in writing.</p> <p>㇗ Understanding that the meaning of a text is formed in context.</p> <p>[Logic national language [knowledge and skills] (1)]</p> <p>イ To increase the number of words and phrases needed to make arguments and learn the basics of academic study, and to refine word sense and enrich vocabulary through their use in writing.</p>
	Through the reading of language works, deepen their ideas about the various ways of being of human beings and society, and be able to view themselves objectively and express their own opinions.	<p>[Language and culture Objectives]</p> <p>(1) To enable students to acquire the knowledge and skills in the national language necessary for life-long social life and to deepen their understanding of the language and culture of our country.</p> <p>[Literature Language Objectives]</p> <p>(2) Develop the ability to empathize deeply and imagine richly, to think creatively, to communicate in relation to others, and to expand and deepen their own thoughts and ideas.</p> <p>[Literature Language [knowledge and skills] (1)]</p> <p>ア Understand that words have the ability to enrich imagination and feelings.</p> <p>[Language expression Target]</p> <p>(2) To develop the ability to think logically, to empathize deeply and to imagine richly, to improve the ability to communicate in diverse relationships with others in the real world, and to broaden and deepen their own thoughts and ideas.</p>
	Be able to read and write Japanese correctly, mainly in Joyo Kanji.	<p>[Modern language Target]</p> <p>(1) Ensure that students acquire the knowledge and skills in the Japanese language necessary for the real world.</p> <p>[Modern Japanese [knowledge and skills] (1)]</p> <p>㇘ Familiarize themselves with the reading of regular kanji and write and use the main regular kanji in sentences and texts.</p> <p>[Language and culture [knowledge and skills] (1)]</p> <p>イ Familiarize yourself with the reading of regular Kanji characters and write and use the main regular Kanji characters in sentences and texts.</p>
Expression and Communication	Be able to produce practical texts (letters, emails, etc.) using style and language appropriate to the recipient and purpose.	<p>[Modern Japanese B Writing (1)]</p> <p>㇘ To think about how to present evidence and explain things in a way that accurately conveys one's ideas and matters, as well as the type of writing, style of writing, words and other forms of expression.</p> <p>[Japanese language expression [knowledge and skills] (1)]</p> <p>㇗ To develop an understanding of the types and characteristics of practical writing and other texts, and how they are structured and developed.</p> <p>[Japanese expression B Writing (1)]</p> <p>カ Examining whether the text is written in a way that effectively conveys your thoughts and ideas to the reader, and so on, and preparing the text as a whole, and reassessing the features and issues in your writing in the light of advice from the reader.</p> <p>[Japanese Expression B Writing (2)]</p> <p>㇗ Practical letter and email writing activities such as introductions, communications and requests.</p>

	<p>Be able to collect, organize and analyze appropriate information from printed material and the internet, depending on the purpose of the report/paper.</p>	<p>[Language and culture A Writing (1)] ア Decide on an appropriate subject matter from your own knowledge and experience, examine the qualities and taste of the materials you have collected and clarify what you want to express.</p> <p>[Logic national language [knowledge and skills] (2)] ア To develop an understanding of the relationship between information and information, including claims and their premises and counter-evidence. イ To develop and use an understanding of how to organize information in a hierarchical manner, such as by importance and abstraction.</p> <p>[Logic National Language A Writing (1)] ア Gathering and organizing information on matters relating to the real world and the foundations of academic study from a variety of perspectives, including the writer's position and arguments, to determine the appropriate subject matter for the purpose and intention.</p> <p>[Logic National Language A Writing (2)] イ Activities in which the content of the analysis of a set subject is summarized in a written report, etc., or the content of a hypothesis and discussion is summarized in an opinion piece, etc.</p> <p>[Japanese Expression A Speaking and Listening (1)] ア Depending on the purpose and the occasion, decide on a topic from among real-world problems or matters that concern you, collect and organize information and consider the content to be communicated, while assuming a variety of interactions with others.</p> <p>[Japanese Expression B Writing (2)] ウ Activities to reorganize the content of a briefing or report according to its purpose and audience, and rewrite it in a different format, such as publicity material.</p> <p>[Language and culture A Writing (1)] ア Decide on an appropriate subject matter from your own knowledge and experience, examine the qualities and taste of the materials you have collected and clarify what you want to express.</p> <p>[Logic national language [knowledge and skills] (2)] ア To develop an understanding of the relationship between information and information, including claims and their premises and counter-evidence. イ To develop and use an understanding of how to organize information in a hierarchical manner, such as by importance and abstraction.</p> <p>[Logic National Language A Writing (1)] ア Gathering and organizing information on matters relating to the real world and the foundations of academic study from a variety of perspectives, including the writer's position and arguments, to determine the appropriate subject matter for the purpose and intention.</p> <p>[Logic National Language A Writing (2)] イ Activities in which the content of the analysis of a set subject is summarized in a written report, etc., or the content of a hypothesis and discussion is summarized in an opinion piece, etc.</p> <p>[Japanese Expression A Speaking and Listening (1)] ア Depending on the purpose and the occasion, decide on a topic from among real-world problems or matters that concern you, collect and organize information and consider the content to be communicated, while assuming a variety of interactions with others.</p> <p>[Japanese Expression B Writing (2)] ウ Activities to reorganize the content of a briefing or report according to its purpose and audience and rewrite it in a different format, such as publicity material.</p>
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	<p>Based on organized information, be able to structure, develop and express logic and prepare reports and papers so that arguments are effectively conveyed.</p>	<p>[Modern Japanese A Speaking and Listening (1)] ｲ To clarify one's own position and ideas so that one's thoughts can be conveyed accurately, and to devise the structure and development of one's speech, for example, by considering the development of logic in anticipation of the other party's reaction.</p> <p>[Modern Japanese B Writing (1)] ｲ The structure and development of the text, considering the development of logic, the amount of information and the importance of the information, in order to ensure that the reader understands it.</p> <p>[Modern Japanese B Writing (2)] ㇔ Activities to organize the research and summarize it in a report or explanatory material.</p> <p>[Logic national language [knowledge and skills] (1)] ㇑ Developing an understanding of how to structure and develop a text, including effective paragraph structure and argument form based on the type of text.</p> <p>[Logic National Language A Writing (1)] ｲ Clarifying your position and arguments, examining the validity and reliability of the information, and putting together appropriate evidence to support your claims. ㇑ Clarify your arguments by reviewing your ideas from multiple and diverse perspectives and by examining your evidence and arguments. ㇒ Check the clarity of the logic of the text as a whole, such as by examining the way individual sentences are expressed and the structure of paragraphs, and devise a text that accurately conveys your point. ㇓ Examining the structure, development and expression of the text, such as whether it is written in a way that accurately conveys one's argument, and preparing the text as a whole, or reassessing the features and issues of one's own writing, taking into account advice from the reader.</p> <p>[Logic National Language A Writing (2)] ㇔ Activities in which students summarize and critique each other's ideas in a short paper, referring to editorial articles written on social topics and related materials.</p> <p>[Logic National Language B Reading (2)] ㇑ Activities in which students read and compare several texts on the same matter with different points of view and compare them to discuss and critique them. ㇒ Activities in which students research various materials on matters of interest and present their findings or summarize them in a report or short paper.</p> <p>[Japanese language expression [knowledge and skills] (1)] ㇑ To develop an understanding of the types and characteristics of practical writing and other texts, and how they are structured and developed.</p> <p>[Language expression A Speaking and listening (1)] ｲ To effectively use appropriate evidence to convey the rationality of your argument, and to devise the structure and development of your talk, for example, by considering the development of logic in anticipation of your opponent's counter-arguments. ㇔ To devise the structure and development of the story, including the effective placement of concrete examples, so that your thoughts and ideas can be conveyed.</p> <p>[Japanese expression B Writing (1)] ｲ To ensure that the reader agrees with the text, the composition and development of the text should be devised by effectively using appropriate evidence and considering the development of logic in anticipation of counter-arguments and other arguments. ㇔ The structure and development of the text, including the effective placement of appropriate concrete examples, so that the reader can empathize with the text.</p> <p>[Japanese Expression B Writing (2)] ｲ Activities to prepare proposals, reports, etc., relating text to charts, images, etc. ㇔ Activities to reorganize the content of a briefing or report according to its purpose and audience and rewrite it in a different format, such as publicity material.</p>
	<p>Be able to summarize the contents of reports and papers prepared and their own thoughts and considerations in documents (illustrations, videos, etc.) and give an accurate oral presentation.</p>	<p>[Modern Japanese A Speaking and Listening (1)] ㇔ Devise expressions so that they can be understood by others, such as speaking in accordance with the characteristics of the spoken language and using materials and equipment effectively according to the situation of the occasion.</p> <p>[Modern Japanese A Speaking and Listening (2)] ㇑ Activities in which the participants give speeches about their ideas, listen to them, agree with them, ask questions or argue against them with arguments.</p> <p>[Modern Japanese A Speaking and Listening (2)] ㇑ Activities to compile the information gathered into a document and present it to an audience.</p> <p>[Logic National Language A Writing (2)] ㇑ Activities to collect a variety of materials on a set subject, organize what they have researched and discuss their opinions and ideas from various perspectives.</p> <p>[Logic National Language B Reading (2)] ㇑ Activities in which students read and compare several texts on the same matter with different points of view and compare them to discuss and critique them.</p>

		<p>才 Activities in which students research various materials on matters of interest and present their findings or summarize them in a report or short paper. [Japanese Expression A Speaking and Listening (1)]</p> <p>ㄨ Devising expressions to gain the agreement and sympathy of others, such as by choosing words in response to their reactions and using materials and equipment effectively according to the situation of the place.</p> <p>才 listening with clarity to the issues and comparing them with their own ideas, evaluating the content and structure of the talk, the development of logic and expression, as well as examining the information they have heard and expanding and deepening their own ideas. [Japanese Expression A Speaking and Listening (2)]</p> <p>ア Activities such as giving speeches to an audience, telling your story in an interview, and listening to and critiquing these speeches.</p> <p>ウ Activities to summarize and present what they have seen or heard by interviewing people of different generations or people they have never met before, or by watching or listening to news reports or documentary footage.</p> <p>ㄨ Activities in which students discuss and debate in order to reach a conclusion or draw out diverse ideas according to the purpose of the discussion, and critique the way they discuss and reach a conclusion based on the record of the discussion. [Japanese expression B Writing (1)]</p> <p>ㄨ To clarify one's own ideas and to devise ways of expressing them, for example by explaining them precisely on the basis of the information on which they are based. [Japanese Expression B Writing (2)]</p> <p>才 Activities in which students collect a variety of materials on a set subject, organize and discuss what they have researched, and summarize their own and group opinions in a proposal or other form.</p>
	<p>Be able to argue on the basis of evidence, depending on the issue and conditions.</p>	<p>[Modern Japanese A Speaking and Listening (1)]</p> <p>才 Sharing issues, expanding and deepening ideas, and devising ways of discussing and drawing conclusions, including expressions and progression, according to the purpose, type and situation of the discussion. [Modern Japanese A Speaking and Listening (2)]</p> <p>ウ Activities that involve discussion and debate in order to reach a conclusion or draw out a variety of ideas according to the purpose of the discussion, referring to records of other discussions and debates.</p> <hr/> <p>[Logic National Language B Reading (2)]</p> <p>イ Activities in which students read editorial texts on social topics and related materials and, on the basis of their contents, discuss and debate their own ideas.</p> <p>ウ Activities in which students read short articles on matters related to the foundations of academic learning and discuss and present their ideas.</p> <p>ㄨ Activities in which students read and compare several texts on the same matter with different points of view and compare them to discuss and critique them. [Japanese Expression A Speaking and Listening (1)]</p> <p>キ Devising ways of discussing and drawing conclusions while broadening and deepening their thinking, for example by examining each other's arguments and arguments, and devising statements to help the discussion progress and develop. [Language expression A Speaking and listening (2)]</p> <p>ア Activities such as giving speeches to an audience, telling people about yourself in an interview, and listening to and critiquing them. [Language expression A Speaking and listening (2)]</p> <p>イ Activities that involve contacting others, talking to them to make referrals or requests, and listening to and critiquing them.</p>
	<p>To be able to summarize their thoughts and ideas as a group through discussion, while respecting the position and ideas of others.</p>	<p>[Modern language Target].</p> <p>(2) To develop the ability to think logically, to empathize deeply and to imagine richly, to communicate in relation to others and to broaden and deepen one's thoughts and ideas. [Language and culture Target]</p> <p>(3) To deepen awareness of the value of language, to improve oneself through a lifelong love of reading, to develop an awareness of oneself as a bearer of our country's linguistic culture, and to develop an attitude of trying to relate to others and society through language. [Logic National Language B Reading (2)]</p> <p>イ Activities in which students read editorial texts on social topics and related materials and, on the basis of their contents, discuss and debate their own ideas.</p> <p>ウ Activities in which students read short articles on matters related to the foundations of academic learning and discuss and present their ideas. [Japanese Expression A Speaking and Listening (1)]</p> <p>カ listening with a clear point of view and using devices to convey empathy with the content of the story and to elicit the thoughts and ideas of others, in order to broaden and deepen their own thoughts and ideas. [Language expression A Speaking and listening (2)]</p> <p>イ Activities that involve contacting others, talking to them to make referrals or requests, and listening to and critiquing them. [Japanese Expression B Writing (2)]</p>

		<p>✧ Activities in which students collect a variety of materials on a set subject, organize and discuss what they have researched, and summarize their own and group opinions in a proposal or other form.</p>
	Can practice techniques for organizing their thoughts and ideas, striving to understand new ideas and the perspectives of others.	<p>[Japanese language expression [knowledge and skills] (1)]</p> <p>イ Deepen understanding of the characteristics, roles and expressive features of spoken and written language, and understand and use appropriate expressions and language according to the purpose, situation, other party and means of communicating.</p> <p>[Japanese Expression A Speaking and Listening (1)]</p> <p>✧ Devising ways of discussing and drawing conclusions while broadening and deepening their thinking, for example by examining each other's arguments and arguments, and devising statements to help the discussion progress and develop.</p> <p>[Language expression A Speaking and listening (2)]</p> <p>✧ Activities to summarize what you have researched on the set subject matter in a presentation material, using charts and images, and explain it to the audience.</p> <p>[Japanese expression B Writing (1)]</p> <p>✧ To clarify their thoughts and ideas and to devise ways of expressing them, such as by accurately describing and explaining events.</p> <p>カ Examining whether the text is written in a way that effectively conveys your thoughts and ideas to the reader, and so on, and preparing the text as a whole, and reassessing the features and issues in your writing in the light of advice from the reader.</p> <p>[Japanese Expression B Writing (2)]</p> <p>ア Activities in which students choose a type of writing about their thoughts and ideas on a social topic or their own future.</p> <p>カ Activities such as interviewing people from different generations or people you have never met before and summarizing what you have heard in a report.</p>
(N/A)		<p>Teaching Reading</p> <p>[Modern Japanese [knowledge and skills] (3)]</p> <p>ア To deepen understanding of the significance and utility of reading in relation to the real world.</p> <p>[Language and culture [knowledge and skills] (2)]</p> <p>カ deepening understanding of the significance and utility of reading for understanding the language and culture of our country.</p> <p>[Logic national language [knowledge and skills] (3)]</p> <p>ア To deepen understanding of the significance and utility of reading in contributing to the construction of new ideas.</p> <p>[Literature Language [Knowledge and Skills] (2)]</p> <p>イ To deepen understanding of the significance and utility of reading in enriching the way we see, feel and think about people, society and nature.</p> <p>[Japanese language expression [knowledge and skills] (2)]</p> <p>ア To deepen understanding of the significance and utility of reading in enriching linguistic expression when communicating one's thoughts and ideas.</p> <p>[Classical exploration [knowledge and skills] (2)]</p> <p>ニ To become familiar with the ways of seeing, feeling and thinking of our ancestors and to deepen our understanding of the significance and utility of reading to enrich our own ways of seeing, feeling and thinking.</p>
(N/A)		<p>Creative Activity</p> <p>[Language and culture A Writing (2)]</p> <p>ア Activities in which students express what they feel and discover in tanka and haiku, using honka-tori and origami, etc., and write essays, etc., by selecting subjects related to culture, such as traditional events and customs.</p> <p>[Literature Japanese A Writing (2)]</p> <p>ア Activities in which students create and critique each other's novels, poems, etc., based on their own ideas and critiques.</p>

III-B English

	Model Core Curriculum	Course of Study Guideline for Upper Secondary Schools
Objective	<p>[Learning achievement goals].</p> <p>(1) Acquire the knowledge and skills that form the basis of English communication and be able to use them appropriately for different purposes, situations and circumstances. (Years 1-5)</p> <p>(2) Develop an understanding of diversity and different cultures, and try to communicate proactively using English while taking others into consideration. (Years 1-5)</p> <p>(3) Understand and express information and ideas on daily and social topics in an appropriate and accurate manner. (Years 1-3)</p> <p>(4) Understand and express basic information and ideas about their field of expertise appropriately and accurately, and exchange simple opinions. (Years 3-5)</p>	<p>The aim is to develop the following qualities and abilities for communicating, accurately understanding information and ideas, expressing them appropriately and communicating them to each other through listening, reading, speaking and writing activities in English and integrated language activities linking these activities, using views and ideas in communication in foreign languages. The aim is to develop the following qualities and abilities.</p> <p>(1) To deepen understanding of English speech, vocabulary, expressions, grammar and language functions, and to develop the skills to use this knowledge appropriately in actual communication through listening, reading, speaking and writing, in accordance with the purpose, situation and circumstances.</p> <p>(2) Develop the ability to accurately understand the outline, main points and details of information and ideas, as well as the intentions of the speaker and writer, in English on daily and social topics, according to the purpose, scene and situation of communication, and to use these to express and communicate appropriately.</p> <p>(3) Deepen their understanding of the culture behind English and develop an attitude of trying to communicate using English independently and autonomously, with consideration for listeners, readers, speakers and writers.</p>

Learning Content	Model Core Curriculum and Learning Content Achievement Goals	Course of Study Guideline for Upper Secondary Schools
Voice	Can read or speak clearly with awareness of stress in words, phrases and sentences, rhythm and intonation in sentences, and sound connections and breaks, so that they are conveyed correctly to the listener.	<p>No.1 English Communication I</p> <p>[Knowledge and skills] (1) Matters related to the characteristics and conventions of the English language.</p> <p>Through actual language activities using English, students are taught to understand the language materials appropriate for achieving the objectives in each of the five domains in Chapter 2, Section 10, Part 2-2 (1) of the Courses of Study for Elementary Schools (Ministry of Education, Culture, Sports, Science and Technology Notice No. 63 of 2009), Chapter 2, Section 9, Part 2-2 (1) of the Courses of Study for Junior High Schools (Ministry of Education, Culture, Sports, Science and Technology Notice No. 64 of 2009) and the language materials shown below. (1) and the language materials listed below in Chapter 2, Section 9, 2-2 (1) and the following five areas, and to link language materials and language activities effectively, and to guide students to acquire skills that can be utilized in actual communication.</p> <p>ア Voice</p> <p>(7) Forces in words, phrases and sentences</p> <p>(4) Intonation in sentences</p> <p>(7) Delimitations in sentences</p>
Vocabulary	To consolidate vocabulary learned up to junior high school and to acquire and appropriately apply new vocabulary according to upper secondary school teaching guidelines, as well as vocabulary required for specialized education.	<p>No.1 English Communication I</p> <p>ウ Words, collocations and idiomatic expressions</p> <p>(7) Words learned in primary and secondary schools plus about 400-600 new words.</p> <p>(4) Collocations</p> <p>(7) Idiomatic expressions</p>
		<p>No.2 English Communication II</p> <p>This shall be handled in the same way as in (1) of 2 of "English Communication I." However, the words to be taught shall be those indicated in (1) ウ (7) of 2 (1) of 'English Communication I' plus about 700-950 new words.</p>
		<p>No.3 English Communication III</p> <p>The same treatment should be applied as in (1) of 2 of English Communication I. However, the words to be taught shall be those indicated in (1) of 2 of 'English Communication II' plus about 700-950 new words.</p>
Grammar and Syntax	In addition to the sentence structures and grammatical matters studied up to junior high school, acquire and appropriately apply sentence structures and grammatical matters in accordance with the high school curriculum guidelines.	<p>No.1 English Communication I</p> <p>エ Sentence structure and grammatical matters.</p> <p>The matters listed in エ of Section 2-2(1) of Chapter 2.10 of the Courses of Study for Elementary Schools, エ of Section 2-2(1) of Chapter 2.9 of the Courses of Study for Junior High Schools and the following matters shall be utilized through repeated exposure in communication in meaningful contexts. In doing so, all matters listed in (4) shall be dealt with appropriately.</p> <p>(7) Sentence structures that are frequently utilized.</p> <p>(4) Grammatical matters.</p>

English Communication (laying the foundations for English language operational skills).	Can hear the necessary information and understand the speaker's intentions from what is spoken on daily and social topics, with clear pronunciation and at a regulated speed.	No.1 English Communication I (3) Matters relating to language activities and the function of language ① Matters relating to language activities (7) Activities to listen to the necessary information from dialogues and at which they are spoken and to paraphrases in basic words and sentences on daily topics. Also, activities in which students communicate what they have heard by speaking and writing. (4) Activities to listen to necessary information from dialogues and explanations and grasp the outline and main points of social topics, while being regulated in the speed at which they are spoken and fully listening to paraphrases in basic words and sentences. Also, activities in which students communicate what they have heard by speaking a broadcast and to understand the speaker's intentions, while listening sufficiently to the adjusted speed d writing.
	Can talk about daily and social topics, using basic expressions to give information, thoughts and feelings.	No.1 English Communication I (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ㄷ Speaking [exchange] (7) Activities in which students improvise and communicate information, thoughts and feelings about daily topics such as familiar events and family life, in situations where the words and sentences used and the specific way of proceeding with the exchange are adequately presented. Also, activities to organize and present the content of exchanges and to write sentences. (4) Activities in which students listen to or read dialogues, explanations, etc., and communicate information, ideas, feelings, etc., from the standpoint of approval or disapproval, together with reasons and grounds, on social topics, in situations where the words and sentences used and the specific way of proceeding with the exchange are fully presented. Also, activities in which students organize and present their own thoughts and ideas based on the content of the exchange, and write sentences.
		No. 1 English Communication I (3) Matters relating to language activities and the functioning of language. ① Matters relating to language activities ㄹ Speaking [Presentation] (7) Activities to convey information, ideas and feelings on daily topics such as familiar events and family life, together with reasons and evidence, in situations where the words, sentences and examples of speech to be used are sufficiently presented or where a lot of time is allocated for preparation. Also, activities in which students ask and answer questions and share their opinions and impressions about what they have presented. (4) Activities to communicate information, thoughts and feelings on social topics, together with reasons and evidence, by listening to and reading dialogues and explanations in situations where the words, sentences and examples of speech to be used are sufficiently presented or where a lot of time is allocated for preparation. Also, activities in which students ask and answer questions and share their opinions and impressions about what has been presented.
		No.4 Logic and representation I (3) Matters relating to language activities and the functioning of language. ① Matters relating to language activities ㄹ Speaking [exchange] (7) Activities in which students communicate information, thoughts and feelings about daily topics such as matters of interest and school life, in situations where the words and sentences used and the specific way of proceeding with the exchange are adequately presented, and obtain necessary information through the exchange. Also, activities to organize and present the content of exchanges and to write sentences. (4) Debates and discussions about what they have heard or read on daily or social topics, in which they communicate excellent points and points that need to be improved, or communicate their opinions and arguments with appropriate reasons and grounds, in situations where the words and sentences used and the specific way of proceeding with the exchange are fully presented. Activities to engage in discussion. Activities in which students organize and present their own thoughts and ideas based on the content of the exchange, and write sentences.
		No.4 Logic and representation I (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ㄹ Speaking [presentation] (7) Activities to convey information, ideas and feelings on daily topics such as matters of interest and school life, together with appropriate reasons and evidence, in situations where the words, sentences and examples of speech used are sufficiently presented or where a large amount of time is allowed for preparation. Also, activities in which questions and answers are asked and answers are exchanged about the content of the presentation, and opinions and impressions are shared. (4) Short speeches and presentations in which opinions, arguments, et ㄹ are conveyed with appropriate reasons and evidence, in a step-by-step procedure, in situations where the words, sentences and examples of speech to be used are adequately presented or where a large amount of time is allowed for preparation, about what has been heard or read on daily or social topics. Presentation activities. Also, activities in which students ask and answer questions and share their opinions and impressions of the content of the presentation.

<p>Can read texts written in plain English on daily and social topics, grasp the overview and read the necessary information, and understand the writer's intentions, outline and main points.</p>	<p>No.1 English Communication I (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ㊦ Reading (7) Activities to read the necessary information from e-mails, pamphlets, etc. and grasp the writer's intentions, while fully listening to and reading about daily topics, paraphrasing in basic words and sentences, and explaining the background of the written text. Also, activities to communicate what they have read by talking and writing. (4) Activities in which students read the necessary information from explanatory and argumentative texts and grasp the outline and main points, while fully listening to and reading about social topics, paraphrasing in basic words and sentences and explaining the background to the written text. Also, activities in which students communicate what they have read by talking and writing.</p>
<p>Can organize their opinions and impressions on daily and social topics and write texts that convey information, ideas and feelings.</p>	<p>No.1 English Communication I (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities カ Writing (7) Activities to write paragraphs on daily topics such as familiar events and family life, conveying information, ideas and feelings with reasons and evidence, in situations where the words, sentences and examples of sentences to be used are sufficiently presented or where a lot of time is allocated for preparation. Also, activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions. (4) Activities in which students listen to or read dialogues and explanations on social topics, in situations where the words, sentences and examples of sentences to be used are sufficiently presented or where a lot of time is allowed for preparation, and write paragraphs that convey information, ideas and feelings, together with reasons and evidence. Also, activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions.</p>
<p>Have a willingness to understand languages and cultures other than their own and communicate actively in practical situations.</p>	<p>No.4 Logic and representation I (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ㊦ Writing (7) Activities to write paragraphs on daily topics, such as matters of interest or school life, in which information, ideas and feelings are conveyed with appropriate reasons and evidence, in situations where the words, sentences and examples of sentences to be used are sufficiently presented or where a lot of time is allocated for preparation. Also, activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions. (4) Paragraphs that convey opinions, arguments, etc., with appropriate reasons and evidence, in a step-by-step procedure from conception to elaboration on what they have heard or read on daily or social topics, in situations where sufficient examples of words, sentences and texts to be used are given or a lot of time is allocated for preparation. Writing activities. Activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions.</p> <p>No.1 Basic communicative English 1 Cultivate an attitude of active communication through English and develop basic skills in listening, speaking, reading and writing. (*Notification issued in March 2009)</p> <p>No.2 Communicative English I 1 Cultivate an attitude of active communication through English, as well as the basic ability to accurately understand and appropriately convey information and ideas. (*Notification issued in March 2009)</p> <p>No.3 Communicative English II 1 To foster an attitude of active communication through English and to develop the ability to accurately understand and appropriately convey information and ideas. (*Notification issued in March 2009)</p> <p>No.5 English Expression I 1 Cultivate an attitude of active communication through English, as well as the ability to consider facts and opinions from a variety of perspectives, and to convey them while developing logic and devising methods of expression. (*Notification issued in March 2009)</p>
<p>Can use basic communication strategies (gestures, eye contact) appropriately for practical situations and purposes.</p>	<p>No.7 English conversation 2 (2) ㊦ Understand the role of non-verbal means of communication, such as gestures, and use them appropriately according to the situation and purpose. (*Notification issued in March 2009)</p>

English Communication (learning to improve English operational skills)	Can listen to the necessary information and grasp the outline and main points of a matter of prior knowledge, such as one's own field of expertise, or a topic of interest, paying attention to the development of the conversation and the speaker's intentions.	No.3 English Communication III (3) Matters relating to language activities and the workings of language ① Matters relating to language activities ↵ Listening (7) Activities to listen to necessary information on daily topics from interviews, news and other sources, and to understand the development of the story and the speaker's intentions. Also, activities to ask and answer questions about what they have heard and to share their opinions and impressions. (4) Activities in which students listen to the necessary information on social topics from several news items or lectures, paying attention to the development of the story, and grasp the outline, main points and details. Also, activities to ask and answer questions about what they have heard and to share their opinions and impressions with each other.
	Can exchange opinions, arguments and solutions to problems in anticipation of discussions (debates if necessary) in English.	No.5 Logic and Expression II (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ↵ Speaking [exchange] (4) Activities in which, in relation to what they have heard or read on daily or social topics, they clearly explain issues and propose solutions to each other, or give detailed information on their opinions, arguments and solutions to issues with appropriate reasons and evidence, in situations where the words and sentences to be used and the specific way of proceeding with the exchange are indicated, as necessary. Debate and discussion activities in which participants debate and discuss with each other. Also, activities in which students organize and present their own thoughts and ideas based on the content of the exchange, and write sentences.
	Students are able to conduct preparatory activities and information gathering on their own and act proactively in order to conduct discussions (and debates, if necessary) in English.	No.6 Logic and Expression III (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ↵ Speaking [exchange] (4) Debates and discussions on what they have heard or read about daily or social topics, in which they ask and answer questions and communicate their opinions, arguments and solutions to problems in detail with effective reasons and evidence, using multiple sources such as news and newspaper articles to persuade their listeners. Activities to engage in discussion. Also, activities to organize and present their own thoughts and ideas based on the content of the exchange, and to write texts.
	Be willing to understand languages and cultures other than their own and be able to communicate smoothly in English inside and outside the classroom.	No.3 English Communication III (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ↵ Speaking [exchange] (7) Activities in which students exchange information, ideas and feelings in detail and develop conversations about daily topics such as life outside school and the local community. Also, activities to organize and present what has been exchanged and to write sentences. (4) Activities in which students listen to or read news or lectures on social topics and communicate information, ideas and solutions to problems in detail, together with clear reasons and evidence. Also, activities to organize and present their own ideas, etc. based on what they have exchanged, and to write sentences.
	No.5 Logic and Expression II (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ↵ Speaking [exchange] (7) Activities to communicate information, thoughts and feelings in detail about daily topics, such as life outside school and the local community, in situations where the words and sentences to be used and the specific way of proceeding with the exchange are indicated, as necessary, and to communicate their own situations and requests, and to negotiate while understanding the intentions of others. Also, activities to organize and present the content of exchanges and to write sentences.	
	No.6 Logic and Expression III (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ↵ Speaking [exchange] (7) Activities to organize and communicate information, ideas and feelings about daily topics by using multiple sources, such as news and newspaper articles, and to discuss issues in order to solve problems. Also, activities to organize and present the content exchanged and to write sentences.	

<p>Can write multiple paragraphs that convey opinions and arguments on topics of interest, together with appropriate reasons and evidence.</p>	<p>No.3 English Communication III (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities 力 Writing (7) Activities in which students write multiple paragraphs giving details of information, thoughts and feelings on daily topics such as life outside school and the local community, together with clear reasons and evidence. Also, activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions. (4) Activities in which students listen to or read news or lectures on social topics and write multiple paragraphs giving information, thoughts and feelings in detail, with clear reasons and evidence, while clarifying their own position. Also, activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions.</p>
<p>Be able to give presentations on topics of interest in plain English and exchange simple questions and answers about the content, with a view to giving oral presentations on their own field of expertise.</p>	<p>No.5 Logic and Expression II (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities 工 Writing (7) Activities in which students write multiple paragraphs on daily topics, such as life outside school and in the community, in which they give details of information, ideas and feelings, together with appropriate reasons and evidence, in situations where, if necessary, examples of words, sentences and sentences to be used are given or a certain amount of time is allowed for preparation. Also, activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions. (4) Activities in which students write multiple paragraphs that give detailed information about what they have heard or read on daily or social topics, taking a step-by-step procedure from conception to elaboration, and giving their opinions and arguments, together with appropriate reasons and evidence, in situations where words, sentences and examples of sentences to be used are given as necessary and where a certain amount of time is set aside for preparation. Activities in which students write multiple paragraphs that convey their opinions and arguments in detail, together with appropriate reasons and evidence. Activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions.</p>
<p>Be able to outline and read the necessary information in articles and manuals on topics of interest and in their own field of expertise.</p>	<p>No.3 English Communication III (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities 才 Speaking [presentation] (7) Activities in which students give detailed information, ideas and feelings about daily topics, such as life outside school and the local community, together with clear reasons and evidence. Also, activities in which students ask and answer questions and share their opinions and feelings about what they have presented. (4) Activities in which students listen to or read news or lectures on social topics and give detailed information, ideas and feelings, together with clear reasons and evidence. Also, activities in which students ask and answer questions and share their opinions and impressions about what they have presented.</p>
<p>Be able to outline and read the necessary information in articles and manuals on topics of interest and in their own field of expertise.</p>	<p>No.5 Logic and Expression II (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ウ Speaking [presentation] (7) Activities in which information, thoughts and feelings are presented in detail, together with appropriate reasons and evidence, on daily topics such as life outside school and the local community, in situations where, if necessary, examples of words, sentences and utterances to be used are given and a certain amount of time is allocated for preparation. Also, activities in which questions are asked and answered, and opinions and impressions are shared about the content of the presentation. (4) Speeches in which opinions, claims, etc. are conveyed in detail, together with appropriate reasons and evidence, in a step-by-step procedure, in situations where, where necessary, examples of words, sentences and utterances to be used and a certain amount of time for preparation are provided for what has been heard or read on daily topics or social topics. Activities to give a speech or presentation. Also, activities in which students ask and answer questions and share their opinions and impressions of the content of the presentation.</p>
<p>Be able to outline and read the necessary information in articles and manuals on topics of interest and in their own field of expertise.</p>	<p>No.3 English Communication III (3) Matters relating to language activities and the functioning of language ① Matters relating to language activities ウ Reading (7) Activities to read the necessary information from newspaper articles and stories on daily topics, and to understand the development of the text and the writer's intentions. Also, activities to ask and answer questions about what they have read and to share their opinions and impressions with each other. (4) Activities in which students read the information necessary to solve a problem on a social topic from multiple argumentative or recorded texts, paying attention to the development of the text, and summarize the outline, main points and details. Also, activities in which students think of solutions based on the summarized content and communicate them to each other by talking and writing.</p>

	<p>Write English-language materials using basic vocabulary and expressions in English technical writing so that they can be used to prepare English-language abstracts for papers in their own field, materials for oral presentations, etc.</p>	<p>No.6 Logic and Expression III</p> <p>(3) Matters relating to language activities and the functioning of language</p> <p>① Matters relating to language activities</p> <p>± Writing</p> <p>(7) Activities in which students write multiple paragraphs that give detailed information, ideas and feelings on daily topics, together with effective reasons and evidence, in order to persuade the reader. Also, activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions.</p> <p>(4) Activities to write multiple paragraphs on daily and social topics, using multiple sources such as news and newspaper articles to convey opinions and arguments in detail, with effective reasons and evidence, in order to persuade the reader, taking a step-by-step procedure from conception to elaboration. Also, activities in which students read what they have written to each other, ask and answer questions, and share their opinions and impressions.</p>
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III-C Social Study

	Model Core Curriculum	Course of Study Guideline for Upper Secondary Schools
Objective	<p>[Learning achievement goals].</p> <p>Be able to participate proactively in society as a formulator of a peaceful and democratic state and society in the international community, and use knowledge, theory and information from the humanities and social sciences to solve problems faced by society.</p>	<p>[geography integrated, geography exploration, history integrated, Japanese history exploration, world history exploration].</p> <p>Through activities in which students use their social perspectives and ideas to pursue and solve problems, they aim to develop the civic qualities and abilities necessary to become effective shapers of a peaceful, democratic state and society that takes a broad perspective and lives independently in an increasingly globalized international society, as follows.</p> <p>(1) To understand the regional characteristics of the modern world and the development of Japanese and world history, and to acquire the skills to appropriately and effectively research and summarize a variety of information from surveys and various materials.</p> <p>(2) Cultivate the ability to consider the meaning, significance, characteristics and interconnections of geography and history from multiple perspectives and perspectives using concepts, etc., and to conceptualize solutions to social issues, as well as to effectively explain and discuss what they have considered and conceptualized based on this.</p> <p>(3) Cultivate an attitude of proactively trying to solve problems in geography and history with a view to realizing a better society, as well as an awareness of Japanese citizenship, love for the land and history of Japan and the importance of respect for other countries and cultures, which are cultivated through multifaceted, multilateral consideration and a deep understanding of these issues. Deepen awareness of the importance of respect for other countries and cultures, etc.</p>
		<p>[Public, Ethics, Politics and Economics]</p> <p>Through activities in which students use social perspectives and ideas to pursue and solve contemporary issues, we aim to develop the civic qualities and abilities necessary to be effective shapers of a peaceful, democratic state and society that takes a broad view and lives independently in a globalizing international society, as follows.</p> <p>(1) To understand concepts and theories that provide clues for selection and judgement, as well as contemporary issues relating to ethics, politics, economics, etc., and to acquire the skills to research and summarize various information from various sources in an appropriate and effective manner.</p> <p>(2) Cultivate the ability to consider various contemporary issues from multiple perspectives using facts and concepts, etc., and to make fair judgements towards solutions, as well as the ability to discuss what has been conceived with a view to consensus-building and social participation.</p> <p>(3) Cultivate an attitude of trying to solve contemporary issues independently with a view to realizing a better society, as well as an awareness of how to live as a human being, which is cultivated through multifaceted and multilateral consideration and deep understanding, and, as citizens responsible for national sovereignty, a love for their own country, its peace and prosperity, and an awareness of the importance of each country's mutual respect for sovereignty and co-operation with each other. The students will deepen their awareness of the importance of respecting the sovereignty of each country and the importance of cooperation between peoples.</p>

Learning Content	Model Core Curriculum and Learning Content Achievement Goals	Course of Study Guideline for Upper Secondary Schools
Geohistorical (geographical) field	Understand the distribution and trends of population, resources and industry in different parts of the world, and the interconnectedness of these regions, and be able to explain modern society from a geographical perspective.	<p>[Geography General]</p> <p>A The modern world as seen through maps and geographic information systems.</p> <p>(1) Maps and geographic information systems and the contemporary world</p> <p>Guidance is given to enable students to acquire the following through activities to pursue and solve problems, focusing on location and distribution.</p> <p>ア The following knowledge and skills</p> <p>(7) Understanding of orientation and time zones, the location and territory of Japan, and national and inter-state links, based on the reading of various maps and other information showing the regional structure of the modern world.</p>
		<p>[Geography General]</p> <p>B International understanding and international cooperation</p> <p>(2) Global issues and international cooperation</p> <p>Guidance is given so that students can acquire the following items through activities to pursue and solve problems with a focus on spatial interdependence and regions.</p> <p>ア To acquire knowledge of the following</p> <p>(7) Based on global environmental problems, resource and energy problems, population and food problems, and urban and settlement problems seen in various parts of the world, to gain a broad view and understanding of the common trends and interconnectedness of global issues in various regions.</p> <p>(4) Based on the global environmental problems, resource and energy problems, population and food problems, and urban and settlement problems seen in various parts of the world, to understand that the solution of global problems requires the efforts of each country and international cooperation aiming at the realization of a sustainable society.</p>
		<p>[geographical exploration]</p> <p>A Systematic geographical considerations of the modern world</p> <p>(2) Resources, industry</p> <p>Guidance is given to enable students to acquire the following through activities to pursue and solve problems, with a focus on place and spatial interdependence effects.</p> <p>ア Knowledge of the following.</p> <p>(7) Based on various phenomena related to resources and energy, agriculture and industry, to understand the spatial regularities and trends of these phenomena, as well as the current situation, factors and efforts to solve the problems of resources, energy and food.</p>

	Understand the diversity of ethnic, religious and living cultures, based on the interaction between humans and the natural environment, and be able to reflect on the importance of the coexistence of different cultures and societies.	<p>[Geography General]</p> <p>B International understanding and international cooperation</p> <p>(1) Cultural diversity and international understanding</p> <p>Guidance is given to enable students to acquire the following through activities to pursue and solve problems, focusing on places and the interdependent relationship between humans and the natural environment.</p> <p>ア Acquire the following knowledge</p> <p>(7) Based on the distinctive lifestyles and cultures of people around the world, understand that people's lifestyles and cultures are affected by and influenced by the geographical environment and have diversity, and that they are transformed by changes in the geographical environment.</p> <p>(4) Based on the distinctive lifestyles and cultures of people around the world, understand the importance of respecting other cultures and promoting international understanding.</p>
		<p>[Geographical exploration]</p> <p>A Systematic geographical considerations of the modern world</p> <p>(5) Culture of life, ethnic groups and religions</p> <p>Guidance is given to enable students to acquire the following through activities to pursue and solve problems, with a focus on place and spatial interdependence effects.</p> <p>ア Knowledge of the following</p> <p>(7) Based on various phenomena related to life and culture, ethnic groups and religions, to understand the spatial regularities and trends of these phenomena, as well as the current situation, factors and efforts to solve ethnic and territorial problems.</p>
	Be able to give an overview of the process by which modernizing Western countries united the world, including Japan, in the 19th century.	<p>[General history]</p> <p>B Modernization and us</p> <p>(1) The question of modernization</p> <p>Guidance is given to enable students to acquire the following through the use of materials on transport and trade, industry and population, awareness of rights and political participation and the duties of citizens, school education, labor and the family, immigration, etc., and through activities to pursue and solve problems.</p> <p>ア Develop the following skills.</p> <p>(7) Develop skills in reading and summarizing information from materials.</p>
		<p>[General history]</p> <p>B Modernization and us</p> <p>(2) The connected world and Japan's opening to the world</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Acquire the following knowledge</p> <p>(7) Understand the economy and society of Asia in the 18th century, based on production and distribution in Asia and Japan, and trade between Asian regions and between Asian countries and Western countries.</p> <p>(4) Understand industrialization and the formation of world markets, based on the Industrial Revolution and innovations in transport and communication, the opening of Chinese ports and the opening of Japan.</p>
		<p>[General history]</p> <p>B Modernization and us</p> <p>(3) The nation-state and the Meiji Restoration</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the formation of constitutional systems and nation-states, based on the civil revolutions and trends in national unity in the West since the late 18th century, as well as the Meiji Restoration in Japan and the enactment of the Imperial Japanese Constitution.</p> <p>(4) To understand the imperialist policies of the powers and the transformation of Asian countries, based on the expansion of the powers and the formation of colonies and the Sino-Japanese and Russo-Japanese wars.</p>
		<p>[Exploring Japanese history]</p> <p>D Modern and contemporary regions, Japan and the world</p> <p>(1) The transition to modernity and the historical environment</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Acquire the following knowledge.</p> <p>(7) Understand the transition from the early modern period to the modern period, based on the transformation of foreign policy and the opening of Japan to the outside world, the collapse of the <i>bakuhau</i> system and the establishment of the new government.</p>

		<p>[Exploring Japanese history]</p> <p>D Modern and contemporary regions, Japan and the world</p> <p>(3) Modern and contemporary regions, Japan and the world's epochs and structures</p> <p>Guidance is given so that students can acquire the following through activities to pursue and solve problems based on the hypotheses expressed in (2), using various materials.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the transition to a constitutional system, the formation of the nation-state and the transformation of relations with Asia and Western countries based on the Meiji Restoration, the liberal civil rights movement, the enactment of the Imperial Constitution of Japan, treaty reform, the Sino-Japanese and Russo-Japanese Wars, World War I, trends in social movements and party politics.</p> <p>(1) To understand the process of industrial development, the characteristics of modern culture and the formation of mass society, based on the climate of civilization and development of the Industrial Revolution, the improvement of transport and transformation of the industrial structure, the development of learning and expansion of the education system, and the occurrence of social problems.</p> <p>(7) To understand the process leading to World War II and the transformation of politics, society and people's lives during the war, based on the Depression and international relations, the rise of the military and its foreign policy, the strengthening of the wartime regime and the development of World War II.</p> <p>(±) To understand Japan's re-start and subsequent political, economic and external relations, the contemporary political and social framework and the transformation of people's lives, based on occupation policy and various reforms, the establishment of the Japanese Constitution, peace treaties and the restoration of independence, post-war economic recovery, relations with Asian countries, rapid economic growth and the internationalization of society, economy and information.</p>
		<p>[World History Inquiry]</p> <p>D Combining and transforming various regions</p> <p>(2) The formation of the global market and the joining of various regions</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on questions from the perspectives considered in (1), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) A structural understanding of the formation of nation-states and modern democratic societies, based on the Industrial Revolution and the Atlantic Rim Revolution, liberalism and nationalism, and the development of the Civil War.</p> <p>(1) Structural understanding of the formation of the world market and the transformation of Asian countries, based on the international division of labor and labor migration, the free trade system centered on the UK, and the colonization and various reforms in Asian countries.</p>
	<p>Can give an overview of the developments in the world, including Japan, leading up to the two world wars through the struggles of the imperialist countries and consider the significance of peace.</p>	<p>[General history]</p> <p>B Modernization and us</p> <p>(3) The nation-state and the Meiji Restoration</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the formation of constitutional systems and nation-states, based on the civil revolutions and trends in national unity in the West since the late 18th century, as well as the Meiji Restoration in Japan and the enactment of the Imperial Japanese Constitution.</p> <p>(1) To understand the imperialist policies of the powers and the transformation of Asian countries, based on the expansion of the powers and the formation of colonies and the Sino-Japanese and Russo-Japanese wars.</p>
		<p>[General history]</p> <p>C We and the changing international order and popularization</p> <p>(1) Questions about the changing international order and popularization</p> <p>Guidance is given to enable students to acquire the following through activities in which they use materials on the growing closeness of international relations, the rise of the United States and the Soviet Union, colonial independence, changes in the political, economic and social status of the masses and changing lifestyles, and pursue and solve problems.</p> <p>ア Develop the following skills</p> <p>(7) Develop skills in reading and summarizing information from materials.</p>
		<p>[General history]</p> <p>C We and the changing international order and popularization</p> <p>(2) World War I and mass society</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(7) To understand total war and the system of international cooperation after World War I, based on the development of World War I, the economic growth of Japan and Asia, the formation of the Soviet Union and the rise of the United States of America, trends in nationalism and the formation of the League of Nations.</p> <p>(1) Understanding the formation of mass society and the spread of social movements, based on mass political participation and the improvement of women's status, Taisho democracy and party politics, mass consumer society and mass culture, the spread of education and the development of mass media.</p>

		<p>[General history]</p> <p>C We and the changing international order and popularization</p> <p>(3) Economic crisis and World War II</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems</p> <p>ア Acquire the following knowledge</p> <p>(7) Understand the upheavals in the system of international cooperation based on the Great Depression, the growth of fascism and Japan's foreign policy.</p> <p>(4) To understand the international order and Japan's return to international society after World War II, based on the development of World War II, the United Nations and the international economic system, the beginning of the Cold War and developments in Asian countries, post-war reforms and the enactment of the Japanese Constitution, peace treaties and the restoration of Japanese independence.</p> <hr/> <p>[Exploring Japanese history]</p> <p>D Modern and contemporary regions, Japan and the world</p> <p>(3) Modern and contemporary regions, Japan and the world's epochs and structures</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the hypotheses expressed in (2), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) Understanding the transition to a constitutional system, the formation of the nation-state and the transformation of relations with Asia and the West, based on the Meiji Restoration, the liberal civil rights movement, the enactment of the Imperial Constitution of Japan, treaty reform, the Sino-Japanese and Russo-Japanese Wars, World War I, trends in social movements and party politics.</p> <p>(4) To understand the development of industry, the characteristics of modern culture and the formation of mass society, based on the climate of civilization, the development of the Industrial Revolution, the development of transport and the transformation of the industrial structure, the development of learning and the expansion of the education system, and the emergence of social problems.</p> <p>(7) To understand the process leading up to and the transformation of political, social and national life during the Second World War, based on the Depression and international relations, the rise of the military and its foreign policy, the strengthening of the wartime regime and the development of the Second World War.</p> <p>(±) To understand the political, economic and external relations, the contemporary political and social framework and the transformation of people's lives based on occupation policy and various reforms, the formation of the Japanese Constitution, peace treaties and the restoration of independence, post-war economic recovery, relations with Asian countries, rapid economic growth, and the internationalization of society, economy and information, as well as the re-start of Japan and the subsequent transformation of the country.</p> <hr/> <p>[World History Inquiry]</p> <p>D Cohesion and transformation of various regions</p> <p>(3) Imperialism and the rise of nationalism</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems based on questions from the perspectives considered in (1).</p> <p>ア Acquire the following knowledge</p> <p>(7) Structural understanding of the development of world division and the rise of nationalism, based on the Second Industrial Revolution, the struggle between imperialist countries and the transformation of Asian countries.</p> <p>(4) To structurally understand the development of the First World War and the transformation of various regions, based on the First World War and the Russian Revolution, the formation of the Versailles-Washington system, the rise of the United States of America, and developments and nationalism in Asia and Africa.</p> <hr/> <p>[World History Inquiry]</p> <p>D Cohesion and transformation of various regions</p> <p>(4) World War II and the transformation of various regions</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems based on questions from the perspectives considered in (1).</p> <p>ア Acquire the following knowledge</p> <p>(7) Structural understanding of tensions and conflicts in international relations, based on the Great Depression, the trend of fascism and the upheaval of the Versailles-Washington system.</p> <p>(4) To understand structurally the development of the Second World War and the transformation of various regions, based on the development of the Second World War and the international order after the war, the Cold War and the beginning of the independence of Asian countries.</p>
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<p>To be able to give an overview of developments in the world, including Japan, since World War II, the development and end of the Cold War, and thereafter to the present day, and to be able to consider historically the various issues that have arisen.</p>	<p>[General history] C We and the changing international order and popularization (3) Economic crisis and World War II Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Acquire the following knowledge (7) Understand the upheavals in the system of international cooperation based on the Great Depression, the growth of fascism and Japan's foreign policy. (4) Understand the international order and Japan's return to international society after World War II, based on the development of World War II, the United Nations and the international economic system, the beginning of the Cold War and developments in Asian countries, post-war reforms and the enactment of the Japanese Constitution, peace treaties and the restoration of Japanese independence.</p>
	<p>[General history] D Globalization and us (1) The question of globalization Guidance is given to enable students to acquire the following through activities in which they use materials on the Cold War and international relations, movement of people and capital, advanced information and communications, food and population, resources, energy and the global environment, infectious diseases and the coexistence of diverse peoples, and pursue and solve problems. ア Develop the following skills. (7) Develop skills in reading and summarizing information from materials.</p>
	<p>[General history] D Globalization and us (2) The Cold War and the global economy Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Knowledge of the following (7) To understand the transformation of international politics based on decolonization and Asian and African countries, regional conflicts during the Cold War, political trends in developed countries, arms expansion and nuclear weapons control. (4) To understand the expansion of the global economy and Japanese society under economic growth, based on regional cooperation in Western Europe and South-East Asia, planned economies and their spillovers, and Japan's rapid economic growth.</p>
	<p>[General history] D Globalization and us (3) Transformation of the world order and Japan Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Knowledge of the following (7) To understand the transformations and challenges of the market economy based on the oil crisis, economic development in various Asian regions, market opening and economic liberalization, and the development of information and communication technology. (4) Understanding the transformations and challenges of international politics since the end of the Cold War, based on the end of the Cold War, the development of democratization, the expansion and transformation of regional integration, and the proliferation of regional conflicts and responses to them.</p>
	<p>[Exploring Japanese history] D Modern and contemporary regions, Japan and the world (3) Modern and contemporary regions, Japan and the world's epochs and structures Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the hypothesis expressed in (2), making use of various materials. ア Knowledge of the following (7) Understanding the transition to a constitutional system, the formation of the nation-state and the transformation of relations with Asia and the West, based on the Meiji Restoration, the liberal civil rights movement, the enactment of the Imperial Japanese Constitution, treaty reform, the Sino-Japanese and Russo-Japanese Wars, World War I, social movements and party politics. (4) To understand the development of industry, the characteristics of modern culture and the formation of mass society, based on the climate of civilization, the development of the Industrial Revolution, the development of transport and the transformation of the industrial structure, the development of learning and the expansion of the education system, and the emergence of social problems. (7) To understand the process leading up to and the transformation of political, social and national life during the Second World War, based on the Depression and international relations, the rise of the military and its foreign policy, the strengthening of the wartime regime and the development of the Second World War. (4) To understand the political, economic and external relations, the contemporary political and social framework and the transformation of people's lives based on occupation policy and various reforms, the formation of the Japanese Constitution, peace treaties and the restoration of independence, post-war economic recovery, relations with Asian countries, rapid economic growth, and the internationalization of society, economy and information, as well as the re-start of Japan and the subsequent transformation of the country.</p>

		<p>[World History Inquiry] E Global world issues (1) The formation of international organizations and the search for peace Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Knowledge of the following (7) To understand the efforts and challenges of conflict resolution based on collective security and the development of the Cold War, the independence of Asian and African countries and the movement towards regional cooperation, the development of peaceful coexistence and multipolarity, the end of the Cold War and the frequency of regional conflicts.</p>
		<p>[World History Inquiry] E Global world challenges (2) Economic globalization and the correction of inequalities Guidance is given so that the following items can be acquired through activities to pursue and solve issues by using various materials. ア Acquire the following knowledge (7) To understand the efforts and challenges of correcting disparities based on the economic growth of developed countries and the North-South problem, the turmoil in the hegemony of the United States, the movement of resource nationalism and the transformation of the industrial structure, the economic growth of Asian and Latin American countries and the South-South problem, economic globalization, et ㊦</p>
	<p>Be able to give an overview of Japan's relations with its Asian neighbors since the late 19th century.</p>	<p>[General history] B Modernization and us (3) The nation-state and the Meiji Restoration Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Knowledge of the following (7) To understand the formation of constitutional systems and nation-states, based on the civil revolutions and trends in national unity in the West since the late 18th century, as well as the Meiji Restoration in Japan and the enactment of the Imperial Japanese Constitution. (4) To understand the imperialist policies of the powers and the transformation of Asian countries, based on the expansion of the powers and the formation of colonies and the Sino-Japanese and Russo-Japanese wars.</p>
		<p>[General history] C We and the changing international order and popularization (2) World War I and mass society Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Knowledge of the following (7) To understand total war and the system of international cooperation after World War I, based on the development of World War I, the economic growth of Japan and Asia, the formation of the Soviet Union and the rise of the United States of America, trends in nationalism and the formation of the League of Nations. (4) Understanding the formation of mass society and the spread of social movements, based on mass political participation and the improvement of women's status, Taisho democracy and party politics, mass consumer society and mass culture, the spread of education and the development of mass media.</p>
		<p>[General history] C We and the changing international order and popularization (3) Economic crisis and World War II Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Knowledge of the following (7) To understand the upheavals in the system of international cooperation based on the Great Depression, the growth of fascism and Japan's foreign policy. (4) Understanding the international order and Japan's return to the international community after World War II, based on the development of World War II, the United Nations and the international economic system, the beginning of the Cold War and developments in Asia, post-war reforms and the Japanese Constitution, peace treaties and the restoration of Japanese independence.</p>
		<p>[General history] D Globalization and us (2) The Cold War and the global economy Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Knowledge of the following (7) To understand the transformation of international politics based on decolonization and Asian and African countries, regional conflicts during the Cold War, political trends in developed countries, arms expansion and nuclear weapons control. (4) To understand the expansion of the global economy and Japanese society under economic growth, based on regional cooperation in Western Europe and South-East Asia, planned economies and their spillovers, and Japan's rapid economic growth.</p>

		<p>[General history]</p> <p>D Globalization and us</p> <p>(3) Transformation of the world order and Japan.</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the transformations and challenges of the market economy based on the oil crisis, economic development in various Asian regions, market opening and economic liberalization, and the development of information and communication technology.</p> <p>(1) Understanding the transformations and challenges of international politics since the end of the Cold War, based on the end of the Cold War, the development of democratization, the expansion and transformation of regional integration, and the proliferation of regional conflicts and responses to them.</p> <hr/> <p>[Exploring Japanese history]</p> <p>D Modern and contemporary regions, Japan and the world</p> <p>(3) Modern and contemporary regions, Japan and the world's epochs and structures.</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the hypotheses expressed in (2), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) Understanding the transition to a constitutional system, the formation of the nation-state and the transformation of relations with Asia and the West, based on the Meiji Restoration, the liberal civil rights movement, the enactment of the Imperial Constitution of Japan, treaty reform, the Sino-Japanese and Russo-Japanese Wars, World War I, trends in social movements and party politics.</p> <p>(7) To understand the development of industry, the characteristics of modern culture and the formation of mass society, based on the climate of civilization, the development of the Industrial Revolution, the development of transport and the transformation of the industrial structure, the development of learning and the expansion of the education system, and the emergence of social problems.</p> <p>(7) To understand the process leading up to and the transformation of political, social and national life during the Second World War, based on the Depression and international relations, the rise of the military and its foreign policy, the strengthening of the wartime regime and the development of the Second World War.</p> <p>(±) To understand the political, economic and external relations, the contemporary political and social framework and the transformation of people's lives based on occupation policy and various reforms, the formation of the Japanese Constitution, peace treaties and the restoration of independence, post-war economic recovery, relations with Asian countries, rapid economic growth, and the internationalization of society, economy and information, as well as the re-start of Japan and the subsequent transformation of the country.</p> <hr/> <p>[World History Inquiry]</p> <p>D Combining and transforming various regions</p> <p>(2) The formation of the global market and the joining of various regions.</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on questions from the perspectives considered in (1), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) Structural understanding of the formation of nation-states and modern democratic societies, based on the Industrial Revolution and the Atlantic Rim Revolution, liberalism and nationalism, and the development of the Civil War.</p> <p>(1) Structural understanding of the formation of the world market and the transformation of Asian countries, based on the international division of labor and labor migration, the free trade system centered on the UK, and the colonization and various reforms in Asian countries.</p> <hr/> <p>[World History Inquiry]</p> <p>D Combining and transforming various regions</p> <p>(3) Imperialism and the rise of nationalism</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on questions from the perspectives considered in (1), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) Structural understanding of the development of world division and the rise of nationalism, based on the Second Industrial Revolution, the struggle between imperialist countries and the transformation of Asian countries.</p> <p>(1) Structural understanding of the development of the First World War and the transformations of various regions, based on the First World War and the Russian Revolution, the formation of the Versailles-Washington system, the rise of the United States of America, and trends and nationalism in Asia and Africa.</p>
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		<p>[World History Inquiry] E Global world issues (1) The formation of international organizations and the search for peace Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Knowledge of the following (7) To understand the efforts and challenges of conflict resolution based on collective security and the development of the Cold War, the independence of Asian and African countries and the movement towards regional cooperation, the development of peaceful coexistence and multipolarity, the end of the Cold War and the frequency of regional conflicts.</p>
		<p>[World History Inquiry] E Global world issues (2) Economic globalization and reducing inequality Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems. ア Knowledge of the following (7) To understand the efforts and challenges of reducing inequality based on the economic growth of developed countries and the North-South problem, the upheaval in the hegemony of the United States of America, the movement of resource nationalism and the transformation of industrial structure, the economic growth of Asian and Latin American countries and the South-South problem, and economic globalization.</p>
Civic field	Using the ideas of previous philosophers and their predecessors as a guide, the students are able to reflect on ideas concerning diverse lifelong self-formation, including better career building, the importance of living with others, and the desirable society and world.	<p>[Public] A Public door (1) We who create public space Guidance is given to enable students to acquire the following through activities that question what it means to be an independent subject participating in society and explore the way of being and living as a human being in contemporary society, focusing on the relationship between public space and people, individual dignity, independence and autonomy, and the diversity and commonality of people and society. ア Knowledge of the following (7) To understand how to be and live as a human being who develops himself/herself through reflecting on his/her own experiences, etc. (4) To understand that human beings, as individuals, are to be mutually respected, that they are social beings who can understand and enhance each other's various positions through dialogue, and that they can form their own values and respect the values of others through contact with tradition, culture, the efforts and wisdom of their predecessors, etc. To understand that they are beings who are able to form their own values and respect the values of others through contact with traditions, culture, the efforts and wisdom of their ancestors, etc. (7) To understand that becoming an independent actor who voluntarily seeks to create a better public space for themselves will lead to the formation of a better society as well as their own career development.</p> <p>[Public] A Public door (2) How to be and live as a human being in public space Guidance is given so that students can acquire the following through activities to pursue and solve problems with a focus on happiness, justice, fairness, etc., towards proactive participation in society and collaboration with others. ア The following knowledge and skills (7) To understand the concept of focusing on the well-being of the individual and society as a whole as a result of an action, as well as the concept of focusing on obligations such as fairness as a motivation for action, as clues for making choices and decisions. (4) To understand that it is important for the actor to explore his/her own way of being and living as a human being in order to find solutions to contemporary issues that are acceptable to both himself/herself and others, through the use of the ideas shown in (7). (7) To acquire the skills to collect and read the information necessary to act as a better actor from various materials related to the way of being and living as a human being.</p>

		<p>[Ethics]</p> <p>A The challenges of the self in the modern world and how to be and live as a human being</p> <p>(1) Awareness of how to be and live as a human being</p> <p>Guidance is given to enable students to acquire the following through activities that contemplate fundamental issues relating to human existence and values.</p> <p>ア The following knowledge and skills</p> <p>(7) To understand the various ways of the human mind, focusing on personality, emotions, cognition and development, which provide clues to deepen the contemplation of one's own way of life to live better with others, with a view to rich self-building.</p> <p>(1) To understand the various views of life that provide clues for contemplating the human way of being and living, with a focus on happiness, love and virtue. In doing so, they should also understand the significance of religion and art in life.</p> <p>(7) To understand the various ethical values that provide clues for contemplating the state of society and how to be and live as a human being, with a focus on goodness, justice and duty.</p> <p>(2) To understand the various worldviews that provide clues for contemplating the world and the human condition, with a focus on truth, existence, etc.</p> <p>(4) To acquire the skills to read information on how to be and live as a human being from various sources, including Japanese translations of original texts on the ideas of ancient and modern philosophers.</p>
		<p>[Ethics]</p> <p>A The challenges of the self in the modern world and how to be and live as a human being</p> <p>(2) Awareness as a Japanese citizen of the international community</p> <p>Guidance is given to enable students to acquire the following through activities in which they contemplate the way of being and living as Japanese people.</p> <p>ア The following knowledge and skills</p> <p>(7) To understand, in relation to oneself, the characteristics of the Japanese view of humanity, nature and religion, which provide clues for contemplating the way of being and living as Japanese people in an international society, based on the climate and traditions of Japan and the acceptance of foreign ideas, with attention to the feelings and ideas of the ancient Japanese people and the ideas of the Japanese philosophers. To understand the characteristics of the Japanese view of human beings, nature and religion in relation to oneself.</p> <p>(4) To acquire the skills to read information relating to the Japanese way of being and living from various sources, including original texts and colloquial translations of original texts, on the feelings and ideas of the ancient Japanese people and the ideas of Japan's forebears.</p>
	<p>Understand basic principles such as fundamental human rights and democracy and basic political, legal and economic structures with regard to a society in which the self participates proactively, and be able to consider various issues in contemporary society.</p>	<p>[Public]</p> <p>A Public door</p> <p>(3) Basic principles in public spaces</p> <p>To guide students to acquire the following through activities in which they pursue and solve problems with a focus on happiness, justice and fairness, with a view to becoming independent actors who voluntarily create better public spaces.</p> <p>ア Knowledge of the following</p> <p>(7) Understanding of the need for public space to ensure human dignity and equality, the benefits of cooperation and social stability together, through fair and equitable adjustment of the opinions and interests of each person, among other things.</p> <p>(1) Understanding of basic principles in the public sphere, including human dignity and equality, respect for the individual, democracy, the rule of law, freedom, rights and responsibilities and obligations.</p> <p>[Public]</p> <p>B We, as independent actors, participate in shaping a better society</p> <p>To enable students to participate in the formation of a better society as independent entities, we set specific themes relating to various issues in the real world and guide them to acquire the following through activities in which they pursue and solve these themes in collaboration with others, focusing on happiness, justice, fairness, etc.</p> <p>ア The following knowledge and skills</p> <p>(7) Based on real-life matters and issues related to the significance and role of laws and norms, various contracts and consumer rights and responsibilities, and the significance of judicial participation, to understand that, under the Constitution and in accordance with due process, rights and freedoms are guaranteed and realized through, among other things, the fair and just adjustment of the opinions and interests of each person and the mediation and resolution of individual and social disputes in accordance with laws and norms. Understand that rights and freedoms are guaranteed and realized, and that social order is formed and maintained through, for example, the conciliation and resolution of individual and social disputes, in accordance with proper procedures and in accordance with laws and norms.</p> <p>(1) Political participation and the formation of fair public opinion, local autonomy, national sovereignty, territory (including territorial waters and airspace). (1) Understand that a better society is built through, for example, individuals participating in discussions, adjusting conflicting opinions and interests and forming consensus under the Constitution, based on real-world matters and issues related to Japan's security and defense, and Japan's role in the international community, including its international contributions.</p> <p>(7) Occupational choice, employment and labor issues, the role of public finance and taxation, the enhancement and stabilization of social security in an ageing society with low fertility, the functions and limitations of the market economy, the functioning of finance, economic globalization and deepening interdependence (including issues of poverty and inequality in the international community). The students understand that the efficient allocation of resources is achieved through fair and free economic activity, that governments and others play a role in making the market economy system function and in contributing</p>

		<p>to the improvement of national welfare, and that more active economic activity and respect for the individual must coexist, based on real social issues and problems related to these issues, such as to understand the need for a more active economy and respect for the individual.</p> <p>(±) To acquire the skills to appropriately and effectively collect, read and summarize the information necessary to act as an independent subject from various materials related to real-world issues.</p> <p>[Politics and economics]</p> <p>A Political and economic issues in contemporary Japan</p> <p>(1) Politics and economy of contemporary Japan</p> <p>Guidance is given to enable students to acquire the following through activities in which they pursue contemporary issues and conceptualize solutions with a focus on respect for individual dignity and basic human rights, conflict, cooperation, efficiency and fairness.</p> <p>ア The following knowledge and skills</p> <p>(7) To deepen understanding of the significance and functions of politics and law, guarantees of fundamental human rights and the rule of law, the relationship between rights and obligations, parliamentary democracy and local self-government through various real-life social phenomena.</p> <p>(4) To deepen understanding of economic activities and markets, economic agents and economic cycles, the size of the national economy and economic growth, prices and business fluctuations, the workings and mechanisms of public finances and the significance of taxation and other forms of taxation, and the workings and mechanisms of finance, through various real-world phenomena.</p> <p>(7) To acquire the skills to appropriately and effectively collect and read the information necessary for considering and conceiving solutions to problems from various materials on contemporary Japanese politics and economics.</p> <p>[Politics and economics]</p> <p>B Issues of the globalizing international community</p> <p>(1) Contemporary international politics and economics</p> <p>Guidance is given to enable students to acquire the following through activities in which they investigate contemporary issues and conceive solutions with a focus on respect for individual dignity and fundamental human rights, conflict, cooperation, efficiency and fairness, with a view to deepening their awareness of the need to contribute to international peace and the welfare of mankind.</p> <p>ア The following knowledge and skills</p> <p>(7) To deepen understanding of the significance of international law in relation to international social transition, human rights, national sovereignty, territory (including territorial waters and airspace), etc. (4) To deepen understanding of the significance of international law, the role of the United Nations and other international organizations, the security and defense of Japan, and international contributions, through various real-life events.</p> <p>(4) To deepen understanding of the current situation and significance of trade, exchange rate fluctuations, the national economy and balance of payments, the need for international cooperation and the role of international economic organizations through various real-world events.</p> <p>(7) To acquire the skills to collect and read appropriately and effectively information from various sources on contemporary international politics and economics, which is necessary when considering and conceptualizing solutions to problems.</p>
<p>Contemporary social considerations</p>	<p>Through activities such as setting appropriate subjects related to the characteristics and issues of contemporary society, exploring them using materials, and discussing and debating the results, students are able to consider, conceptualize and express, from the perspective of the humanities and social sciences, multifaceted and multifaceted ideas about the realization of a sustainable society in which people around the world can co-operate and coexist.</p>	<p>[Geography General]</p> <p>C Sustainable community development and us</p> <p>(2) Survey of living areas and regional outlook</p> <p>Guidance is given to enable students to acquire the following through activities that explore issues with a focus on spatial interdependence effects, regions, etc.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the approaches to solving geographical problems and the methods to be explored, based on the investigation of living areas.</p> <p>[Geographical exploration]</p> <p>C The future image of Japan's national land in the modern world.</p> <p>(1) Exploration of a sustainable national land vision.</p> <p>Guidance is given to enable students to acquire the following through activities that explore issues with a focus on spatial interdependence effects, regions, etc.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the importance of envisioning the direction of solutions to the various geographical problems facing Japan and the future of the country, based on an exploration of the future image of Japan's land in the modern world, and the methods used to explore this.</p> <p>[General history]</p> <p>B Modernization and us</p> <p>(4) Modernization and contemporary issues.</p> <p>Based on the studies from (1) to (3) in A and B of the contents, etc., set up subjects from the perspective of freedom/restriction, equality/disparity, development/conservation, integration/differentiation, conflict/cooperation, etc., and guide students to acquire the following items through activities to pursue and solve them by making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) Understanding the history of modernization as it relates to the formation of various contemporary issues.</p>

		<p>[History General] C We and the changing international order and popularization (4) Changes in the international order and popularization and contemporary issues. Based on the studies from (1) to (3) of A and C of the contents, etc., set subjects from the perspective of freedom/restriction, equality/disparity, development/conservation, integration/differentiation, conflict/cooperation, etc., and guide students to acquire the following matters through activities to pursue and solve them by making use of various materials. ア Knowledge of the following (7) Understanding the history of changes in the international order and popularization in the formation of various contemporary issues.</p> <hr/> <p>[History General] D Globalization and us (4) Formation and prospects of contemporary issues. Based on the studies from (1) to (3) in A, B, C and D of the contents, etc., guide students to acquire the following items through activities in which they set themes, use various materials and explore them, with a view to realizing a sustainable society. ア Knowledge of the following (7) Understanding contemporary issues in the context of the historical background.</p> <hr/> <p>[World History Inquiry] E Global world issues (4) Exploration of global world issues Guidance is given so that students can acquire the following items ア and イ through activities in which they set the subject matter, use various materials and explore with a view to realizing a sustainable society, based on the study of A, B, C, D and E (1) to (3) of the following items ① to ③. ① Conflict resolution and coexistence ② Reduction of economic disparities and economic development ③ Scientific and technological developments and cultural transformations ア Knowledge of the following (7) Understanding the challenges of the global world in the context of its historical background.</p> <hr/> <p>[Exploring Japanese history] D Modern and contemporary regions, Japan and the world (4) Exploration of contemporary Japanese issues ① to ③ below, based on the study of A, B, C and D (1) to (3), with a view to realizing a sustainable society, set the subject matter in relation to the local community and events around them, and through activities to explore using various materials, learn the matters listed in ア and イ below. Guidance. ① Society and groups and individuals ② Japan in the world ③ Traditions and culture ア Knowledge of the following (7) Understanding contemporary issues in Japan in the context of the historical background.</p> <hr/> <p>[Public] C We are the actors in the creation of a sustainable society To help students to become independent public-spirited actors who can play a role in building sustainable communities, nations, societies and international society, we guide them to acquire the following through activities that explore contemporary issues with a focus on happiness, justice, fairness and so on. ア Finding issues from the perspective of creating a region, building a better state and society and proactively participating in the formation of a peaceful and stable international society, and building a society in which we can live together, collaboratively considering and conceiving solutions to these issues based on facts, using validity, effectiveness and feasibility as indicators, and explaining your ideas based on arguments and describe their ideas on the basis of arguments.</p> <hr/> <p>[Ethics] B Issues and ethics (1) Issues and ethics related to nature and science and technology Guidance is given to enable students to acquire the following through activities in which they explore contemporary issues in relation to nature and science and technology, using their views and ideas about the way of being and living as human beings, and in dialogue with others. ア To find ethical issues concerning the relationship between humans and life, nature, science and technology, etc., and to consider them from multiple perspectives using concepts and theories concerning ethics as clues, to make fair judgments and conceptualize them, and to explain and discuss their own ideas.</p>
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Note: For the qualities and abilities to be fostered “the ability to think, judge and express” (in the section “a” of the contents) and “humanity” indicated in “2 Contents” of each subject of the revised Courses of Study, see the attainment objective “Consideration of contemporary society” and Note 2. In other words, they are to be developed in the curriculum organization of each KOSEN and the lesson design of each subject, guided by the MCC (model) “Fundamental Qualities and Competencies”, and in the educational practices based on these.

New Curriculum Content Not Supported by MCC

Learning Content	Model Core Curriculum and Learning Content Achievement Goals	Course of Study Guideline for Upper Secondary Schools
geohistorical (geographical) field	(N/A) *For more information on the forms of use of geographic information systems, see IV-C Information literacy learning content 'Information Fundamentals'.	[Geography General] A The modern world as seen through maps and geographic information systems (1) Maps and geographic information systems and the contemporary world. Guidance is given to enable students to acquire the following through activities to pursue and solve problems, focusing on location and distribution. ア The following knowledge and skills (1) To understand the role and usefulness of maps and geographic information systems, based on the reading of various maps and other information found in daily life. (7) To acquire basic and fundamental skills in collecting, reading and summarizing various geographical information about the modern world, using maps and geographical information systems.
	(N/A) *Refer to the learning content of IV-B Engineer ethics, 'Contribution of engineering and science and technology to the problems and challenges of society and mankind'.	[Geography General] C Sustainable community development and us (1) Natural environment and disaster prevention Guidance is given to enable students to acquire the following through activities to pursue and solve problems, focusing on the interdependent relationship between humans and the natural environment and the local area. ア The following knowledge and skills (7) Based on natural disasters seen in Japan and other parts of the world and natural disasters seen in the students' own communities, to understand the relationship between the characteristics of the local natural environment and natural disaster preparedness and response, as well as the scale and frequency of natural disasters and the importance of preparedness and response based on local characteristics. (1) To develop geographical skills in collecting, reading and summarizing information on various types of geographical information, including hazard maps and old and new topographical maps for various natural disasters.
	(N/A)	[Geographical exploration] A Systematic geographical considerations of the modern world (1) Natural environment Guidance is given to enable students to acquire the following through activities to pursue and solve problems, focusing on the interdependent relationship between places, humans and the natural environment. ア Knowledge of the following (7) Based on various phenomena related to topography, climate and ecosystems, to understand the spatial regularities and trends of these phenomena, as well as the current state of global environmental problems, their factors and efforts to solve them.
	(N/A)	[Geographical exploration] A Systematic geographical considerations of the modern world (3) Transport, communications and tourism Guidance is given to enable students to acquire the following through activities to pursue and solve problems, with a focus on place and spatial interdependence effects. ア Knowledge of the following (7) Based on various phenomena related to transport and tourism related to transport and communication networks and logistics and movement of people, to understand the spatial regularities and trends of these phenomena, as well as the current situation, factors and efforts to solve problems related to transport, communication and tourism.
	(N/A)	[Geographical exploration] A Systematic geographical considerations of the modern world (4) Population, urban and rural Guidance is given to enable students to acquire the following through activities to pursue and solve problems, with a focus on place and spatial interdependence effects. ア Knowledge of the following (7) Based on various phenomena related to population, cities and villages, to understand the spatial regularities and trends of these phenomena, as well as the current situation, factors and efforts to solve population, settlement and urban problems.

(N/A)	<p>[Geographical exploration]</p> <p>B Geographical considerations of the contemporary world</p> <p>(1) Regional divisions of the modern world.</p> <p>Guidance is given to enable students to acquire the following through activities to pursue and solve problems, focusing on location, distribution and region.</p> <p>ア The following knowledge and skills</p> <p>(7) To understand how the world is divided into several regions, the concept of regions and the significance of regional divisions, based on various thematic maps and documents on the world and world regions.</p> <p>(1) To develop geographical skills in classifying regions of the world and world regions based on various thematic maps and documents.</p>
(N/A)	<p>[Geographical exploration]</p> <p>B Geographical considerations of the contemporary world</p> <p>(2) Regions of the modern world</p> <p>Guidance is given to enable students to acquire the following through activities to pursue and solve problems, with a focus on spatial interdependence and regions.</p> <p>a Knowledge of the following</p> <p>(7) Based on the various regions of the modern world, which are divided into several regions, to understand the regional characteristics and global issues found in the various regions.</p> <p>(1) To understand, among other things, how to examine geographically the links, structures and transformations of regions based on the various regions of the modern world, which are divided into several regions.</p>
(N/A)	<p>[General history]</p> <p>A The door to history</p> <p>(1) History and us.</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following.</p> <p>(7) To understand, on the basis of events in our daily lives and in familiar areas, that these events are connected to the history of Japan, the regions around Japan and the world.</p>
(N/A)	<p>[General history]</p> <p>A Doors to history</p> <p>(2) Historical characteristics and sources</p> <p>Guidance is given to enable students to acquire the following through activities to pursue and solve problems by using materials such as artefacts, documents and iconography, which are traces and records of the historical activities of people in various regions of Japan and the world.</p> <p>ア Acquire the following knowledge</p> <p>(7) To understand that history is described based on documents.</p>
(N/A)	<p>[Exploring Japanese history]</p> <p>A Japan and East Asia in primitive and ancient times</p> <p>(1) The Japanese archipelago at the dawn of time and its historical environment.</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the historical environment and cultural formation of the Japanese archipelago at the dawn of time, and the characteristics of primitive societies, based on the changes from Paleolithic to Jomon culture and the formation of Yayoi culture.</p>
(N/A)	<p>[Exploring Japanese history]</p> <p>A Japan and East Asia in primitive and ancient times</p> <p>(2) Historical sources and perspectives on primitive and ancient times</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the question of looking through the period expressed in (1), making use of various materials.</p> <p>ア Develop the following skills</p> <p>(7) To develop skills in collecting and reading information relating to history from sources, based on appropriate historical sources that show features of primitive and ancient times.</p>

(N/A)	<p>[Exploring Japanese history]</p> <p>A Japan and East Asia in primitive and ancient times</p> <p>(3) The development of ancient states and societies and the epochs (interpretation, explanation and discussion of history).</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the hypothesis expressed in (2), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the characteristics of primitive to ancient politics, society and culture based on the formation of the state and the Kofun culture, the process of establishing the <i>Ritsuryo</i> system and the formation of various cultures.</p> <p>(4) Understanding the restructuring and transformation of the <i>Ritsuryo</i> system and the transformation of ancient society and culture, based on the development of aristocratic politics, Heian-period culture, changes in local rule and the emergence of the samurai.</p>
(N/A)	<p>[Exploring Japanese history]</p> <p>B Japan and the world in the Middle Ages</p> <p>(1) The transition to the Middle Ages and the historical environment.</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the transition from ancient to medieval times, based on the transformation of aristocratic politics, the entry of warriors into politics and the transformation of land rule.</p>
(N/A)	<p>[Exploring Japanese history]</p> <p>B Japan and the world in the Middle Ages</p> <p>(2) Historical sources and medieval perspectives</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the question of looking through the period expressed in (1), making use of various materials.</p> <p>ア Develop the following skills</p> <p>(7) To develop skills in gathering and reading historically relevant information from sources, based on appropriate historical sources that show the characteristics of the Middle Ages.</p>
(N/A)	<p>[Exploring Japanese history]</p> <p>B Japan and the world in the Middle Ages</p> <p>(3) The development of the state and society in the Middle Ages and the epochs (interpretation, explanation and discussion of history).</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the hypothesis expressed in (2), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) Understand the expansion of the samurai regime and the characteristics of society and culture based on the establishment and development of the samurai regime, the development of industry, and the development of religion and culture.</p> <p>(4) Understanding the growth of local power, social transformation and cultural characteristics based on the transformation of the samurai regime, the development of Sino-Ming trade and the establishment of the Ryukyu Kingdom, the independence of villages and cities, and the formation and fusion of diverse cultures.</p>
(N/A)	<p>[Exploring Japanese history]</p> <p>C Japan and the world in the early modern period</p> <p>(1) The transition to the early modern period and the historical environment</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the transition from the medieval to the early modern period, based on the political and economic policies of the Weiho regime, trade and foreign relations.</p>
(N/A)	<p>[Exploring Japanese history]</p> <p>C Japan and the world in the early modern period</p> <p>(2) Historical sources and the outlook for the early modern period.</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the question of looking through the period expressed in (1), making use of various materials.</p> <p>ア Develop the following skills</p> <p>(7) To develop skills in gathering and reading information relating to history from sources, based on appropriate historical sources that show the characteristics of the early modern period.</p>

(N/A)	<p>[Exploring Japanese history]</p> <p>C Japan and the world in the early modern period</p> <p>(3) The development of the state and society in the early modern period and the epoch of the painting (interpretation, explanation and discussion of history)</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the hypothesis expressed in (2), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the establishment of the shogunate and clan system and the social and cultural characteristics of the early modern period, based on the formation of the ruling order and status system through laws and institutions, the control of trade and external relations, the improvement of technology and development, and the development of learning and culture.</p> <p>(1) To understand the transformation of the shogunate system, the characteristics of the life and culture of the common people in the early modern period and the formation of the foundations of modernization, based on the development of industry, famines and revolts, the political upheavals of the shogunate and the various domains, the development of learning and thought, and the life and culture of the common people.</p>
(N/A)	<p>[Exploring Japanese history]</p> <p>D Modern and contemporary regions, Japan and the world</p> <p>(2) Historical sources and modern perspectives</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on the question of looking through the period expressed in (1), making use of various materials.</p> <p>ア Develop the following skills</p> <p>(7) To develop skills in collecting and reading information relating to history from sources, based on appropriate historical sources that show the characteristics of the modern period.</p>
(N/A)	<p>[World History Inquiry]</p> <p>A Gaze into world history</p> <p>(1) Human history in terms of the global environment</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the relationship between human history and the global environment, based on the birth of mankind and its global spread and movement.</p>
(N/A)	<p>[World History Inquiry]</p> <p>A Gaze into world history</p> <p>(2) World history as seen through daily life</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(7) To understand that our daily lives are connected to the history of the world based on various phenomena around us, such as food, clothing, shelter, family, education and leisure.</p>
(N/A)	<p>[World History Inquiry]</p> <p>B Formation of the historical characteristics of the various regions</p> <p>(1) Questions about the historical characteristics of the various regions</p> <p>Guidance is given to enable students to acquire the following through activities in which they use materials related to livelihood, status and class, kingship, religion, culture and thought, and pursue and solve problems.</p> <p>ア Develop the following skills</p> <p>(7) Develop skills in reading and summarizing information from materials.</p>
(N/A)	<p>[World History Inquiry]</p> <p>B Formation of the historical characteristics of the various regions</p> <p>(2) Historical characteristics of ancient civilizations</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on questions from the perspectives considered in (1), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the historical characteristics of ancient civilizations, based on the Orient, Indus and Chinese civilizations.</p>

(N/A)	<p>[World History Inquiry]</p> <p>B Formation of the historical characteristics of the various regions</p> <p>(3) Historical characteristics of the various regions</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on questions from the perspectives considered in (1), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) To understand the historical characteristics of East Asia and Central Eurasia, based on the Qin and Han dynasties and nomadic states, and the Tang dynasty and its neighbors.</p> <p>(4) To understand the historical characteristics of South and South-East Asia, based on the establishment of Buddhism and Hinduism, and the states of South and South-East Asia.</p> <p>(7) To understand the historical characteristics of West Asia and the surrounding Mediterranean region, based on the establishment of Christianity and Islam and the formation of states based on them.</p>
(N/A)	<p>[World History Inquiry]</p> <p>C Interaction and restructuring of various regions</p> <p>(1) Questions of exchange and restructuring of various regions</p> <p>Guidance is given to enable students to acquire the following through activities in which they use materials related to the expansion of trade, the development of cities, changes in state systems, religion, science and technology, and the spread of culture and ideas, and to pursue and solve problems.</p> <p>ア Develop the following skills</p> <p>(7) Develop skills in reading and summarizing information from materials.</p>
(N/A)	<p>[World History Inquiry]</p> <p>C Interaction and restructuring of various regions</p> <p>(2) Eurasia and regions that are linked</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on questions from the perspectives considered in (1), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) Structural understanding of the spread of interactions between various regions across the seas and inland, based on trends in West Asian societies and the spread of Islam to Africa and Asia, European feudal society and its development, Song society and the expansion of the Mongol Empire.</p> <p>(4) A structural understanding of the development of trade and European expansion in various regions, based on the rise of trade in the Asian seas, the Ming Dynasty and Japan and Korea, and the activities of Spain and Portugal.</p>
(N/A)	<p>[World History Inquiry]</p> <p>C Interaction and restructuring of various regions</p> <p>(3) Restructuring of Asian regions and Europe</p> <p>Guidance is given so that the following items can be acquired through activities to pursue and solve problems based on questions from the perspectives considered in (1), making use of various materials.</p> <p>ア Knowledge of the following</p> <p>(7) A structural understanding of the characteristics of the Asian regions, based on developments in West and South Asian empires, the Qing and Japan/Korea, etc.</p> <p>(4) Structural understanding of the formation of sovereign state systems and the expansion of trade on a global scale, based on the Reformation and the struggle between European states, the development of the Atlantic triangular trade, the Scientific Revolution and the Enlightenment.</p>
(N/A)	<p>[World History Inquiry]</p> <p>D Combining and transforming various regions</p> <p>(1) Questioning the cohesion and transformation of various regions</p> <p>Guidance is given to enable students to acquire the following through activities in which they use materials related to the international movement of people, the spread of free trade, the development of mass media, the transformation of international norms, the development of science and technology, and the development of culture and thought, and to pursue and solve problems.</p> <p>ア The following knowledge and skills</p> <p>(7) Develop skills in reading and summarizing information from materials.</p>

	<p>(N/A)</p> <p>*Refer to the learning content of IV-B Engineer ethics, 'The role and significance of engineering and science and technology'.</p>	<p>[World History Inquiry]</p> <p>E Global world issues</p> <p>(3) Science and technology and knowledge-based society</p> <p>Guidance is given to enable students to acquire the following through activities in which they use various materials and pursue and solve problems.</p> <p>ア Knowledge of the following</p> <p>(ア) Understanding the development and challenges of a knowledge-based society based on science and technology, including the use of nuclear energy and space exploration, medical technology, biotechnology and bioethics, artificial intelligence and the changing nature of work, and the development of information and communication technology and the spread of knowledge.</p>
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IV-C Fundamentals of Engineering (Information literacy)

	Model Core Curriculum	Course of Study Guideline for Upper Secondary Schools
Objective	<p>[Learning achievement goals].</p> <p>The goal is for students to be able to handle information correctly in consideration of security, utilize information technology and create programs by considering basic algorithms for solving problems, regardless of their field of specialization. The aim is also to acquire the basic knowledge and skills to be able to use mathematics, data science and AI in daily life and work, and to be able to explain and utilize this knowledge and skills according to their own specialization.</p> <p>(1) use knowledge of basic hardware, software and networks to collect, process and disseminate information</p> <p>(2) Be able to devise and describe an algorithm for a specific task.</p> <p>(3) Be able to handle information correctly with due regard to information security.</p> <p>(4) Explain and use their knowledge and skills in information technology according to their field of expertise.</p> <p>(5) Develop a predisposition to use mathematics, data science and AI.</p>	<p>[Information I]</p> <p>Through learning activities in which students use scientific views and ideas about information, and discover and solve problems by using information technology, we aim to develop the following qualities and abilities to use information and information technology appropriately and effectively to discover and solve problems, and to participate proactively in the information society.</p> <p>(1) Ensure that students deepen their understanding and acquire skills in the realization of effective communication and the use of computers and data, and deepen their understanding of the relationship between the information society and people.</p> <p>(2) Cultivate the ability to perceive various phenomena as information and its connections, and to use information and information technology appropriately and effectively in order to discover and solve problems.</p> <p>(3) Develop an attitude of proactive participation in the information society, as well as the appropriate use of information and information technology.</p> <p>[Information II]</p> <p>Through learning activities in which students use scientific views and thinking about information and utilize information technology to discover and solve problems, the following qualities and abilities should be developed in order to make appropriate, effective and creative use of information and information technology to discover and solve problems, to participate proactively in the information society and to contribute to its development Aim.</p> <p>(1) Ensure that students deepen their understanding and acquire skills in the realization of diverse communication, the use of information systems and diverse data, and deepen their understanding of the development of information technology and changes in society.</p> <p>(2) Cultivate the ability to perceive various phenomena as information and its connections, and to use information and information technology appropriately, effectively and creatively to discover and solve problems.</p> <p>(3) Develop an attitude of making appropriate use of information and information technology, aiming to create new value, participating proactively in the information society and contributing to its development.</p>

Learning Content	Model Core Curriculum and Learning Content Achievement Goals	Course of Study Guideline for Upper Secondary Schools
Fundamentals of Information Technology	<ul style="list-style-type: none"> Understand and explain the development and challenges of the Digitalization of society. Be able to describe typical information systems and their modes of use. Understand the structure of a computer and the role of the operating system (OS), and be able to perform basic handling. Explain the difference between analogue and digital information and how data (numerical, textual, etc.) is represented in computers. Be able to collect and obtain information appropriately. Be able to explain the significance and overview of databases. 	<p>[Information I (1) Problem solving in the information society]</p> <p>Focusing on methods of finding and solving problems using information and information technology, the course guides students to acquire the following through activities to find and solve problems in the information society.</p> <p>ア(ア) To learn how to use information and information technology to find and solve problems, based on the characteristics of information and media.</p> <p>ア(ウ) Understanding the role and impact of information technology on people and society.</p> <p>イ(ア) Consider how to use information and information technology appropriately and effectively to identify and solve problems, depending on the purpose and situation.</p> <p>イ(ウ) Consideration of the appropriate and effective use of information and information technology and the construction of a desirable information society.</p> <p>[Information I (2) Communication and information design]</p> <p>Guidance is given to enable students to acquire the following through activities that focus on media, means of communication and information design, and convey information in a way that is easy to understand for recipients according to their purpose and situation.</p> <p>ア(ア) A scientific understanding of the characteristics of the media and their means of communication, taking into account their evolution.</p> <p>ア(イ) Understanding the role that information design plays for people and society.</p> <p>ア(ウ) To acquire the skills to understand and express the concept and methods of information design for effective communication.</p> <p>[Information I (3) Computers and programming]</p> <p>Focusing on the mechanisms by which information is processed by computers, the course provides guidance to enable students to acquire the following items through activities to discover and solve problems by programming and simulation.</p> <p>ア(ア) Understand the structure and characteristics of computers and external devices, and the limitations related to the internal representation and computation of information on computers.</p> <p>イ(ア) Consider the relationship between the characteristics of the information handled by computers and the capabilities of computers.</p> <p>[Information I (4) Information and communication networks and use of data]</p> <p>Guidance is given to enable students to acquire the following through activities that focus on data distributed via information and communication networks, utilize the services provided by information and communication networks and information systems, and discover and solve problems.</p> <p>ア(イ) Understanding of the ways in which data is stored, managed and provided, and the mechanisms and characteristics of the services provided by information systems via information and communication networks.</p> <p>ア(ウ) To understand and acquire skills in how to represent and store data and how to collect, organize and analyze data.</p>

		<p>イ(イ) Consider the effective use of the services provided by information systems. イ(ウ) Appropriate methods of collecting, organizing, analyzing and expressing data and results are selected, implemented, evaluated and improved.</p> <p>[Information II (1) Progress of the information society and information technology] Guidance is given to enable students to acquire the following through activities that focus on the impact of the development of information technology on people and society, take a historical view of the relationship between the development of the information society and information technology, and look ahead to information technology in the future. ア(ア) To understand the development of the information society, based on the history of the development of information technology. ア(ウ) Understanding the impact of the development of information technology on people's intellectual activities. イ(ア) Consider the future of information technology and the information society in light of developments in information technology and the information society. イ(ウ) Consider the significance of the creation of information systems and the use of data in a society where people's intellectual activities are changing.</p> <p>[Information II(3) Information and data science] Focusing on the usefulness of utilizing diverse and large amounts of data, the course teaches students to analyze data using data science methods and to acquire the following through activities in which the results are read and interpreted. ア(ア) To understand the existence of diverse and large amounts of data, the usefulness of data utilization and the role data science plays in society, and to understand and acquire skills in the collection, organization and shaping of appropriate data according to purpose. イ(ア) Collecting, organizing and formatting appropriate data for the purpose.</p> <p>[Information II (4) Information systems and programming] Guidance is given to enable students to acquire the following through activities in which they focus on the nature of information systems, their impact on social life, the flow of information and processing mechanisms, and the collaborative development of information systems. ア(ア) Understand the flow of information and processing mechanisms in information systems, as well as methods and technologies to ensure information security. ア(イ) Understanding of software development processes and project management, including how to describe the design of information systems, design, implementation, testing and operation. イ(ア) Consideration of information systems and the services provided by them, the way they work and the role they play in society and their impact.</p>
Programming and Algorithms	<ul style="list-style-type: none"> • Be able to create basic programs. • Can perform mathematical operations using a computer. • Understand basic algorithms and be able to describe them using any programming language. • Explain that for the same problem there can be more than one algorithm that can solve it. 	<p>[Information I (3) Computers and programming] ア(イ) To understand and acquire skills in the means of expressing algorithms and in the use of computers and information and communication networks through programming. ア(ウ) Understanding how to model events in society, nature and other areas, and how to evaluate and improve models through simulation. イ(イ) Thinking of algorithms that meet the purpose and expressing them in an appropriate way, utilizing computers and information and communication networks through programming, as well as evaluating and improving the process. イ(ウ) Appropriate modelling and simulation for the purpose and appropriate solutions to the problem based on the results.</p> <p>[Information II (4) Information systems and programming] ア(ア) Understand the flow of information and processing mechanisms in information systems, as well as methods and technologies to ensure information security. ア(イ) Understanding of software development processes and project management, including how to describe the design of information systems, design, implementation, testing and operation. ア(ウ) To understand and acquire skills in how to produce the programs that make up information systems. イ(ア) Consideration of information systems and the services provided by them, the way they work and the role they play in society and their impact. イ(イ) The information system should be designed in consideration of development efficiency and operational convenience, for example, by dividing the information system into several functional units for production and integration. イ(ウ) Producing the programs that make up the information system, and evaluating and improving the process.</p>

<p>Media</p>	<ul style="list-style-type: none"> • Be able to explain how to examine the truth or falsity of information on the basis of evidence. • Select appropriate means of representation and communication of information, and send and receive information. 	<p>[Information I (2) Communication and information design]</p> <p>ア(ア) A scientific understanding of the characteristics of the media and their means of communication, taking into account their evolution.</p> <p>ア(イ) Understanding the role that information design plays for people and society.</p> <p>ア(ウ) To acquire the skills to understand and express the concept and methods of information design for effective communication.</p> <p>イ(ア) To take a scientific view of the relationship between media and means of communication and to select them appropriately according to their purpose and situation.</p> <p>イ(イ) Clarify the purpose of communication and consider appropriate and effective information design.</p> <p>イ(ウ) To express, evaluate and improve based on information design concepts and methods for effective communication.</p> <p>[Information I (4) Information and communication networks and use of data]</p> <p>ア(ウ) To understand and acquire skills in how to represent and store data and how to collect, organize and analyze data.</p> <p>イ(ウ) Appropriate methods of collecting, organizing, analyzing and expressing data and results are selected, implemented, evaluated and improved.</p> <p>Information II (1) Progress of the information society and information technology]</p> <p>ア(イ) Understanding the diversification of communication due to the development of information technology.</p> <p>イ(イ) Consider the significance of the creation and use of content in a society where communication is becoming increasingly diverse.</p> <p>[Information II (2) Communication and content]</p> <p>Guidance is given to enable students to acquire the following through activities in which they focus on the characteristics of various forms of communication and media, consider information design in accordance with the purpose and situation, collaboratively produce content combining text, sound, still and moving images, etc., and transmit it by various means.</p> <p>ア(ア) Understanding of the relationship between various forms of communication and the characteristics of the media.</p> <p>ア(イ) Develop skills in producing content that combines text, sound, still and moving images.</p> <p>ア(ウ) Understanding how to disseminate content to society in an appropriate and effective manner through various means.</p> <p>イ(ア) To think about forms of communication and select and combine text, sound, still and moving images, depending on the purpose and situation.</p> <p>イ(イ) Produce, evaluate and improve content with due regard to information design.</p> <p>イ(ウ) Considering the effects and impact of transmitting content to society, evaluating and improving the means of transmission and content.</p>
<p>Network</p>	<ul style="list-style-type: none"> • Knowledge of the structure, composition and components of information and communication networks, the role of protocols and technologies, and be able to explain the role of information and communication networks in society. 	<p>[Information I (4) Information and communication networks and use of data]</p> <p>ア(ア) Understanding of the structure and components of information and communication networks, the role of protocols and methods and technologies to ensure information security.</p> <p>ア(イ) Understanding of the ways in which data is stored, managed and provided, and the mechanisms and characteristics of the services provided by information systems via information and communication networks.</p> <p>イ(ア) To select the necessary components in information and communication networks according to the purpose and situation, and to consider how to ensure information security.</p> <p>イ(イ) Consider the effective use of the services provided by information systems.</p>
<p>Information Security</p>	<ul style="list-style-type: none"> • Understand the need for information security and be able to explain countermeasures. • Be able to explain the fundamentals of cryptography supporting information security. • Be able to explain how to access information based on information security. • Explain the laws, regulations and rules related to information and communications and the need for such laws, regulations and rules. • Be able to explain the importance of manners and morals in living in an information society. • Be able to explain the concept and methods for operating information security. 	<p>[Information I (1) Problem solving in the information society]</p> <p>ア(イ) Understanding of information laws and systems, the importance of information security, individual responsibility and information morality in the information society.</p> <p>イ(イ) The significance of laws, regulations, systems and manners related to information, the roles and responsibilities of individuals in the information society, and information morality, with a scientific understanding of their background.</p> <p>[Information I (4) Information and communication networks and use of data]</p> <p>ア(ア) Understanding of the structure and components of information and communication networks, the role of protocols and methods and technologies to ensure information security.</p> <p>イ(ア) To select the necessary components in information and communication networks according to the purpose and situation, and to consider how to ensure information security.</p> <p>[Information II (4) Information systems and programming]</p> <p>ア(ア) Understand the flow of information and processing mechanisms in information systems, as well as methods and technologies to ensure information security.</p> <p>イ(ア) Consideration of information systems and the services provided by them, the way they work and the role they play in society and their impact.</p>

Data Science and AI	<ul style="list-style-type: none"> • Provide an overview of data science and AI technologies. • Be able to explain, based on application examples, that data science and AI technologies are useful tools for solving problems in society and daily life and create value when combined with knowledge from various specialist areas. • Understand the morals and ethics required when using data science and AI technologies and be able to explain what is required to protect data. • Use basic skills (data acquisition, visualization and analysis) required for the use of data science and AI technologies. • Be able to explain the relationship between data science and AI technologies and their use in society and daily life in their own field of expertise. 	<p>[Information II(3) Information and data science]</p> <p>ア(ア) To understand the existence of diverse and large amounts of data, the usefulness of data utilization and the role data science plays in society, and to understand and acquire skills in the collection, organization and shaping of appropriate data according to purpose.</p> <p>ア(イ) To understand and acquire skills in how to model data-based phenomena and process data to interpret and represent them.</p> <p>ア(ウ) To understand and acquire skills in the significance and methods of evaluating models based on the results of data processing.</p> <p>イ(ア) Collecting, organizing and formatting appropriate data for the purpose.</p> <p>イ(イ) Appropriate modelling, processing, interpretation and representation in order to predict future phenomena or to reveal links between multiple phenomena.</p> <p>イ(ウ) Evaluating the results of models and data processing and improving modelling, processing, interpretation and representation methods.</p>
(N/A)		<p>[Information II (5) Exploration of problem finding and solving using information and information technology]</p> <p>To enhance the qualities and abilities to use information and information technology appropriately and effectively, aiming to create new value through activities to discover and solve problems using information and information technology, making comprehensive use of the qualities and abilities acquired in 'Information I' and 'Information II'.</p>

Chapter 2: MCC achievement goals and the measurement and evaluation of learning outcomes

As mentioned in Part 1, each KOSEN defines the desired profile of human capital, establishes a Diploma Policy that embodies this vision, and designs its curriculum accordingly. After identifying and implementing effective educational methods and learning opportunities to achieve the Diploma Policy, it is essential to visualize and monitor learning outcomes (including educational impact) to drive continuous improvement. For the quality assurance system based on the Diploma Policy to function effectively, each KOSEN must develop an assessment plan and evaluate learning outcomes in individual courses using appropriate standards and methods.

KOSEN education is characterized not only by the acquisition of academic knowledge and theories but also by the simultaneous development of practical application skills. In addition to lectures and practical exercises, KOSEN offers a comprehensive range of laboratory experiments and hands-on practices to help students apply specialized knowledge and theory in real-world situations. The MCC Achievement Goals establish achievement goals for these abilities in “VI. Engineering Experiments and Practical Skills by Field”. Both students, as learners, and educators must be able to assess whether these achievement goals have been met and whether the necessary skills have been acquired through learning activities such as laboratory experiments and hands-on practices.

The MCC achievement goals also include “VII. General Skills”, “VIII. Attitude and Mindset” and “IX. Creativity and Design Competencies” as part of the MCC (model). Since these qualities and abilities are considered different from the acquisition of knowledge, traditional methods of measuring and assessing learning outcomes, such as written examinations, may not be suitable. However, for effective learning (and educational) activities, it is essential that both educators and learners share a common understanding of the outcomes they aim to achieve. It is also important to visualize and assess learning outcomes using shared indicators and methods in advance.

In releasing the MCC 2023, NIT developed a model for fostering and evaluating “VI. Field-specific Engineering s and Practical Training Skills” and cross-disciplinary skills, including “VII. General Skills”, “VIII. Attitude and Mindset (Human Skills)”, and “IX. Integrated Learning Experience and Creative Thinking Skills”, and shared it within all KOSENs. These models are also considered valuable for the MCC 2023. However, the “Cross-Disciplinary Competencies” from the 2009 MCC have been reconstructed into the MCC (model) for this revision, and reference materials have been prepared as the “MCC (model) Explanation”.

Detailed documents will be provided separately. The following outlines the approach to the development and evaluation of “VI. Field-Specific Engineering Experiments and Practical Training Skills”, as well as the MCC (model), including “VII General “Skills”, “VIII. Attitude and Mindset” and “IX. Creativity and Design Competencies”.

2-1 Development and evaluation of skills in engineering field-specific laboratory experiments and hands-on practices

When designing the curriculum, skills to conduct engineering laboratory experiments and hands-on practices in each subject area (hereinafter referred to as “Laboratory Skills”) must be clearly indicated within the curriculum, ensuring alignment with the Diploma Policy and specifying the sequence in which these skills are acquired (e.g., using a curriculum map or curriculum tree). Additionally, it is necessary to establish measurement and evaluation methods to assess whether the Diploma Policy has been achieved.

In the individual subjects (laboratory experiments and hands-on practice subjects) that contribute to each KOSEN’s Diploma Policy, the following factors are considered important for the development and assessment of Experimental Skills.

- Clearly outline the skills that can be acquired through laboratory experiments and hands-on practices, organized by theme.
- Specify the teaching content and methods necessary for skill acquisition.
- Assess learning outcomes (skills gained through learning activities).
- Provide feedback to students on the results of learning outcome assessments.

The “*Handbook of Model Laboratory Experiments and its Evaluation Metrics by Subject Area based on Level of Achievement*” (hereinafter referred to as the “Handbook of Model Laboratory Experiments”) has been developed as a reference document for planning, implementing and assessing the learning outcomes of laboratory experiments and hands-on practice subjects.

The *Handbook of Model Laboratory Experiments* provides the following materials (“Laboratory Skill Set”) for laboratory experiments and hands-on practices up to MCC achievement levels 1 to 3:

- Laboratory Handbook: A reference material for lesson design covering levels 1 to 3 for individual topics in each subject area.
- Laboratory Skill Set Assessment Sheet: A rubric for measuring and assessing learning outcomes corresponding to the Laboratory Handbook.

The “Laboratory Skill Set” serves as a model of experimental content and assessment methods. When applied, it should be adapted to the specific conditions of each KOSEN, including available equipment for laboratory experiment and hands-on practices. The corresponding methods are also provided as reference documents, covering the following fields:

- Mechanical field
- Materials field
- Electrical and Electronic field
- Informatics field
- Chemistry and Biological field
- Civil Engineering field
- Architectural field

This Handbook of Model Laboratory Experiments was developed based on the MCC 2009. Although the achievement goals have been revised in the MCC 2023, it continues to serve as a valid reference model, as it generally aligns with updated objectives.

Location of Laboratory Skill Set Model

The Handbook of Laboratory Skill Set Model is available at the following website (accessible only within the National KOSEN):

<https://kosenjp.sharepoint.com/sites/88pj-Test/SitePages/%E3%83%9B%E3%83%BC%E3%83%A0.aspx>

2-2 Development and evaluation of MCC (model)

Similar to Laboratory Skill Set Model, the MCC (model) must clearly indicate how individual subjects align with the Diploma Policy within the curriculum designed to achieve each KOSEN’s Diploma Policy. It is also essential to outline how these subjects contribute to achieving the policy through a structured sequence of learning, along with a plan to monitor and assess the achievement of these policies. Furthermore, in developing and evaluating achievement goals, including the MCC (model) in each subject, specific outcome indicators should be established and shared with learners. This helps support and promote learning activities while enabling the measurement and assessment of learning

outcomes.

However, the achievement goals outlined in the MCC (model) : Fundamental Qualities and Competencies (“VII. General Skills” and “VIII. Attitude and Mindset”) are structured and defined from various contexts and perspectives. Examples include “*Basic Skills for Working Adults*”, “*Bachelor-Level Skills*” and “*Skills Necessary for a Smooth Transition to Social and Professional Life*”. Therefore, when organizing them as MCC achievement goals, it is essential to specify the perspective from which they were structured. Similarly, it is important to present the perspective from which the MCC (model) : Creativity and Design Competencies Skills was organized when outlining the achievement goals.

There is also a need to provide reference guidelines for measuring and understanding learning outcomes related to these achievement goals, as there are various methods and approaches available.

Therefore, the following reference materials are provided for the development and evaluation of MCC (model) included in the MCC 2023 achievement goals, as well as the MCC 2009 “Cross-Disciplinary Competencies”.

- MCC (model) Description
- MCC (model) Standard Rubric
- MCC (model) Quick Test

The “MCC (model) Description” outlines the learning content encompassed in the MCC (model) Achievement Goals, specifying the perspectives from which they are organized. It also provides an explanation of the “MCC (model) Standard Rubric”. “The MCC (model) Standard Rubric” categorizes the level of achievement into three stages within the MCC (model) Achievement Goals and presents an evaluation criteria table (rubric) with examples of the behavioral characteristics with each stage. The “MCC (model) Quick Test” consists of a collection of self-assessment questions designed to measure and assess the achievement status based on the “MCC (model) Standard Rubric”.

Similar to the Laboratory Skill Set Model, these materials are not meant to restrict the educational content of each KOSEN; rather, they serve as reference material. They should be modified as needed to align with the Diploma Policy and subject objectives or used as a guideline for consideration by each KOSEN or teachers in charge. Further details are provided in a separate document.

Location of MCC (model) reference material

The MCC (model) reference materials are available at the following website (accessible only within the National KOSEN):

<https://kosenjp.sharepoint.com/sites/88pj-Test/SitePages/%E3%83%9B%E3%83%BC%E3%83%A0.aspx>

Review process

June 2021	Enquiry into the opinions of each KOSEN on issues related to the revision of the Model Core Curriculum.
September 2021	First meeting of the WG (Group A) on the MCC Revision Direction
October 2021	MCC revision study WG plenary kick-off meeting
December 2021	Presentation of a comparison table between the current MCC and the Courses of Study for Senior High Schools (notified in 2008).
January 2022	Additional survey of the actual situation in each KOSEN: survey of the actual situation in each KOSEN for consideration.
May 2022	Kick-off meeting of the working group 'Cross-sectoral competencies'.
June 2022	Notification to each KOSEN of the first draft of the MCC revision (draft revision of the achievement goals for “common basic competencies in the field” and “specialized competencies in the field”).
July 2022	Confirmation of opinions from each KOSEN on the first draft of the revised MCC. <ul style="list-style-type: none">• Opinions on the draft revised achievement goals for each field, opinions on matters to be taken into consideration for multidisciplinary departments/courses, opinions on the application of MCC to the curricula of each KOSEN, etc.
October 2022	Notification of the second draft of the MCC revision to the various KOSEN: the following details were compiled and notified as the second draft of the revision. <ul style="list-style-type: none">• Curriculum management and its relationship with MCC.• Overall structure of the revised MCC• Quality assurance approach to KOSEN education based on MCC.• Draft revised achievement goals ('common basic competencies for disciplines', 'field-specific professional competencies' and 'cross-disciplinary competencies')
October 2022	Briefing sessions on the second draft of the revised MCC were held and opinions from the various KOSEN were confirmed in a questionnaire. « Main opinion » <ul style="list-style-type: none">• Noted difficulties in maintaining attainment standards in the context of a diverse student population, curriculum management issues, etc.• MCC (model) (current MCC 'cross-disciplinary competencies'), and issues related to the development and assessment of these competencies.• Opinions on the proposed revision of the achievement goals, etc.
December 2022	Conducting reviews by external experts.
January 2023	Joint meetings held with external experts « Details of the study with input and advice from external experts ». <ul style="list-style-type: none">• The role and significance of the model core curriculum is clearly presented, and the philosophy and features of KOSEN education are presented.• It is necessary to clearly indicate the position of KOSEN education within the international framework of engineering education.• Organize the name 'Model Core Curriculum' and the position of the Bloom's Taxonomy so that there is no conflict with the general understanding.• Consideration will be given to sharing good practices in curriculum organization and classroom practice.• Developing creativity is difficult with thinking skills alone. The specific types of learning activities and teaching methods to be implemented will be discussed.
February 2023	Revised third draft prepared. A revised draft 3 (final draft) was considered based on the opinions from the various KOSEN on the revised draft 2 and the opinions of external experts. WG confirms revised draft 3, including a complete review of the description of the overall design of the MCC, final draft revised achievement goals for each area and a draft MCC Plus.
Mar 2023	Notification of the final draft of the MCC revision to the various KOSEN.
April 2023	Revised MCC published.

Member of the working committee for the revision of the Model Core Curriculum
(September 2021 - March 2023)

○ **National Institute of Technology (NIT) headquarters secretariat**

Nobunaga Doi	Director in charge (Principal, Nagano KOSEN)	until March 2022
Tomohiko Otsuka	Director in charge (Principal, Kushiro KOSEN)	from April 2022
Satoshi Tsurumi	Education General Counsellor	until March 2022
Sadayuki Shimoda	Education General Counsellor	from April 2022
Yasuhiro Nishii	Councilor of education	
Yukito Kobayashi	Councilor of education	from April 2022
Junya Kobayashi	Education Counsellor (concurrent appointment, Hakodate KOSEN)	Liaison officer
Takuma Kishi	Education Counsellor (concurrent appointment, Hiroshima Merchant Marine College)	Liaison officer
Toru Takahashi	Education Counsellor (concurrent appointment, Oita KOSEN)	Liaison officer
Mari Morimoto	Education Counsellor (concurrent appointment, Akita KOSEN)	Liaison officer
Shota Fukushima	Head of Education and Planning Section	
Yu Amano	Education and Planning Section (formerly Research Section)	Until March 2022.
Nanae Mori	Education and planning section	until September 2022
Osaki, Yugawa.	Education and planning section	from April 2022
Yoshida, Kazutaka	Education and planning section	from October 2022
Yoko Saito	Education and planning section	

○ **Direction review committee members (Group A)**

Tomohiko Otsuka	Tokyo KOSEN	Head of WG (until March 2022)
Yukito Kobayashi	Kumamoto KOSEN	Head of WG (Headquarters Secretariat since April 2022)
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Kazuto Tennai	Tokuyama KOSEN	
Naoki Hamaguchi	Nagano KOSEN	from April 2022
Cross-disciplinary competence working group	Yukito Kobayashi Hiroyasu Hamada Tsubasa Ikeda	Head office Sasebo KOSEN Kumamoto KOSEN
		from April 2022 from April 2022

○ **Subject field review committee members (Group B)**

Mathematics	Toshitoshi Imai Akira Yamada Higuchi, Ikuo	Sendai KOSEN Nagaoka KOSEN Oita KOSEN	Chief examiner
Physics	Kenichi Fukuchi Yasuhiko Niino Ken Sakai	Kisarazu KOSEN Nara KOSEN Ariake KOSEN	Chief examiner
Chemistry	Chihiro Hashimoto Taku Ohtani Ayumi Taketomo	Niihama KOSEN Anan KOSEN Okinawa KOSEN	Chief examiner
Life Sciences	Sawada, Keiki	Toba National College of Maritime Technology	Chief examiner
Earth Sciences	Junya Kobayashi Takeshi Yamaguchi	Hakodate KOSEN Matsue KOSEN	
National language	Tetsushi Tateshita	Kushiro KOSEN	Chief examiner

(Japanese)	Ogeda dusky sparrowhawk (Accipiter ogeda, Ogeda gentilis) Hatamura, Manabu	Maizuru KOSEN Ube KOSEN	
English (language)	Makoto Omori	Kure KOSEN	Chief examiner
Community	Toshifumi Azuma Hitoshi Yokomizo Eiji Nagai Tomohide Kashiwagura Taiki Machi	Tomakomai KOSEN Tokyo KOSEN Akita KOSEN Tokuyama KOSEN	Chief examiner until March 2022
Fundamentals of Engineering	Shinya Takehara Katsuhisa Oba Toru Takahashi Yukito Kobayashi	Kagoshima KOSEN Nara KOSEN Numazu KOSEN Oita KOSEN Kumamoto KOSEN	from April 2022 Chief examiner
Mechanical fields	Jun Nakayama Hiroyuki Onuma Hideki Takeuchi	Ichinoseki KOSEN Ibaraki KOSEN Kochi KOSEN	Chief examiner
Field of materials	Kuroda, Daisuke Hideyuki Hirasawa Tomokazu Seicho	Suzuka KOSEN Niihama KOSEN Kurume KOSEN	Chief examiner
Electrical and electronic fields	Kasuga, Takashi Koichi Koizumi Toshiyuki Masamoto	Nagano KOSEN Fukushima KOSEN Kagawa KOSEN	Chief examiner
Informatics field	Kazuhiko Fujiwara Iijima, Yosuke Hara, T.	Sendai KOSEN Oyama KOSEN Kagoshima KOSEN	Chief examiner
Chemistry and biological fields	Kazuo Ogawa Ryosuke Sakaii Yasushi Suzuki	Yonago KOSEN Asahikawa KOSEN Ibaraki KOSEN	Chief examiner until March 2022.
Construction sector	Hayase, Nobuki Haruhiko Kakuno Makoto Kasai Masashige TAYASU	Niihama KOSEN Gifu KOSEN Akita KOSEN Fukui KOSEN	from April 2022 Chief examiner
Architectural fields	Koji Yamada Katsuki Maehara Tsutomu Iwashita	Toyota KOSEN Yonago KOSEN Ariake KOSEN	Chief examiner
Merchant marine (navigation) sector	Yoshiaki Kawamura Kubota, T. Akira Nimura	Hiroshima Merchant Marine KOSEN Oshima Merchant Marine KOSEN Yuge Merchant Marine KOSEN	Chief examiner
Merchant marine (engine) sector	Sadahiro Akiba Kyoda, Yoshiaki Takeshi Watanabe	Yuge Merchant Marine KOSEN Toyama KOSEN Oshima Merchant Marine KOSEN	Chief examiner

○ External collaborators

Emiko Isogai	Assistant Manager, Human Capital and Organizational Development Section 2, Human Capital and Organizational Development Office, Human Capital Department, Denso Corporation
Masashiro Ohno	Japan Accreditation Board for Engineering Education (JABEE) Secretariat
Tetsuya Kajisa	President, Hyogo University of Education
Kikuo Kishimoto	Vice-President, Japan Accreditation Board for Engineering Education (JABEE)
Hiroaki Sato	Associate Professor, Department of Education and Learning Support, Osaka University, Japan
Keiji Terasawa	Executive Director and Secretary General, Institution of Professional Engineers of Japan
Eiji Tobihara	Specially Appointed Professor, Research and Development Department, National Institution for Academic Degrees and University Reform
Satoko Fukahori	Professor, Future Talent Development Institute, Kyushu University
Shinji Fukushima	Director, Enrolment Management Institute, Taisho University / Professor, Faculty of Regional Development Studies
Tsuyoshi Moriya	General Manager, Advanced Data Planning Department, Corporate Innovation Division, Tokyo Electron Limited
Association of CTOs (cooperated as a legal entity).	

○ MCC revision review WG

Direction Review Working Group (Group A)

September 2021	First meeting (kick-off) 2nd meeting. 3rd Meeting.
October 2021.	4th Meeting. Fifth meeting.
November 2021.	6th Meeting. 7th Meeting. 8th Meeting.
December 2021	9th Meeting. Tenth meeting.
January 2022	Eleventh meeting. 12th Meeting.
Feb 2022.	13th Meeting. 14th Meeting. 15th meeting.
Mar 2022	16th Meeting. Seventeenth meeting.
April 2022	18th Conference (1st Conference in 2022) 19th Conference (2nd Conference in 2022)
May 2022	20th Conference (3rd Conference in 2022) 21st Conference (4th Conference in 2022)
June 2022	22nd Meeting (5th Meeting in 2022) 23rd Conference (6th Conference in 2022) 24th Conference (7th Conference in 2022)
July 2022	25th Meeting (8th Meeting in 2022) 26th Meeting (9th Meeting in 2022) 27th Conference (10th Conference in 2022)
August 2022	28th Conference (11th Conference in 2022) 29th Conference (12th Conference in 2022)
September 2022	30th Conference (13th Conference in 2022) 31st Conference (14th Conference in 2022) 32nd Conference (15th Conference in 2022)
October 2022	33rd Conference (16th Conference in 2022) 34th Conference (17th Conference in 2022)
Nov 2022.	35th Conference (18th Conference in 2022) 36th Conference (19th Conference in 2022)
December 2022	37th Conference (20th Conference in 2022)

January 2023	38th Conference (21st Conference in 2022) 39th Conference (22nd Conference in 2022) 40th Meeting (23rd Meeting in 2022)
February 2023	41st Conference (24th Conference in 2022) 42nd Conference (25th Conference in 2022)

Cross-disciplinary competence working group (Group B)

May 2022	First meeting (kick-off)
June 2022	2nd meeting. 3rd Meeting. 4th Meeting. Fifth meeting.
July 2022	6th Meeting. 7th Meeting.
August 2022	8th Meeting.
October 2022	9th Meeting. Tenth meeting.
Nov 2022.	Eleventh meeting.
December 2022	12th Meeting.
January 2023	13th Meeting.

Field-specific WG

Mathematics

October 2021	First meeting (kick-off)
Nov 2021.	2nd meeting.
December 2021	3rd Meeting.
Mar 2022	4th Meeting. Fifth meeting.
May 2022	6th Conference (1st Conference in 2022) 7th Conference (2nd Conference in 2022)
August 2022	8th Meeting (3rd Meeting in 2022) 9th Conference (4th Conference in 2022)
September 2022	Joint meetings with basic engineering disciplines Joint meetings with the merchant marine sector Tenth meeting (fifth meeting in 2022) 11th Conference (6th Conference in 2022)

Physics

October 2021	First meeting (kick-off)
January 2022	2nd meeting.
February 2022	3rd Meeting.
May 2022	4th Meeting.
August 2022	Fifth meeting.
February 2022	Chat deliberations (1st session). Chat deliberations (2nd session).
Mar 2022	Chat deliberations (3rd). Chat deliberations (4th). Chat deliberations (5th).
July 2022	Chat deliberations (6th session).
August 2022	Chat deliberations (7th).
September 2022	Team submission deliberations (1st session)
October 2022	Chat deliberations (8th session).
Nov 2022.	Chat deliberations (9th).

Chemistry

October 2021	1st Meeting.
Nov 2021.	2nd meeting.
	3rd Meeting.
December 2021	4th Meeting.
	Fifth meeting.
	6th Meeting.
January 2022	7th Meeting.
February 2022	8th Meeting.
	9th Meeting.
Mar 2022	Tenth meeting.
	Eleventh meeting.
May 2022	12th Meeting.
	13th Meeting.
August 2022	14th Meeting.
September 2022	15th meeting.

Life Sciences Earth Sciences

Nov 2021.	First meeting (kick-off)
	2nd meeting.
December 2021	3rd Meeting.
February 2022	4th Meeting.
April 2022	Fifth meeting (first meeting in 2022)
	6th Conference Teams deliberations.
June 2022	7th Conference (2nd Conference in 2022)
August 2022	8th Meeting (3rd Meeting in 2022)
December 2022	9th Meeting Teams deliberations.
	Tenth Meeting Teams Deliberations.

National language (Japanese)

Nov 2021.	First conference kick-off
	2nd meeting.
December 2021	3rd Meeting.
	4th Meeting.
January 2022	Fifth meeting.
February 2022	6th Meeting.
	7th Meeting.
Mar 2022	8th Meeting.
April 2022	9th Conference (1st Conference in 2022)
	Tenth meeting (2nd meeting in 2022)
May 2022	11th Conference (3rd Conference in 2022)
	12th Conference (4th Conference in 2022)
August 2022	13th Conference (5th Conference in 2022)
	14th Conference (6th Conference in 2022)

English (Language)

October 2021	First meeting (kick-off)
Nov 2021.	2nd meeting.
Dec 2021.	3rd Meeting.
February 2022	4th Meeting.
Mar 2022	Fifth meeting.
May 2022	6th Conference (1st Conference in 2022)
August 2022	7th Conference (2nd Conference in 2022)
January 2023	8th Meeting (3rd Meeting in 2022)

Social Study

October 2021	First meeting (kick-off)
Nov 2021.	2nd meeting. 3rd Meeting. 4th Meeting.
December 2021	Fifth meeting. 6th Meeting.
January 2022	7th Meeting. 8th Meeting.
February 2022	9th Meeting. Tenth meeting.
Mar 2022	Eleventh meeting. 12th Meeting.
May 2022	13th Conference (1st Conference in 2022) 14th Conference (2nd Conference in 2022) 15th Conference (3rd Conference in 2022)
June 2022	16th Conference (4th Conference in 2022)
August 2022	17th Conference (5th Conference in 2022) 18th Conference (6th Conference in 2022) 19th Conference (7th Conference in 2022)
September 2022	20th Conference (8th Conference in 2022) 21st Conference (9th Conference in 2022)
October 2022	22nd Conference (10th Conference in 2022)
Nov 2022.	23rd Conference (11th Conference in 2022) 24th Conference (12th Conference in 2022)
December 2022	25th Conference (13th Conference in 2022)

Fundamentals of engineering

Nov 2021.	First meeting (kick-off) 2nd meeting.
December 2021	3rd Meeting.
January 2022	4th Meeting.
February 2022	Fifth meeting. 6th Meeting.
Mar 2022	7th Meeting. 8th Meeting.
April 2022	9th Conference (1st Conference in 2022) Tenth meeting (2nd meeting in 2022)
May 2022	11th Conference (3rd Conference in 2022) 12th Conference (4th Conference in 2022) 13th Conference (5th Conference in 2022) 14th Conference (6th Conference in 2022) 15th Conference (7th Conference in 2022)
June 2022	16th Conference (8th Conference in 2022) 17th Conference (9th Conference in 2022)
August 2022	18th Conference (10th Conference in 2022) 19th Conference (11th Conference in 2022) 20th Conference (12th Conference in 2022) (Exchange of views with the COMPASS study group)
September 2022	21st Conference (13th Conference in 2022) 22nd Conference (14th Conference in 2022) MCC Revision WG Mathematics & Engineering Fundamentals opinion exchange 23rd Conference (15th Conference in 2022) 24th Conference (16th Conference in 2022)
October 2022	25th Conference (17th Conference in 2022)
December 2022	26th Conference (18th Conference in 2022)
January 2023	27th Conference (19th Conference in 2022)

Mechanical field

Nov 2021.	First meeting (kick-off)
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December 2021	2nd meeting. 3rd Meeting.
January 2022	4th Meeting. Fifth meeting.
February 2022	6th Meeting. 7th Meeting.
Mar 2022	8th Meeting. 9th Meeting.
April 2022	Tenth meeting (first meeting in 2022)
May 2022	11th Conference (2nd Conference in 2022) 12th Conference (3rd Conference in 2022) 13th Conference (4th Conference in 2022) 14th Conference (5th Conference in 2022)
June 2022	15th Conference (6th Conference in 2022) 16th Conference (7th Conference in 2022)
August 2022	17th Conference (8th Conference in 2022) 18th Conference (9th Conference in 2022) 19th Conference (10th Conference in 2022)
September 2022	20th Conference (11th Conference in 2022) 21st Conference (12th Conference in 2022)
October 2022	22nd Conference (13th Conference in 2022)
Nov 2022.	23rd Conference (14th Conference in 2022)
January 2023	24th Conference (15th Conference in 2022) 25th Conference (16th Conference in 2022) 26th Conference (17th Conference in 2022) For the 21st to the 26th, glue-chat meetings

Materials field

October 2021	First meeting (kick-off)
Nov 2021.	2nd meeting. 3rd Meeting.
December 2021	4th Meeting. Fifth meeting.
Mar 2022	6th Meeting. 7th Meeting. 8th Meeting.
April 2022	9th Conference (1st Conference in 2022) Tenth meeting (2nd meeting in 2022)
May 2022	11th Conference (3rd Conference in 2022) 12th Conference (4th Conference in 2022)
June 2022	13th Conference (5th Conference in 2022) 14th Conference (6th Conference in 2022)
July 2022	15th Conference (7th Conference in 2022)

Electrical and Electronic field

October 2021	First meeting (kick-off)
Nov 2021.	2nd meeting.
December 2021	3rd Meeting.
February 2022	email deliberation 4th Meeting.
April 2022	Fifth meeting (first meeting in 2022)
May 2022	email deliberation
August 2022	email deliberation email deliberation 6th Conference (2nd Conference in 2022)
December 2022	email deliberation email deliberation

Informatics field

October 2021	First meeting (kick-off)
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Nov 2021.	2nd meeting.
December 2021	3rd Meeting.
	4th Meeting.
January 2022	Fifth meeting.
	6th Meeting.
Mar 2022	7th Meeting.
	8th Meeting.
May 2022	9th Conference (1st Conference in 2022)
June 2022	Tenth meeting (2nd meeting in 2022)
	11th Conference (3rd Conference in 2022)
	12th Conference (4th Conference in 2022)
July 2022	13th Conference (5th Conference in 2022)
	14th Conference (6th Conference in 2022)
August 2022	15th Conference (7th Conference in 2022)
	Meeting with K-SEC side
September 2022	16th Conference (8th Conference in 2022)
October 2022	17th Conference (9th Conference in 2022)
	18th Conference (10th Conference in 2022)
	19th Conference (11th Conference in 2022)
December 2022	20th Conference (12th Conference in 2022)
January 2023	21st Conference (13th Conference in 2022)
	22nd Conference (14th Conference in 2022)
	23rd Conference (15th Conference in 2022)
Mar 2023	24th Conference (16th Conference in 2022)

Chemical and Biological fields

October 2021	First meeting (kick-off)
Nov 2021.	Teams deliberations (1st meeting)
	2nd meeting.
Dec 2021.	Teams deliberations (2nd meeting)
	Teams deliberations (3rd meeting)
	Teams deliberations (4th meeting)
	3rd Meeting.
	Teams deliberations (5th meeting)
February 2022	Teams deliberations (6th meeting)
	4th Meeting.
	Teams deliberations (7th meeting)
Mar 2022	Teams deliberations (8th meeting)
May 2022	Teams deliberations (9th meeting)
	Fifth meeting (first meeting in 2022)
August 2022	Teams deliberations (10th meeting)
September 2022	Teams deliberations (11th meeting)
October 2022	Teams deliberations (12th meeting)
December 2022	Teams deliberations (13th meeting)
January 2023	Teams deliberations (14th meeting)

Construction fields

October 2021	First meeting (kick-off)
Nov 2021.	2nd meeting.
Dec 2021.	3rd Meeting.
January 2022	4th Meeting.
February 2022	Fifth meeting.
Mar 2022	6th Meeting.
April 2022	7th Conference (1st Conference in 2022)
May 2022	8th Meeting (2nd Meeting in 2022)
June 2022	9th Conference (3rd Conference in 2022)
July 2022	Tenth meeting (4th meeting in 2022)
August 2022	11th Conference (5th Conference in 2022)

Architectural fields

Nov 2021.	First meeting (kick-off)
	2nd meeting

December 2021	3rd meeting
February 2022	4th meeting
Mar 2022	Fifth meeting.
	6th Meeting.
May 2022	7th Conference (1st Conference in 2022)
June 2022	Teams Submission deliberations (1st meeting)
July 2022	Teams Submission deliberations (2nd meeting)
August 2022	8th Meeting (2nd Meeting in 2022)
December 2022	Teams Submission deliberations (3rd meeting)
January 2023	Teams Submission deliberations (4th meeting)

Merchant Marine sector (navigation)

October 2021	First joint meeting of merchant marine systems (kick-off)
January 2022	First meeting of the Merchant Marine (Navigation) System (Teams). Second joint meeting of the Merchant Shipping Systems.
February 2022	Third joint meeting of the merchant marine system.
Mar 2022	Merchant Marine Chiefs Teams Meeting
May 2022	Fourth joint meeting of the merchant marine system.
September 2022	Mathematics and merchant marine opinion exchange Joint 5th Meeting of the Merchant Marine Systems.
Nov 2022.	Merchant Marine Systems (Navigation) 2nd Meeting (Teams).
January 2023	Merchant Marine (Navigation) 3rd Meeting (Teams).

Merchant Marine sector (engine)

October 2021	First joint meeting of merchant marine systems (kick-off)
January 2022	First meeting of the Merchant Marine (Navigation) System (Teams). Second joint meeting of the Merchant Shipping Systems.
February 2022	Third joint meeting of the merchant marine system.
Mar 2022	Merchant Marine Chiefs Teams Meeting
May 2022	Fourth joint meeting of the merchant marine system.
September 2022	Mathematics and merchant marine opinion exchange Joint 5th Meeting of the Merchant Marine Systems.
Nov 2022.	Merchant Marine (Navigation) 2nd Meeting (Teams).
January 2023	Merchant Marine (Navigation) 3rd Meeting (Teams).

Joint meeting of the revision WG

October 2021	MCC Revision WG plenary kick-off meeting
Nov 2021.	Joint meeting of MCC Revision WG AB (R3.November)
December 2021	MCC Revision WG interim briefing (R3. December)
January 2022	Joint meeting of MCC Revision WG AB (R4.January)
February 2022	Joint meeting of MCC Revision WG AB (R4.February)
Mar 2022	Joint meeting of MCC Revision WG AB (R4.March)
April 2022	Joint meeting of MCC Revision WG AB (R4.April)
May 2022	Joint meeting of MCC Revision WG AB (R4.May)
June 2022	Joint meeting of MCC Revision WG AB (R4.June)
July 2022	Joint meeting of MCC Revision WG AB (R4.July)
August 2022	Joint meeting of MCC Revision WG AB (R4.August)
September 2022	Joint meeting of MCC Revision WG AB (R4.September)
October 2022	Joint meeting of MCC Revision WG AB (R4.October)
December 2022	Joint meeting of MCC Revision WG AB (R4.December)
January 2023	Joint meetings with external experts
Mar 2023	Joint meeting of MCC Revision WG AB (R5.March)

