基礎理工学専攻

School of
FUNDAMENTAL
Science and Technology

基礎理工学専攻 School of FUNDAMENTAL

新時代のキーワードとしてのFUNDAMENTAL
Keyword for a New Era:Fundamental

真理を基礎にした論理的思考を目指して
Significance of Logical Thought Based on Truth

現在、われわれは科学技術の成果を享受して生きています。一方でこれらの成果にのみ目を奪われて、その背後にある科学的知識と論理的思考の価値を見失っていることも否定できません。さらに、人々の価値観が多様化するにつれ、真理を基礎にした論理的思考の普遍性が軽視される風潮さえあります。ちょっとした不注意、誤解から大きな事故が起きるのも、このような風潮と無関係ではないでしょう。放っておくと、反科学主義、反技術主義さえ台頭しかねません。しかし、人類の将来は新しい自然法則の発見と、その応用に負うところが多々あります。そのために、しっかりした理工学の基礎知識と飽くなき問題意識を身につけ、緻密な論理に基づいて物事の本質に迫っていく姿勢を習得させるところに、本専攻の存在理由があります。

Today, although we enjoy the fruits of modern science and technology, we often overlook the significance of the scientific knowledge and logical thought that made these fascinating fruits possible. As our sense of values becomes more fragmented, we begin to lose our appreciation of the universality of logical thought based on truth. This trend is reflected in the high incidence of apparently minor mistakes or misunderstanding which can potentially evolve into serious techno-industrial accidents, and consequent heightening of public distrust in science and technology. If we allow such a trend to develop, the principles of anti-science or anti-engineering could emerge. However, we need to continue research of science and engineering for the ongoing future of mankind. For that reason, it is vital that we have a solid knowledge of science and technology, together with a critical appreciation of the problems to be solved. Educating students to master the essence of natural phenomena based on sound logical thinking by using sound reasoning is the "raison d'etre" of the School of Fundamental Science and Technology.

新しい法則の発見とその正しい理解・記述を目指して
Discovery of New Laws and Their Understanding and Description

「今ある最先端を学ぶのではなく、次の最先端を拓くための基礎を学ぶ」をモットーに慶應義塾が基礎重視の教育研究を行ってきたことは、基礎理工学専攻を語る上でもとくに重要なことです。新しい法則はおもいがけないところに潜んでいるかも知れません。それをいち早く見いだし、現象を理解・記述し、そして将来の科学技術全般へインパクトを与えるためには、それぞれの学問分野を深く究めることのみならず、大局を見据える広い視野を涵養することが必要です。基礎理工学専攻の「理工学」は、「理学プラス工学」ではありません。基礎理工学専攻の基本理念は、どのような研究対象に関しても、「工学的応用を予想した理学、科学法則の理解の上に立つ工学」という広い視野に立つというところにあります。

It should be emphasized that research and education policy at Keio University has always attached importance to the fundamentals of various disciplines, under the slogan: "Study the fundamentals of future scientific frontiers, rather than frontiers of the present". New laws are often discovered by chance. In order to recognize an unexpected phenomenon quickly, and to analyze its implications and likely impact on science and technology, it is necessary to have both a broad perspective and a deep insight into each branch of science. The "science and technology" in the name of the School does not refer to a blend of natural science and technology. The basic concept of the School is to advance the application of science to technology, and to facilitate technology based on scientific laws.

Science and Technology

基礎理工学専攻の概要と特色

Fundamentals behind everything

Overview of the School of Fundamental Science and Technology

ボーダレスな基礎理工学を目指して

No Borders Between Branches of Science and Technology

基礎理工学専攻には他大学院の６、７専攻分に相当する数の教員がおり、その研究分野は数学、物理学、応用物理学、化学、応用化学、システム工学、生命科学にまたがり、理工学の各分野間がボーダレスになっています。慶應義塾では、自然科学はもちろん、基礎科学の直接の応用であるテクノロジーの分野までをボーダレスに総称して、「基礎理工学」と呼んでいるのです。大学院学生諸君は１、２名の教員から研究指導を受けながら、これらの多彩な教員の授業を受けることができます。また、他分野の教員と議論しながら広い視野をもって研究を完成させることもできます。科学者に国籍はあっても科学に国境はありません。また基礎理工学専攻は、「先端科学技術国際コース」の一翼もになって、大学院教育の国際協力を行っています。

The fields of research at the School of Fundamental Science and Technology range across mathematics, pure and applied physics, pure and applied chemistry, systems engineering and life sciences. Research topics are dispersed among these branches of science in a "borderless" manner. At Keio, there has never been a distinction between natural science and technology. As a result, the practical application of both natural science and all other sciences has been termed "fundamental science and technology".
Each student in the School is supervised by one or two academic staff members, but students may also participate in classes conducted by specialist tutors in various fields of research. The student can conduct his or her research utilizing a broad spectrum of viewpoints gleaned through discussion with researchers from the various disciplines. Furthermore, science observes no national borders, even though individual scientists may belong to different nations. The School contributes to International Graduate Programs on Advanced Science and Technology, for international education at the graduate school.

広い視野をもった深遠な研究を目指して

Training in Deep Research from a Broad Perspective

これからは、数学、物理、化学の素養をもった生命科学者が求められます。また反対に、数学、物理学、化学の分野で研究する人たちの中にも研究対象を生命現象に求める人が増えています。これに限らず、基礎理工学専攻では、基礎理工学の広い分野の最先端の話題にいつでも触れることができるので、いろいろな分野に興味をもって下さい。しかし、このことは決して研究が中途半端でよいということを意味するものではありません。広い視野のもとに選んだ研究テーマを、狭くシャープに最後まで追求する態度を貫くことが重要なのです。優れた研究者でもある基礎理工学専攻の教員は、君たち大学院生がブレークスルーを起こし、さらに研究を深く徹底的に進めることを助けてくれるでしょう。

Upcoming young biologists are expected to be already well grounded in mathematics, physics and chemistry. At the same time, the range of research subjects in these branches of science is being broadened to encompass biological phenomena. At the School of Fundamental Science and Technology, we recommend that students keep abreast of the latest developments in various fields of science and technology, with this knowledge being constantly updated by the School. This, however, does not give students an excuse to leave their own specialist research incomplete. Once a research subject has been selected from the wide range available, it must be investigated incisively and fully. The teaching staff at the School of Fundamental Science and Technology are also excellent researchers in their own right, and will assist students to make breakthroughs and to carry out their research projects with depth and thoroughness.

基礎理工学専攻

数理科学専修

数理科学とは、数学および数学と諸科学との関係領域に構築された学問分野の総称であり、数学理論（いわゆる純粋数学）の探究とともに、現実現象の記述（抽象化・定式化・モデル化）の開発にも重点を置くものです。1981 年、慶應義塾は他大学にさきがけて数理科学科を設置しましたが、数理科学はあらゆる科学技術を語る共通の言葉として、理工学はもちろん経済学の現象記述にまで至る広範囲領域をカバーしています。

物理学専修

物理学は、自然界の基本法則と原理を探求する学問分野です。その対象は、宇宙から素粒子、生物や人工物質等まで広がっており、自然界における未知の現象の発見と理論化が探求されています。また、自然の探求だけでなく工学の諸分野にもインパクトを与えることを目的とし、固体、生体、原子分子等を対象に多彩な条件下の物性を調べる実験研究と基礎理論、およびそれらに基づく計算物理学にも積極的に取り組んでいます。

分子化学専修

分子化学は、化学の中でも特に錯体化学、表面化学、材料化学、量子化学、有機合成化学、天然物化学、生化学、高分子化学等を統合した学問分野であり、新規かつ有用な機能や性質を持った分子（無機・有機分子、有機金属分子、タンパク質、クラスター、ナノ材料等）の設計と合成、さまざまな化学反応の理論的解析、複雑な生物現象の解明等が中核的なテーマとなっています。さらに電子技術の発展に必須な分子素子の開発や、医薬・農薬等の開発のための取り組みも行っています。

物理情報専修

複雑な自然現象・生体現象・物質現象を情報の面から理解する動きが進んでいます。しかし多くの物理現象について、まだまだ工学的応用に必要十分な情報が引き出せていないのが実状です。物理情報専修では、物理学を基盤として、新たなセンシング技術とプロセッシング技術の開発をめざすとともに、アナリシスやモデリング等の数理的手法を援用して、機能性材料・素子や生体工学システムの設計などの開発に応用していきます。

生物化学専修

生物化学専修は、「化学」と「生物」を知識や技術の基盤とした生命科学への新たな展開を研究・教育の柱としています。研究の内容として、細胞内シグナル伝達系の解明、天然および人工生体機能分子の設計と合成、バイオミメティック・インテリジェント高分子材料の創製などに取り組んでいます。一方で、基礎生物学を重視し、発生生物学を取り入れています。特に、化学的手法と生物学的手法を融合して、医療や環境に有用な化合物を創製することを重要な目標としています。

生命システム情報専修

分子細胞生物学に代表されるようなウェットバイオロジーと計算機科学の融合分野が 21 世紀のライフサイエンスにおいて重要であると考えられてきています。特に核酸、タンパク質、糖鎖などの重要な生体高分子とそれらの相互作用に対する大規模かつ網羅的な計測方法の開発と、それから得られた膨大な情報の蓄積が急速に進む現在、生命現象をシステムとして捉え、情報科学の立場から解析することが可能な人材の育成は急務です。本専修では生命現象の解明はもちろん、生命機能の活用、新規薬物のスクリーニング、脳科学等などを視野に入れた幅広い課題に取り組んでいます。

Fundamental Science and Technology

The Center for Mathematics

The Center for Mathematics offers graduate programs in mathematics, statistics, and information mathematics. These programs are an excellent preparation for post-graduate positions in industry, government, finance, and teaching, as well as for the advanced study of mathematics.
Graduate programs leading to the Master's Degree and the Doctoral Degree are also offered. Students can work for Master's or Doctorates in either Science or Engineering, according to their program concentration and/or their degree objectives. Our staff includes specialists in Functional Analysis, Complex Analysis, Differential Equations, Differential Geometry, Topology, Probability Theory, Ergodic Theory, Algebra, Number Theory, Graph Theory, Combinatorics, Statistics and Computer Science. Staffs are qualified to supervise student work leading to Master's and/or Doctoral Degrees.

Key words: Mathematics, Statistics

The Center for Physics

Physics is a branch of learning in which the principles and fundamental laws of nature are studied. The major tasks of the field cover a wide spectrum: understanding the universe, elementary particles, living things and human artifacts, and exploring new phenomena and their formulations. In our Center of Physics we place emphasis on experimental and theoretical studies of the properties of solids, liquids, living bodies, atoms and molecules all under a variety of conditions so that we can contribute to advances in science and technology.

Key words: General Physics, Condensed Matter Physics, Laser Physics, Biophysics, Astrophysics

The Center for Molecular Chemistry

Molecular Chemistry is a unified research field of a wide range of chemical science, including quantum chemistry, organometallic chemistry, material chemistry, synthetic organic chemistry, natural product chemistry, cluster chemistry, biochemistry, and polymer chemistry. The core subjects being investigated in the Center are (1) design and synthesis of novel, versatile and functional inorganic and organic compounds, organometallics and nanomaterials, (2) physicochemical understanding of chemical reactions, and (3) clarification of complex biological phenomena. In addition, important Center goals are development of molecular devices essential for progress in electronic technology and development of useful pharmaceuticals and agrochemicals.

Key words: Theoretical Chemistry, Natural Product Chemistry, Synthetic Organic Chemistry, Polymer Chemistry, Material Chemistry

The Center for Applied Physics and Physico-Informatics

Creating a livable climate means balancing the complex relation among and between human information, technology, and economics, with the natural environment of our planet -all within a viable framework of physical principles. Understanding these components and developing new methods to interpret and ultimately to resolve conflicts forces are the major objectives of our educational and research endeavors. The first part of the Center name,"Applied Physics", represents the application of physical principles to numerous fields in science and technology. The second part, "Physico-Informatics", emphasizes the importance of advanced mathematical analysis of information governed by the laws of physics. It also indicates the strong commitment to develop applied physics as a new key for the advancement of today's information technology.

Key words: Applied Physics, Instrumentation Engineering, Medical Physics

The Center for Chemical Biology

“Chemical biology” as fusion of “chemistry” and “biology” is one of the most promising fields of science and technology. “Chemical biology” is a new field involving analysis and synthesis. The core subjects being carried out in the Center include 1) fundamental developmental biology, 2) clarification of signal transduction in cells, 3) design and synthesis of natural and artificial bioactive molecules, 4) design and synthesis of soft matters and biomacromolecules possessing novel diversity and functionality, and development of biomedical tools and techniques for drug delivery and tissue engineering.

Key words: Biochemistry, Molecular Biology, Medicinal Chemistry, Bioorganic Chemistry, Natural Product Chemistry, Synthetic Organic Chemistry, Polymer Chemistry

The Center for Biosciences and Informatics

The new field that integrates wet biology, represented by molecular and cellular biologies, and computer sciences has been considered as one of the most important fields for life science in the 21st century. While extensive and comprehensive measurement systems for important biomolecules, such as nucleic acid, protein and sugar chain, and interaction among them being developed, accumulation of staggering volume of information has been increased rapidly. Our prime task is therefore in development of human resources capable of analyzing the life process from viewpoints of systems biology and informatics. In the Center for Biosciences and Informatics, we are working on a wide scope of subjects including utilization of life-related functions, screening of new medicines and brain science in addition to clarification of the life process.

Key words: Bioinformatics, Bioimaging, Neuroscience, Drug Discovery, Glycoengineering, Molecular Cell Biology, System Biology