2-12-1 Hisakata, Tempaku-ku,Nagoya
468-8511 Japan
Tel：＋81-52-802-1111

※ Note: Unless otherwise noted, the affiliations, years of study, positions, and comments of persons mentioned in this brochure are accurate as of the time of editing (October 2022). However, some of this information may have been corrected, where, for example, the person in question requested a change.

TOYOTA
TECHNOLOGICAL
INSTITUTE

TOYOTA TECHNOLOGICAL INSTITUTE

TTI GUIDE BOOK

English-Based

Toyota Technological Institute (TTI) is a single-department engineering college founded in 1981 as part of Toyota Motor Corporation's social contribution initiatives. Despite having a small undergraduate intake of just one hundred students, we have developed a unique range of education and research programs, encompassing late specialization, interdisciplinary study, a focus on laboratory experiments and hands-on learning, liberal arts education from undergraduate to doctoral level, off-campus training within companies and overseas, overseas language training, and study/research at our overseas sister and partner institutions. In 2020, we completed a campus renovation project, renewing our educational and research facilities, communication spaces, student dormitory and International House (Ti-House), Collaborative Clean Room, and Creativity Development Studios.

Learning is about understanding, not memorizing. Since understanding is obtained through reasoning, logical thinking skills are developed in that process. These skills are also strengthened through research, and eventually develop into generic abilities that are important in life as a working adult. Other generic abilities acquired through learning and research include presentation skills and the ability to work independently. However, to acquire these skills, students must find ways of engaging in learning and research–and faculty members must find ways of guiding this process. At TTI, we view learning and research as two driving forces in the development of human resources in higher education. I hope that, in addition to ability in your major, you will acquire a wide-ranging knowledge and understanding, along with diverse experiences, through the study of liberal arts, off-campus training, overseas language training, and the other programs we offer, and through your dormitory life.

I trust that all students and faculty members at TTI will turn their learning and research into more effective forms, and that our students will grow into individuals with both professional skills, a grounding in liberal arts, and generic abilities, contributing greatly to the development of a peaceful and vibrant society.

President
Kazuo Hotate

Developing the ability to contribute to society, through learning and research

The Founding Spirit

Respect the spirit of research and creativity, and always strive to stay ahead of the times

Sakichi Toyoda

Nurturing engineers and researchers with practical skills, who rise to the challenges of modern society

Toyota Technological Institute (TTI) was founded as part of Toyota Motor Corporation's social contribution initiatives. It was established in 1981, inheriting as its founding philosophy the maxim of Sakichi Toyoda (1867–1930), who laid the foundations for the Toyota Group and is referred to as the father of Japanese industrial technology development. Aiming to "serve society and the nation through invention," Sakichi Toyoda focused his efforts on developing automatic looms. At the age of 23 he invented the Toyoda Wooden Hand Loom, receiving his first patent. The Non-Stop Shuttle Change Toyoda Automatic Loom, Type G, completed in 1924, pushed the envelope of efficiency and quality in textile industries worldwide. His words, "Respect the spirit of research and creativity, and always strive to stay ahead of the times," encapsulate TTI's mission of creating new value and giving it back to society through cutting-edge research in engineering, and nurturing engineers and researchers with practical skills to enable them to rise to the challenges of modern society.

Developing human resources at the undergraduate and graduate level

Through both learning and research, students acquire knowledge and understanding in fields of major and general education, produce research results, and develop generic abilities, such as logical thinking, that are important for contributing to society

As the frontiers of modern science and technology continue to broaden, the pace of progress is also accelerating. To nurture individuals who can grasp the state of science and technology and open up new frontiers, TTI offers a program of "human resource development" through learning and research, which stretches over nine years of study at undergraduate and graduate levels. The four years of undergraduate study serve as a period of foundation building, where all students belong to a single department: the Department of Advanced Science and Technology. Students' majors are not restricted at the time of enrollment, and lectures encompass the whole range of engineering; then students choose a major in the second semester of their second year. In the fourth year, students join a laboratory and undertake the challenge of graduation research, while also building their foundational knowledge of advanced science and technology. Advancement to graduate school is recommended for students who wish to attain further mastery of a cutting-edge field. Every year, more than half of the students who graduate from the Undergraduate School of Engineering go on to the Master's Program, where they acquire creativity, research skills, and various generic abilities, such as logical thinking, at a higher level. Our Doctoral Program is the final stage of human resource development, where we focus on nurturing world-class engineers and researchers. At TTI, we view learning and research as two means of developing human resources.

Education

Gaining a broad overview of engineering and in-depth knowledge of specialized fields

TTI students do not choose a field to specialize in at the time of enrollment, but undertake a broad study of the basic elements of three disciplines: mechanical systems engineering, electronics and information engineering, and materials science and engineering; then, in the second semester of their second year, students choose a major based on their interests and skills, and develop their expertise in that field. With emphasis on experiential learning from an early stage, our curriculum offers a full range of experiment-based and practical learning courses, including Engineering Literacy. In addition to Off-Campus Training in the first and third years, there are plenty of opportunities for students to learn how engineering can be of service to society, including the courses, Introduction to Modern Engineering and TOYOTA Production System, which are taught by visiting lecturers from the business world. Importance is also placed on our general education program, which consists of liberal arts and foreign language courses, enabling students to acquire the rich human qualities and internationality required of engineers and researchers. Through this process of learning and their graduation research, students also develop generic abilities, such as logical thinking.

Cultivating human qualities

Aiming to nurture engineers and researchers with rich human qualities, TTI considers the dormitory life that students experience in the first year of university as an integral part of human resource development. The close relationships that students develop through living alongside their peers are instrumental in helping students achieve independence, get along with others, and communicate well. Moreover, students can develop human qualities as part of their overall university study experience, through detailed instruction provided in small groups and by interacting with adult students.

Experiential learning

In engineering education, it is important for students to deepen their understanding of the knowledge they learn through experience, and to transform that knowledge into practical and applied skills. That is why we emphasize education centered on experiments and practical learning. Our course offerings include Engineering Literacy, to foster an engineering mindset; Basic Engineering Laboratory, to learn about experimental methods and evaluation/analysis of observation data; and Creativity Development Seminar, to develop the ability to produce and implement ideas by tackling problems that require creative solutions.

Business collaboration courses

To nurture engineers and researchers who understand the needs of industry, Off-Campus Training is offered as a mandatory subject for all first- and third-year students. Through practical training in the fields of manufacturing and development, delivered in collaboration with businesses, students learn about the significance of studying engineering and develop a vision for their future career. We also offer Toyota Production System, in which students learn about efficient production methods under the guidance of instructors from Toyota Motor Corporation, and Intensive Seminar on Practical Data Science, where they learn applied techniques for practical data science using real data from the field of development in business.

State-of-the-art facilities for research and education

Our research facilities provide one of the best support environments in Japan. Besides our Collaborative Clean Room and other shared facilities, each research laboratory is equipped with state-of-the-art equipments for formation, processing, observation, analysis, and measurement. Moreover, the Creativity Development Studios are equipped with various machine tools used at actual manufacturing sites, and technical advisors from companies are available to support students with their learning and research.

Master's and Doctoral Programs at the graduate school

In our Master's Program in Advanced Science and Technology, students join a small-group seminar led by their laboratory supervisor, and undertake practical training at companies and research institutes in Japan and overseas to develop advanced specialized knowledge and research skills, building on the basic knowledge of engineering they acquired at the undergraduate level. In the Doctoral Program, we offer specialization in either Information-aided Technology or Future-Industry-oriented Basic Science and Materials. These courses nurture individuals capable of pursuing creative research, through detailed instruction tailored to the individual learning program.

Research

Mechanical Systems Engineering

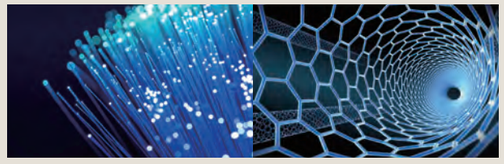
This research division aims to create new mechanical systems by tracing the essence of various phenomena related to fluid mechanics, thermodynamics, material mechanics, machine mechanics, and processing. We also consider the environmental impacts of these mechanical systems, venturing into the domain of renewable energy. We are engaged in a wide range of research, from basic and academic aspects of each area of mechanics to applied and technological aspects such as design, production, and controls.

Electronics and Information Engineering

This research division conducts cutting-edge research on electronics, information, and control, from devices that manipulate electrons and photons to information systems, networks, and robotic control. We also carry out a wealth of research on AI-based language and image processing, motors and power devices for electric vehicles, and energy, including development of next-generation solar cells and ultra-low-power memory. In addition, we are focusing on developing the interdisciplinary fields on the mechanical systems and materials engineering fields.

Materials Science and Engineering

Today's society allows us to exchange information and energy freely. These foundations are supported by various functional materials. The Materials Science and Engineering division aims to build understanding of materials at the atomic and molecular levels, creating the new materials and devices that the times demand and laying academic foundations. To achieve this, we will utilize quantum mechanics, material engineering, polymeric material science, and nanotechnology. We will also collaborate closely with the Mechanical Systems Engineering and Electronics and Information Engineering divisions.

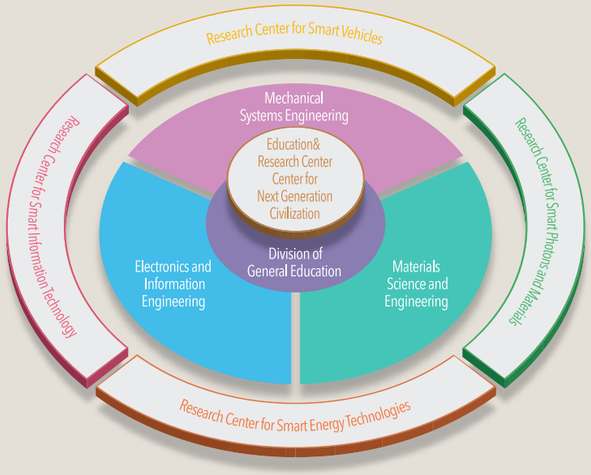


Division of General Education

To nurture the next generation of global industry-leading engineers and researchers, armed with creativity and rich human qualities, TTI places importance on general education (courses in liberal arts, foreign languages, and health and sport sciences). The curriculum is designed so that students can take general education courses throughout their four years in the Undergraduate School of Engineering. We are also engaged in our own research in the humanities (philosophy),foreign languages (english), and health and sport sciences.

TTI Research and Education Centers

Having established laboratories specializing in mechanical systems engineering, electronics and information engineering, and materials science and engineering, we are working to deepen these academic foundations through cutting-edge research in each division. In parallel with this, we have established four research centers to facilitate collaboration between laboratories in different fields, with the aim of opening up new possibilities for interdisciplinary/integrative joint research. We have also established the Center for Next Generation Civilization, which has both education and research functions, for the humanities/social sciences and liberal arts.



Research Center for Smart Vehicles

Established in 2010 Project Leader : Professor Masatoshi Shimoda

A base for research on future smart mobility

Research Center for Smart Energy Technologies

Established in 2012 Project Leader：Professor Yoshio Ohshita

Advanced solar cells and other clean energy technologies

Research Center for Smart Photons and Materials

Established in 2016 Project Leader：Professor Yasutake Ohishi

Consistently pioneers next-generation sensing and information technologies

Research Center for Smart Information Technology

Established in 2021 Project Leader：Professor Norimichi Ukita

Develops new information technologies and promotes their advanced use in a wide range of application areas

Education & Research Center / Center for Next Generation Civilization

Established in 2016 Project Leader：Professor Emeritus Yoichiro Murakami (The University of Tokyo・International Christian University)

Works to enhance our liberal arts education while promoting civilization research that integrates the humanities and sciences

Internationalization

Training engineers who make the world their stage

Engineers and researchers need to have a high level of English proficiency. When researchers around the world share their latest findings, the work is first published in English. If we wait for this work to be translated into Japanese, we risk falling behind the rest of the world. Moreover, to promote their research findings globally, engineers and researchers in Japan need to be able to write papers in English. Therefore, TTI has established an educational system and environment aimed at fostering the ability to use English not only in daily conversation, but also for academic purposes such as technical presentations and academic writing. In addition to our English language learning curriculum, which spans six years from undergraduate enrollment to completion of the Master's Program, we have introduced the E-SUP※1 program to encourage students to study English on their own initiative, along with iPlaza※2 and other learning facilities.

※1 E-SUP stands for English Step-Up Point.
※2 iPlaza stands for International Communication Plaza.

Toyota Technological Institute at Chicago (TTIC)

Toyota Technological Institute at Chicago (TTIC) is a graduate school established by TTI in 2003 on the campus of the University of Chicago, specializing in doctoral programs in basic theory of information science. TTIC has since been accredited as an independent institution of higher education in the United States, developing a sister institution relationship with TTI. It also works with the University of Chicago to promote research and education, and has come to be recognized as one of the top institutions for machine learning theory in the whole of the United States. In addition to our study abroad program for graduate students, we also offer generous scholarship systems to support students who study abroad, including the Toyoda Tatsuro Scholarship Fund, which provides travel costs, living expenses, and other costs. Students can also achieve personal growth by engaging in in-depth learning alongside outstanding students from around the world.

Fostering internationality on campus

To encourage students to learn English continuously, from enrollment through to graduation, our E-SUP program sees students earn points by completing a variety of English language-related activities, including the TOEIC® Listening & Reading Test, which encourages them to take the initiative in their English learning. iPlaza is a center for promoting exchange, foreign language learning, and internationalization at the university, staffed by full-time employees, who are fluent in English and well-versed in overseas affairs, and who assist students with their self-directed learning and activities.

International exchange and overseas training programs

Through substantive collaboration with universities and research institutions around the world, including research exchange and credit transfer, we are working to promote internationalization in research and education. We have established our own study abroad programs with partner universities that provide opportunities to study the latest engineering topics overseas, in addition to English language training and intercultural experiences. For master's students, we also offer overseas off-campus training and study abroad programs at TTIC. In addition, we offer support for students who undertake off-campus programs, such as Vulcanus in Europe, which takes place in EU member countries. As a result, more than 40% of our undergraduate students and 30% of our master's students have experienced study abroad before completing their courses.

Laboratories

Mechanical Systems Engineering

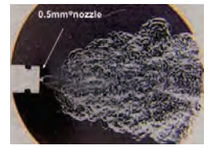
Mechanical Systems Engineering

Heat and Energy System Laboratory

Professor Keiji Takeno

Combustion and explosion phenomena based on reactive thermo-hydrodynamics

Regarding hydrogen, which is attracting attention as a next-generation fuel, we are focusing on elucidating the ignition and flame stabilization mechanism for rocket, gas turbine, and safety engineering, and also interested in the effective use of high-viscosity fuel residue, the heat transfer resistance, and high efficiency energy conversion of biomass.



Shlieren image for diffusion flame of 40 MPa pressurized hydrogen

Main Research Themes

- Combustion and gasification mechanisms of low grade fuel
- Combustion mechanism of high pressurized gas and safety analysis
- High efficiency energy conversion of the biomass
- Dependence of thermal resistance on the surface asperity

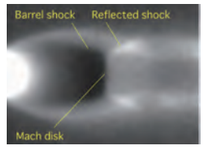
Mechanical Systems Engineering

Fluid Engineering Laboratory

Professor Taro Handa
Associate Professor Yasumasa Watanabe

Optical diagnostics of complicated flow phenomena and development of the actuators for flow control

Using laser diagnostic techniques and molecular sensors, we study complicated phenomena of micro- and macro-scale flows appearing in various flow devices, for example, MEMS devices, air-breathing engines, and so on. We also develop the methods of active flow control.



Laser-aided non-intrusive measurement of high-speed flow

Main Research Themes

- Development of laser-aided diagnostic techniques for measuring high-speed flow
- Study on active flow control with high-frequency momentum addition
- Plasma-assisted high-speed flow control and application for high-speed aircraft
- Unsteady hypersonic flow phenomena related to shock waves

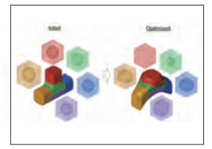
Mechanical Systems Engineering

Solid Mechanics Laboratory

Professor Masatoshi Shimoda
Associate Professor Yoshinori Shiihara

Computational mechanics and optimization in structural design for light-weight and stiff structures/materials

Light is weak and stiff is heavy; these two directly-opposed properties should exist together for a highly competitive industrial products, especially for a transportation vehicle. Using the state-of-the-art computational mechanics from nanoscale to macroscale is a promising key to overcome this difficulty. We have developed and applied the simulation-based methodologies of structural optimization and strength estimation to realize new structural/material designs for high added-value industrial products.



3D numerical example of micro- and macro-scale shape optimization of multi-scale structure with developed concurrent shape optimization method

Main Research Themes

- Solutions to structural optimization problems and their application to practical designs
- Research on multi-scale optimum design of composite structure
- Computational study on nanoscopic material strength using machine-learning molecular dynamics
- Development of impact fracture simulation based on Peridynamic theory

Mechanical Systems Engineering

Design Engineering Laboratory

Associate Professor Masakazu Kobayashi

Computer aided design for future product

We study on next generation computer aided design system that implements conceptual design support, lifecycle assessment and design, structural optimization, system optimization and aesthetic design based on kansei engineering for improving the designers' ability.

Generation of product designs using GAN (Generative Adversarial Network) based on customers' preferences

Main Research Themes

- Optimal design of product concepts considering product lifecycles
- Application of compliant mechanisms to mechanical systems
- Optimal design of work process and layout
- Optimal design of product aesthetics based on customers' kansei evaluation

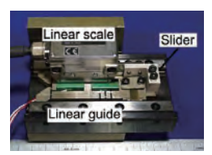
Mechanical Systems Engineering

Innovative Machine Laboratory

Professor Katsushi Furutani

Studies on mechanical devices and working methods to create and measure precision products

We study on devices and methods for the rapid fabrication of various precision products and for support for advanced scientific research. Advanced mechatronics such as precision positioning devices and precision machining methods by combinations of physical and chemical phenomena are intensively studied.



Precision positioning device with nanometer accuracy equipped AZARASHI mechanism

Main Research Themes

- Micromanipulation with AZARASHI precision positioning mechanism
- Miniaturized mechanical systems for sustainable manufacturing
- Precision machining by electrical machining
- Elements of scientific inspection devices for lunar and planetary explorations

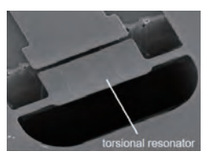
Mechanical Systems Engineering

Micro-Nano Mechatronics Laboratory

Professor Minoru Sasaki

Small valuable devices : Micro-/nano-machines and related technology

The recent performances required to the instruments are comfortableness, safety, and eco-friendliness. For realizing them, micro/nano texturing of the element surfaces, and sensing environment information are important. In case of cars, sensing driver or cabin environment, and sensing inertia forces acting on the body, are related. Based on MEMS technology introducing new ideas of structures and materials, we are working for creating new valuable devices.



Uncooled infrared sensor using electrostatic torsional resonator

Main Research Themes

- 3D photolithography with high productivity
- Micro-plasma and its applications
- Resonator-type sensors
- Wavelength selective infrared emitter and optical MEMS devices

Mechanical Systems Engineering ／ Electronics and Information Engineering

Mechanical Systems Engineering
Materials Processing Laboratory

Development of novel materials processing for the upmost improve-ment in material functions through the microstructure, surface and interface control

Professor Masahiro Okumiya

The research programs are focused on the development of novel processing for the upmost improvement in physical, chemical and mechanical properties of structural materials. They are aimed at achieving the upmost improvement in material functions through the microstructure, surface and interface control based on the original innovative ideas.

Plasma high temperature nitriding andquenching furnace

Main Research Themes

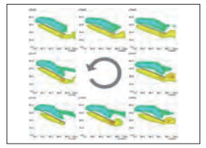
- Surface modification of aluminum using barrel-nitriding and ion-nitriding
- Steel surface hardening heat treatment using nitrogen and carbon
- Control of steel structural transformation in liquid quenching
- Additive manufacturing using jet electro plating

Mechanical Systems Engineering
Mechanical Systems Engineering

Elucidation of structures of complex flow fields and controlling them

Assistant Professor Akira Urita

To make structures of unsteady flows around various vehicles and structures be clear, and to improve their performances with flow control using the obtained knowledge.



Periodic variation of vortex structure around a flexible wing self-excited vibrating in uniform flow

Main Research Themes

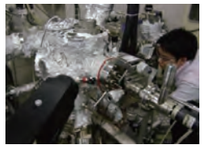
- Fundamental flows like separation on basic shapes such as circular cylinders and flat plates
- Aerodynamic behaviour of objects with vibrations excited by flows and variation of the flow structures around them

Electronics and Information Engineering
Semiconductor Laboratory

Research and development of high efficiency solar cells and materials for the new clean energy source in the next generation

Professor Yoshio Ohshita
Lecturer Nobuaki Kojima

Photovoltaic(PV)power generation is the key technology for the new energy source of the 21st century. We study various semiconductor materials and devices, including super-high efficiency multi-junction solar cells to achieve ultimate conversion efficiency, crystalline Si solar cells, concentrator solar cells and other innovative new solar cell materials.



Semiconductor crystal growth by molecular beam epitaxy

Main Research Themes

- Study on high-efficiency solar cells
- Study on new solar cell materials and principles
- Study on concentrator solar cells
- Study on novel opto-electronic functional materials

Electronics and Information Engineering
Advanced Electron Devices Laboratory

Development of low-cost high-functionality semiconductor devices with high-efficiency operation for the energy conservation society

Professor Naotaka Iwata

Much attention has been paid to cost reductions, power saving operations and high functionalities of semiconductor devices constituting electronic products indispensable to our lives. To address it, the Advanced Electron Devices Laboratory investigates semiconductor materials, fabrication processes, devices and application technologies.

AlGaN/GaN high electron mobility transistor on GaN substrate under test

Main Research Themes

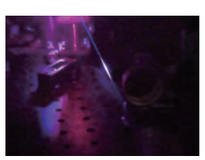
- Compound semiconductor heterojunction power devices
- Compound semiconductor devices with novel features
- Ultra-low energy consumption semiconductor devices and systems

Electronics and Information Engineering
Laser Science Laboratory

Ultrafast laser science and next-generation metrology

Professor Takao Fuji
Lecturer Tetsuhiro Kudo

We are developing the cutting-edge technologies to control and measure optical electric fields oscillating with a period of a few femtoseconds (10−15 seconds), and constructing the lasers which produce ultimately short optical pulses. We are also studying next-generation metrology, multi-photon microscopy and optical trapping using the lasers developed in our laboratory.



A plasma filament generated by high intensity ultrashort pulses

Main Research Themes

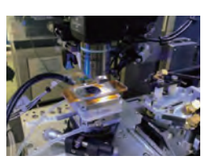
- Cutting-edge ultrashort pulse lasers
- Direct measurement of optical field oscillations
- Spectroscopy with ultrashort pulse lasers
- Novel Laser trapping with the developed lasers

Electronics and Information Engineering
Memory Engineering Laboratory

Creating new functional materials via spin control of nanostructures

Professor Hiroyuki Awano
Associate Professor Kenji Tanabe

Nanometer-sized spin materials, which enable electron spin control, are expected to lead to new functional devices. Our laboratory is committed to innovating spin metamaterials to develop ultra-low power petabyte memories(magnetic and/or optical)and to addressing global warming and other energy-related problems.



Specialized tester for magnetic nanowire memory, logic, IoT sensors, etc. (recording / reading / thermal distribution etc.)

Main Research Themes

- Century archive petabyte magnetic solid state memory using spin transfer torque
- Creation of domain wall type spin logic device with spin transfer torque effect.
- Research on spin power generation and thermomagnetic power generation
- Estimation of magnetic parameters by machine learing

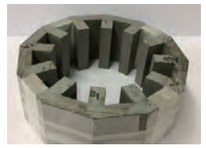
Electronics and Information Engineering ／ Materials Science and Engineering

Electronics and Information Engineering
Electromagnetic Energy System Laboratory

Electrical motor drive system for electrical vehicle by electromagnetic field fusion science from material to system

Professor Keisuke Fujisaki
Assistant Professor NGUYEN Gia Minh Thao

In order to realize higher efficient electrical vehicle society, motor drive system comprised of power electronics and electrical equipment technology is researched theoretically and experimentally from a new point of material (magnetic body, power semiconductor) and its manufacturing method. Fusion science of electromagnetic field beyond the conventional framework of technique is expected.



Low iron loss motor by nano-crystal magnetic material

Main Research Themes

- Research on motor drive system for electrical vehicle
- Research on high efficiency motor which makes use of material property
- Research on mutual interaction and fusion science of power semiconductor and magnetic material
- Electromagnetic solution by multi-physics and multi-scale

Electronics and Information Engineering
Control System Laboratory

Development of advanced control theory for realizing high-performance control of complicated dynamical systems

Associate Professor Michihiro Kawanishi

The main research target of our laboratory is the development of advanced control theory to realize high-performance control of complicated dynamical systems for contributing to human society. The application includes space robots, underactuated mechanical systems, and human support systems.

Beowulf cluster computer

Main Research Themes

- Nonlinear control system design via numerical optimization approaches
- Control for smart grids
- Robust control theory (An unified control system design method with BMI approach)
- Control theory for human support systems

Electronics and Information Engineering
Computational Intelligence Laboratory

Exploring human intelligence and creating artificial intelligence

Professor Yutaka Sasaki
Associate Professor Makoto Miwa

The Computational Intelligence Laboratory(COIN Lab) focuses primarily on fundamental theories and application techniques that allow users to communicate with machines using natural language. Especially, we devote ourselves to developing software systems that automatically analyze large amount of scientific and engineering literature and discover useful knowledge.

IR with Distributed Representations of Bibliography

Main Research Themes

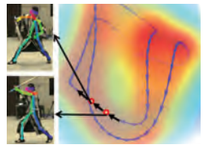
- Deep Learning based natural Language Processing
- Knowledge Acquisition from Life and Materials Science Literature
- Deep Learning for Autonomous Driving by Utilizing Knowledge
- Embedding of Knowledge Structures in Hyper Spaces

Electronics and Information Engineering
Intelligent Information Media Laboratory

Man-machine symbiotic intelligent systems with multimedia technologies

Professor Norimichi Ukita

We realize man-machine symbiotic systems with (1) intelligent information media sensing and recognition such as computer vision and (2) big-data analysis using machine learning for high-performance sensing and recognition and for knowledge modeling and structuring.



Recognizing real-world events and activities such as complex and various human motions

Main Research Themes

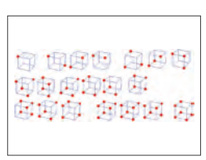
- Human action/behavior recognition in images and videos
- Driver, passenger, and pedestrian analysis for smart vehicle technologies
- Human crowd analysis, Sports video analysis
- Image super resolution and its application to scale-free object detection

Electronics and Information Engineering
Information and Communication Engineering Laboratory

Basic researches and their applications on information theory and computer science

Associate Professor Hajime Matsui

Digital communications and storage technology for mass information and recognition technology for various objects and scenes using computers are active and challenging research areas. Our laboratory is trying to solve various unsolved problems in these research areas. In addtion to these basic technologies, their applications are also developed.



Classification of logic polynomials

Main Research Themes

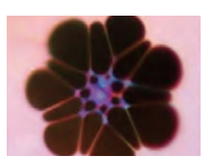
- High efficiency error correcting codes
- Fast product of multiple-valued logic polynomials and its application
- Various applications of artificial intelligence, machine learning and Bayesian inference
- Tackling various unsolved problems in computer science

Materials Science and Engineering
Optical Functional Materials Laboratory

Studies on photonics materials controlling lightwave at will

Professor Yasutake Ohishi
Associate Professor Takenobu Suzuki

We aim at broadband optical signal processing and lightwave generation through developing novel functional materials according to our own guideline of materials design and fabricating novel devices such as micro-structured fibers and microspheres.



Cross section of microstructured optical fiber

Main Research Themes

- Super continuum lightwave generation by microstructured fibers
- Lightwave processing by highly nonlinear fibers
- Studies on ultrabroadband gain and laser media doped with novel optically active ions
- Studies on solar pumped lasers

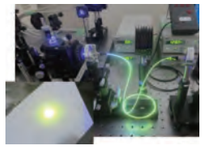
Materials Science and Engineering

Materials Science and Engineering
Frontier Materials Laboratory

A better understanding of glass structure and optical properties for developing high-performance photonic devices

Professor Kazuya Saito

Our research is focused on the correlation between glass structure and optical properties in silica and silica-related glasses to control the glass structure and develop high-performance photonic devices.



The world's first yellow Dy-doped silica fiber laser

Main Research Themes

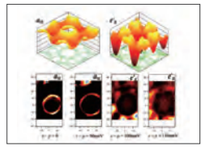
- Study on the correlation between glass structure and optical properties in silica-related glasses
- Development of ultra-low loss optical fiber
- Development of high-power fiber laser
- Development of high-performance fiber amplifier

Materials Science and Engineering
Energy Materials Laboratory

Development of functional materials leading to sustainable low-carbon society

Professor Tsunehiro Takeuchi
Associate Professor Masaharu Matsunami

In the Energy Materials Laboratory, we are developing functional materials, such as thermoelectric materials, thermal diodes, and high-Tc superconductors. These materials strongly contribute to the construction of sustainable low-carbon society. For these studies, we are using detailed analyses on electronic structure both from experiments and theoretical calculations.



The ε-*k* dispersion of Na_xCoO_2. The top figures represent two bands crossing the Fermi level, and the bottom figures the ARPES momentum mapping of constant energy surface.

Main Research Themes

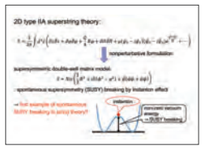
- Development of cheap, non-toxic, high-performance thermoelectric materials on the basis of electronic structure analyses
- Development of innovative devices for controlling heat flow : thermal diodes and thermal switches
- Electronic structure and electron transport properties of high-Tc superconductors
- Fundamental and applied researches on materials characterized by strongly correlated electrons

Materials Science and Engineering
Theoretical Physics Laboratory

Spontaneous symmetry breaking in string theory

Professor Tsunehide Kuroki

We study how higher symmetry in string theory is broken to that at present by clarifying fundamental degrees of freedom in a whole string theory.



Spontaneous supersymmetry breaking in superstring theory by instanton effect in supersymmetric matrix model

Main Research Themes

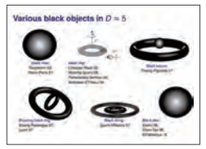
- Nonperturbative formulation of string theory based on matrix model
- Spontaneous symmetry breaking in the large-N limit
- Space-time structure described by matrix models
- Relation between perturbative series in string theory or field theory and its nonperturbative effect

Materials Science and Engineering
Mathematical Physics Laboratory

Construction of black hole solutions and elucidation of its mathematical structure

Professor Shinya Tomizawa

A black hole is a region of the spacetime where gravity is so strong that any particles and even light entering the region never can escape from it and is described by exact solutions to the Einstein equation within the framework of general relativity. We clarify the mathematical structure of such a black hole and attempted to find a new black hole solution and unknown black hole physics by developing new solution-generation techniques.



Various black holes generated by solitonic techniques

Main Research Themes

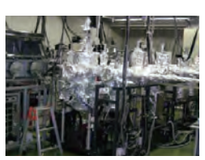
- Uniqueness for higher dimensional black holes
- Stability analysis of black hole spacetimes
- Generation of black hole solutions
- Gravitational waves described by gravitational solitons

Materials Science and Engineering
Quantum Interface Laboratory

Fundamental studies and applications of opto/electronic/chemical properties of surfaces and interfaces of quantum structures

Professor Itaru Kamiya
Assistant Professor ROCA,Ronel Christian

Basic studies on the electronic properties of surfaces and interfaces of quantum nano-structures, that are prepared by both physical and chemical techniques, are performed. The control and generation of novel optical/electronic/chemical functions are aimed. Focus is placed on the interdisciplinary topics of electronic physics and chemistry.



Ultra-high vacuum quantum structure growth machine

Main Research Themes

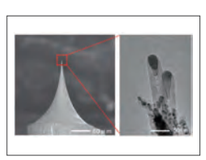
- Optical and electronic properties of surfaces and interfaces of quantum structures
- Epitaxial growth of III-V semiconductors - mechanisms and physical properties
- Colloidal synthesis of nanoparticles and physical properties
- Energy conversion devices using quantum structures

Materials Science and Engineering
Surface Science Laboratory

Atomic-scale characterization and fabrication of material surfaces for future functional nanomaterials

Professor Masamichi Yoshimura
Associate Professor Masanori Hara

The goal of the atomic-scale characterization and fabrication of material surfaces is to design and develop new energy and environmental materials mainly using nanocarbons such as graphene and CNT. These new materials are applied for next-generation optelectronics, fuel cells, solar cells, water filters, surface coatings, etc.



Carbon Nanotube Probe
(left:SEM, right:TEM)

Main Research Themes

- Synthesis and application of nanocarbon materials
- Characterization of materials using tip-enhanced Raman scattering spectroscopy
- Development of high-performance electrode materials for next-generation battery

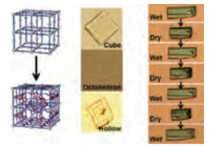
Materials Science and Engineering ／ Division of General Education

Materials Science and Engineering
Polymer Chemistry Laboratory

Development of new synthetic methods of macromolecules based on precise arrangement of atoms and molecules and exploration of their functions

Professor Kenta Kokado

Based on the knowledge of organic chemistry and supramolecular chemistry, we aim to create polymers with precisely controlled chain and network structures, by precisely arranging or aligning atoms and molecules. Such new polymers will have completely new electronic, optical, and mechanical materials, that utilize the properties of organic elements to the utmost limit.



Precise synthesis of linear polymer and gels from metal-organic framework (MOF)

Main Research Themes

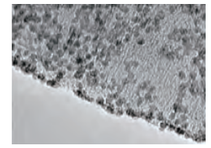
- Macromolecular synthesis linking the components of crystals
- Synthesis of sequence-controlled polymers using oligomeric blocks

Materials Science and Engineering
Catalytic Organic Chemistry Laboratory

Development of practical catalytic transformations of organic molecules based on the precise design of metal catalysts

Professor Yukihiro Motoyama

Our objective is the development of novel and efficient transformations of organic molecules on the basis of organometallic chemistry. In order to maintain a global environment as well as to solve energy problems, we design and prepare a variety of molecular catalysts and metal cluster catalysts with high activity and selectively.



TEM image of Ru nanoparticles on the platelet-type carbon nanofiber (CNF-P)

Main Research Themes

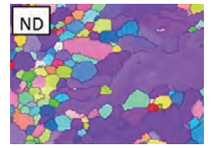
- Creation of Supported Metal Clusters
- Science of Subnano-Sized Soluble Metal Clusters
- Development of Practical Catalytic Reactions

Materials Science and Engineering
Functional Ceramics Laboratory

Processing of highly-functional ceramics by taking advantage of structures ranging from atomic arrangement to microstructure

Lecturer Shuichi Arakawa

We study designing and processing of highly-functional ceramics by taking advantage of structures at various levels ranging from atomic arrangement to microstructure. Controlling texture or crystal anisotropy and utilizing nanoporous structure are the keywords of our study. The aim of our research is making contribution to fields of energy, environment, and medicine.



EBSD crystal direction map of epitaxially-grown (211) oriented YAG thin film on the c-plane sapphire substrate

Main Research Themes

- Texture control of ion conductive ceramics taking notice of anisotropic ionic conduction
- Searching novel structural families providing fast ionic conduction
- Development of novel reactive-templated grain growth method using self-orientation
- Processing of highly-functional nanocomposites based on hollow spherical allophane nanoparticles

Division of General Education
Humanities (Philosophy)

We help students develop their thinking and dialogical-interactive skills.

Professor Takeru Eguchi

This laboratory helps students develop the ability to think logically and critically, to discern right from wrong, to see the essence of a problem, and to respond tolerantly to others. We value interactive or dialogical thinking: asking questions, thinking together about the questions, talking about them in words, and listening to others' opinions. In my class, we will examine various thought experiments of so-called moral dilemmas.

Co-thinking based on dialogue

Main Research Themes

- Philosophy for Children (P4C)
- The possibilities of a citizenship education based on philosophical education

Division of General Education
English

Accurate understanding and application of English grammar

Professor Daisuke Hara

Language is a system of rules, and it is essential for reading English correctly to grasp the sentence structure of English accurately. It is by organically linking fragmentary pieces of grammatical knowledge to understand the whole system of English that you can read and write English in a correct manner.

Exploration of Japanese Sign Language Linguistics and elucidation of the grammar of Japanese Sign Language

Main Research Themes

- Well-formedness condition of the Japanese Sign Language syllable
- Grammatical categories which the sentence-final pointing refers to

Division of General Education
English

The study of English education +α through Culture Training in the English Classes for Students Majoring in Engineering

Associate Professor Ken Ichikawa

My research field is applied linguistics and intercultural communication. At present, I am interested in how cross-cultural training is conducted in English language classes at the college level. The study aims to fulfil two purposes. The first is to help confirm whether a form of Culture Training known as Cultural Assimilators (hereafter referred to as CA), can be introduced into college English classes. The second purpose is to confirm how CA may develop students' competence in English and cross-cultural communication, and by extension contribute to English language development.

Investigating the possibility of introducing culture training into standard English classes

Main Research Themes

- Introducing culture training into English classes at the university level
- Developing new Culture Assimilators more suited to modern needs

Division of General Education ／Center of Support for Education and Research ／Specially Appointed Faculty

Division of General Education

Health and Sport Sciences

Deepen understanding of health and physical strength and promote physical and mental growth

Lecturer Mami Yoshimura

It is important to learn the theory of physical education field and be able to apply the knowledge gained. It is also important to enhance performance of the chosen area as well as to cooperate with team members and to enhance communication skills.

Measurement of ankle dorsiflexion angle and passive torque

Main Research Themes

- Comparison of factors related to jump performance in volleyball players and swimmers
- The effects of lower limb muscle strength characteristics and muscle shape on jump height

Library and ICT&Network Center

Information Technology Laboratory

The network with secure and convenient usage by The Internet technology

Professor Mineo Suzuki

We will develop technology so that the campus network will be secure and convenient, and support for information technology education and related work based on this technology. This will make a technological contribution to society.

Main Research Themes

- Achievement of a secure and effective environment of users under the mixed various standards about ICT technology
- Research about authentication platform usage of campus network through the Internet

Monodzukuri Science and Education Center

Monodzukuri Science Laboratory

Engineering design education for creativity development

Professor Shigeki Fujiwara

Research on engineering design education to foster student creativity and practical skills, design technology without rework during product development, mechatronics and robotics.

Education on how to think of original product planning

Main Research Themes

- Engineering design for creativity development while promoting science, academic and technical education
- Efficient design technology without backtracking for mechatronics product based on quality function deployment

Specially Appointed Faculty (Electronics and Information Engineering)

Development of human in the loop control systems

Specially Appointed Professor Tatsuo Narikiyo

We develop the control system design methods for human in the loop systems as power-assist robots and apply to the real systems.

Main Research Themes

- Development of Assist-as-Needed passive velocity field control and its application to power assist robots
- Development of nonlinear control theory via artificial intelligent technology and its application

Specially Appointed Faculty (Materials Science and Engineering)

Theoretical research to elucidate quantum phenomenon in materials

Specially Appointed Professor Ken'ichi Takano

We theoretically investigate the mechanisms of electrical conduction and magnetism, focusing on cases in which electrons strongly interact with each other and quantum effects are particularly important in materials.

Main Research Themes

- Magnetism of quantum spin systems
- Properties of low-dimensional strongly correlated electron systems
- Melting phenomena of materials

Specially Appointed Faculty (Division of General Education)

Do you know what you are?

Specially Appointed Associate Professor Kozi Asano

Think rationally and throughly. Try to understand yourself and the world around you. I will help you better understand the world including yourself.

Main Research Themes

- Animal Rights
- Global Justice

Specially Appointed Faculty (Materials Science and Engineering)

Biomaterials for tissue engineering and regenerative medicine

Specially Appointed Associate Professor Masami Okamoto

Biomaterials for use in regenerative medicine and promising strategy of cancer diagnosis are examined.

Main Research Themes

- Fabrication of biocomposites using mesenchymal stem cells
- Origin of cancer stem cells cultured on polymeric scaffolds

Specially Appointed Faculty (Materials Science and Engineering)

Laser-heating-based methods for fabricating semiconductor microspheres with definite sizes

Specially Appointed Associate Professor Akihisa Yanase

Semiconductor microspheres with definite sizes are obtainable by heating and melting semiconductor thin films with a definite volume using pulsed laser irradiation. We study the processes for fabricating semiconductor microspheres with high sphericity promising in optical device applications.

Main Research Themes

- Preparation of Ge microspheres by heating Ge thin patches with pulsed laser irradiation
- Preparation of hydrophilic polymer templates for thin-film micropatterning

Visiting Faculty

TOYOTA CENTRAL R&D LABS.,INC.

Toyota Central R&D Labs. and our Institute (TTI) started in 1994 the joint graduate school program. By inviting some of their researchers as visiting professors and by using their research facilities, TTI has expanded the range of its research activities.

Information-aided Technology

Mobility Engineering Laboratory

Research on comfortable mobility via modeling of occupant behavior and control engineering.

Visiting Professor Eiichi Ono

The occupant behavior in response to mobility motion is modeled with control laws derived based on natural human characteristics. Mobility control designed based on occupant behavior model achieves comfortable mobility.

Main Research Themes

- Analysis on Vehicle Maneuver Feeling
- Modeling of Occupant Behavior under Lateral Vehicle Motion

Future Industry-orientedBasic Science and Materials

Environmental Chemistry Laboratory

Environment-friendly materials and catalysts design based on LCA method

Visiting Professor Yoshihide Watanabe

We study the structural phase transition materials and the green process for molecular and energy conversion based on nanostructured or quantized particles in the light of the sustainability and life cycle assessment.

Main Research Themes

- Environmental catalyst system for green conversion utilizing flow reactors
- Phase transition and properties of environmental materials

Toyota Technological Institute at Chicago (TTIC)

Toyota Technological Institute at Chicago (TTIC) was inaugurated in 2003 as the sister institute of TTI in collabora-tion with the University of Chicago so as to strengthen TTI's graduate program in the computer science (CS) field. TTIC conducts world-class PhD education and research in fundamental CS field with focus on machine learning.

Theoretical Computer Science and Machine Learning

Adjoint Professor Avrim Blum

My research focuses on machine learning theory, algorithmic fairness, and issues of incentives in machine learning systems.

Main Research Themes

- Providing theoretical foundations for machine learning algorithms and approaches
- Developing algorithms with human-centered goals such as privacy, fairness, and incentive alignment

Machine Learning, Natural Language Processing, and Automated Reasoning

Adjoint Professor David McAllester

Recent research has been in the area of answering question about natural language news articles using deep neural network models.

Main Research Themes

- The design of deep neural network architectures for understanding natural language
- Automated reasoning architectures combining deep and classical methods

Cluster Research Laboratory

The Special Cluster Research Project of Genesis Research Institute, Inc., which was founded by Toyota Motor Corp. in 1996, focuses on physical properties, chemical reactivity, and functionalities of atomic clusters consisting of a few to hundreds of atoms. The research unit of this project has been integrated in TTI so as to expand its research and educational activities with higher quality.

Design and measurements of novel materials created from combination of clusters

Visiting Professor Masahiko Ichihashi

Clusters are elemental units to compose novel materials. Just as "chemistry" came from the bond formation between atoms, the combination of clusters produces "cluster complex chemistry". We propose novel useful materials such as composite catalysts from the cluster-based design.

Main Research Themes

- Research in catalyst world and realization of cluster catalysts: Complexes of metal clusters
- Research in cold world and applications: Complexes of metal clusters and liquid helium clusters

Novel functional development utilizing sub-nano interface between atomic cluster and solid surface

Visiting Professor Hisato Yasumatsu

On the basis of our invention of the low-temperature and highly-durable reduction/oxidation catalysts driven at the sub-nano interface, we are pioneering novel functions of molecular- and energy-conversion materials and electronic devices through atomic-level measurements of their geometry, reaction kinetics and electronic properties.

Main Research Themes

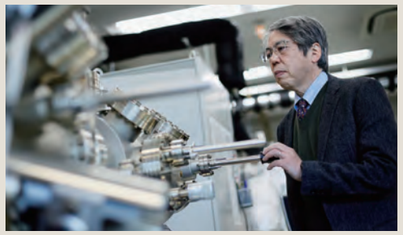
- Controlling structure and electronic states of the sub-nano interface by means of cluster impact
- Atomic-level measurements of molecular- and energy-conversion kinetics and electronic properties

TTI Research Centers

Research Center for Smart Vehicles

Established in 2010　Project Leader : Professor Masatoshi Shimoda

The Smart Vehicle Research Center of the Toyota Technological Institute was established in April 2010 with the aim of promoting R&D on "Smart Vehicles".We regard "Smart Vehicles" as any means of intelligent mobility from land mobility to space mobility, including drones and mobile robots. In this center, laboratories in the fields of mechanical engineering and computer science have been closely cooperating to create essential technologies that lead to the future smart and green vehicle society.



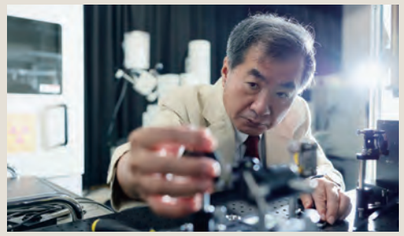
Research Center for Smart Energy Technologies

Established in 2012　Project Leader：Professor Yoshio Ohshita

This center aims at developing smart energy technologies for sustainable society. We integrate science and technologies of "generation", "control" and "conversion and storage" of energy. Our research focuses on (1) photoelectric conversion devices and systems (2) control of electric power network, (3) high efficiency energy conversion and new electric energy storage.

Research Center for Smart Photons and Materials

Established in 2016　Project Leader：Professor Yasutake Ohishi



Research Center for Smart Photons and Materials brings together research related to photonics at Toyota Technological Institute. The center conducts research on themes from materials to devices and systems necessary for generating and manipulating light and constructing high-precision measurement technology using light. Representative research projects include; generation and control of lightwave in the ultraviolet to far-infrared region using microstructured optical fibers made of special glasses developed by our own research group; development of high-performance optical fiber lasers based on silica optical fiber technology; development of light sources, sensors, actuators, and other devices using MEMS technology; research on highly sensitive surface measurement methods using light as a probe; research on ultrashort optical pulse lasers and optical field waveform measurement technology; development of new synthetic methods of macromolecules and semiconductor microspheres for controlling lightwave, in order to develop these research areas. Our research activities in this center will lead to not only the innovation of information communication technologies, but also green and life innovation including environmental technology, medical sensing and diagnostics, etc.

Research Center for Smart Information Technology

Established in 2021　Project Leader：Professor Norimichi Ukita

Recent information technologies including machine learning and data science are being developed in a variety of research fields. The research center for smart information technology aims to develop basic research and applied research in such information technology areas. Among all such areas, our main targets are knowledge representation, media processing/recognition, and real-world sensing as the basic research. Based on these basic technologies, we also focus on material informatics, mechanical informatics, and other interdisciplinary application areas.

TTI Education & Research Center

Education & Research Center / Center for Next Generation Civilization

Established in 2016　Project Leader：Professor Emeritus Yoichiro Murakami (The University of Tokyo・International Christian University)

As an institution with both “educational” and “research” functions, the Center will, on the one hand, advance the enrichment and development of general education based on liberal arts and, on the other hand, promote civilization research from the integrated perspectives of the humanities, natural sciences, and engineering, thereby aiming to contribute to building an intellectual foundation for creative and leading-edge knowledge that is ahead of the times.

Access & Location

Refining sensibilities and furthering learning, among the bustle of the city area

1. Nagoya Station area
2. SCMAGLEV and Railway Park
3. Nagoya Castle
4. Atsuta Shrine
5. Central Japan International Airport
6. Toyota Automobile Museum

The TTI campus is located in Nagoya City. In addition to the Nagoya Station and Sakae areas, where the latest commercial facilities and restaurants are concentrated, our location offers easy access to popular spots such as the historic castle, temples, shrines, and manufacturing-related museums.

Access From Airport

- Narita International Airport — JR Line (70min) → Tokyo Station — JR Shinkansen (100min) → Nagoya Station
- Kansai International Airport — JR Line (80min) → Shin Osaka Station — JR Shinkansen (50min) → Nagoya Station
- Chubu Centrair International Airport — Meitetsu Line (40min) → Nagoya Station

Nagoya Station — Subway Sakura-dōri Line (32min) → Aioiyama Station — Walk (10min) → Toyota Technological Institute