Dreams for the Future

Green Innovation

Research and development of active energy management of smart grid communities

The aim of this research is to develop an active energy management system for a smart community. The energy management has a crucial role in the community where electrical energy is supplied from renewable power sources such as solar, wind, and wave power plants, in addition to the conventional power plants and batteries. In the smart grid community, the power system is mixed one which consists of AC-DC line, DC-DC line, and DC-AC line. Moreover, the renewable resources are not stable since they are affected from environmental conditions. Therefore, the complicated power control method is required for the high efficient power management system. We have already established the power management technology for specific purposes such as data centers. We now challenge to develop a power control for the active energy management for the smart community, which is more a general and complicated system. The complicated power system in the smart grid community requires a superior control and management to achieve high efficiency and low power consumption. We focus on the potential of the digital technology to realize such management system for smart community. Our development will contribute to an energy recycling-oriented society in the near future.

Message from the Dean

The Nagasaki University School of Engineering was founded in 1966. The year 2015 marked our Golden Jubilee celebrations. On November 28th, 2016, a memorial ceremony was held to mark this 50th anniversary. As of March 2017, a total of 15494 engineering students have graduated since the foundation, and have been highly recognized in a broad range of industries worldwide.

In 2011, the School was restructured into a seven-department system into an interdisciplinary body with six complete programs: Mechanical Engineering, Electrical and Electronic Engineering, Computer and Information Science Engineering, Structural Engineering, Civil and Environmental Engineering, and Chemistry and Materials Engineering Programs. The structure of the new programs allows us to train individuals to acquire professional and extensive knowledge through specialized courses built on fundamental engineering, providing flexible responses to various social and industrial demands. Education reform in the undergraduate program also requires engineers to acquire crucial aptitudes like problem tackling, communication skills and work ethics. The Graduate School of Science and Technology also reorganized and started a new era of the Graduate School of Engineering in the same year. Students are equipped with specialized engineering knowledge in our integrated undergraduate and master's programs, and further enhanced in the doctoral program. Our 5-year program (Department of Advanced Technology and Science for Sustainable Development) was created to demonstrate a continuous education that can nurture researchers with sophisticated research capability. In April 2015, the Water and Environmental Engineering Program (master's program) and the Water and Environmental Science Program (doctoral program) were established as another integrated educational system to strengthen our program in globally active human resource development. We have taken the initiative in pursuing globalized and cutting-edge research innovation through education and research guidance reform.

In this reform movement, several centers within the Graduate School also reorganized and consolidated into four centers: Infrastructures Lifeline Extending Maintenance Research Center (founded in January 2007), Research Center for Future Science and Technology (October 2012), Engineering Education Center (October 2013), and Center for the Promotion of Global Cooperation (October 2014). Activities held in these facilities also have reflected in the faculties’ research achievements and teaching performances positively.

We offer top-notch education and research guidance for individuals who strive for knowledge and those who are willing to expand their expertise in engineering. We welcome you to join us on the journey of seeking and exploring undiscovered science.

Yasuhiro Shimizu

Development of robotics for medical, nursing, and welfare cares by cooperation of medicine and engineering

With regard to medical innovation, a process has been developed whereby medical instruments, which are easy for doctors to use and gentle on patients, can be seamlessly developed using CAD (Computer Aided Design) and 3D printing making immediate evaluation possible. Furthermore, in response to medical needs, intelligent operating systems are being developed. Developments are also being made in robotics in order to provide assistance for nurses and care workers to provide improved care for the disabled and elderly.

Fig1  CAD design of forceps
Fig2 3D printed forceps

Fig1 High Voltage Direct Current (HVDC) Power Conversion System (NEDO, Green IT Project).
(a) Container type power conversion system (b) Prototype of HVDC power supply unit.
The Novel Creative Research

Materials science research on innovative low carbon technologies

Nowadays, we are facing severe environmental issues such as global warming and climate change. Greenhouse gas emissions, convincingly a major cause of the global warming, are mainly derived from the transportation sector and electricity power generation based on the consumption of fossil fuels. This project focuses on the two research themes: (1) Development of innovative materials for next-generation energy storage devices, (2) Development of novel synthetic technologies of energy resources. For example, we have been developing new materials for high performance Li-ion batteries with high power, high energy and safety, to apply to electric vehicles and electric power grid connection systems. Furthermore, we are strengthening the developments of novel technologies for CO2-reduction and conversion into valuable carbon resources. We are aiming at essential innovation by seeking new breakthrough technologies and chemical transformations, in addition to addressing the perspectives of environmental issues.

Research project on innovative next generation magnets –“Control of Nanostructure” and “Alloy Composition Exploration” –

A conventional Ni-Fe-B permanent magnet is an attractive material and has been widely used, however we are still searching for new materials as a next generation permanent magnet from a future application point of view. In our project, we focus on the preparation of various permanent magnet materials by taking account of analysis results with the micro magnetic theory. For example, the computer simulation indicated that [Bi]-prase exceeded 300 kJ/m3 under the high temperature at 473 K in Sm-Co-Fe nanocomposite magnets with multi-layered structure (see Fig. 1). The value was much higher than that of an Nd-Fe-B magnet. We, therefore, try to fabricate Sm-Co-Fe multilayered films by using a PLD (Pulsed Laser Deposition) method as shown in Fig. 2. It was clarified that the control of microstructure of Sm-Co permanent magnets including a Fe phase is an effective method of developing a high-temperature magnet. Our group also attempt to control the microstructure for Sm-Co-Fe nanocomposite magnets synthesized by using a wet process. We will demonstrate several prominent candidates as a next generation magnet through the simulative and experimental approaches.

School of Engineering and Graduate School of Engineering

Organization

(As of 1 May, 2017)

<table>
<thead>
<tr>
<th>Division</th>
<th>Engineering Field</th>
<th>Professor</th>
<th>Associate Professors</th>
<th>Assistant Professors</th>
<th>Research Associates</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division of System Science</td>
<td>Engineering for Sustainable Development</td>
<td>5</td>
<td>1</td>
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<td>9</td>
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<tr>
<td></td>
<td>Human and Engineered Environmental Science</td>
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<td>9</td>
<td>2</td>
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<td></td>
<td>Computer Science</td>
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<td>2</td>
<td>3</td>
<td></td>
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<tr>
<td></td>
<td>Information Science</td>
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</tr>
<tr>
<td>Division of Chemistry and Materials Science</td>
<td>Surface and Interfacial Nano-Science</td>
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<td>5</td>
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<td>Molecular and Life Science</td>
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<td>Affiliated Division</td>
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<td>Eco Materials Science</td>
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<td>2</td>
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<td></td>
<td>Future-Oriented Control and Metrology Course</td>
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<td></td>
<td>1</td>
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<tr>
<td></td>
<td>Total</td>
<td>40</td>
<td>47</td>
<td>25</td>
<td>1</td>
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</tbody>
</table>

History

1966.4.1 The Faculty of Engineering (Department of Mechanical Engineering and Electrical Engineering) was established.

1971.4.1 The Department of Structural Engineering, Department of Civil Engineering, Department of Materials Science and Engineering, Department of Industrial Chemistry, Department of Electrical and Electronic Engineering, Department of Computer and Information Science were established in following years.

1987.4.1 The Department of Marine Science and Development was established in the Graduate School of Engineering Science (Doctoral Course). It was transferred to the Graduate School of Marine Science and Engineering in the following year.

2001.4.1 The Graduate School of Marine Science and Development was reorganized into the doctoral course of the Graduate School of Science and Technology. Along with this, the Graduate School of Engineering (Master’s Course) was transferred to the Graduate School of Science and Technology (Doctoral Course).

2008.4.1 TDK Endowed Chair “Energy Electronics Laboratory” was established.

2010.3.31 Due to the establishment of Advanced Computing Center, Ultra-High Speed Many Core Computing Research Center was discontinued.

2011.4.1 Faculty of Engineering’s seven departments (Mechanical Systems Engineering, Electrical and Electronic Engineering, Computer and Information Sciences, Structural Engineering, Civil Engineering, Materials Science and Engineering, and Applied Chemistry) were restructured into one engineering department, and renamed The School of Engineering.

The Graduate School of Science and Technology was restructured to establish the Graduate School of Engineering and the Graduate School of Fisheries Science and Environmental Studies.
Programs and Majors

Educational Philosophy and Aim

Philosophy of the School of Engineering
Based in Nagasaki, a city echoing the heartbeat of Asia, the school seeks to contribute to the sustainable development of society by acquiring intelligence, spirit, and a strong understanding of science and technology to shape the future.

Educational Aim of the School of Engineering
Extensive educational programs are provided to deliver a strong fundamental education and robust knowledge of the individual specialties, while also focusing on students acquiring technical ethics, communication skills, and task-researching capabilities.

Educational Philosophy and Aim of the Graduate School of Engineering
(Educational Philosophy)
As an educational and research base for advanced engineering which coexists with nature and commits to the sustainable development of human society, the Graduate School of Engineering will foster highly professional engineers and researchers who possess professional and interdisciplinary knowledge along with the high expertise across a wide range of engineering topics, and who will be able to play an active role in the international field. We will also contribute to promoting innovative science and technology of the next generation through conducting pioneering and innovative research.

(Aim)
To develop in students professional and interdisciplinary knowledge along with high expertise across a wide range of engineering topics, and to cultivate their skills to explore and solve problems as well as their capabilities to conduct internationally pioneering research and development.

(As of 1 May, 2017)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>School of Engineering</td>
<td>Mechanical Engineering Program</td>
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<td>Electrical and Electronic Engineering Program</td>
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<td>Computer and Information Science Program</td>
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</tr>
<tr>
<td></td>
<td>Structural Engineering Program</td>
<td>181</td>
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<td></td>
<td>Civil and Environmental Engineering Program</td>
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<td>Chemistry and Materials Engineering Program</td>
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<tr>
<td>Graduate School of Engineering</td>
<td>Mechanical Engineering Program</td>
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<td>Electrical and Electronic Engineering Program</td>
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<td>Computer and Information Science Program</td>
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<td>Structural Engineering Program</td>
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<td>Civil and Environmental Engineering Program</td>
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<td>Chemistry and Materials Engineering Program</td>
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<tr>
<td></td>
<td>Water and Environmental Engineering Program</td>
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</tr>
<tr>
<td>Master's Degree</td>
<td>Department of Advanced Engineering Program</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineering Program</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Electrical Engineering and Computer Science Program</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Chemistry and Materials Science Program</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Water and Environmental Science Program</td>
<td>4</td>
</tr>
<tr>
<td>Doctoral Degree (3 Year Program)</td>
<td>Department of Advanced Technology and Science for Sustainable Development</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Next Generation Energy System Program</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advanced Functional Materials Program</td>
<td>11</td>
</tr>
<tr>
<td>Doctoral Degree (5 Year Program)</td>
<td>Department of Science and Technology Program</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Master’s Degree</td>
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</tr>
<tr>
<td></td>
<td>Doctoral Degree (3 Year Program)</td>
<td>6</td>
</tr>
</tbody>
</table>
**Electrical and Electronic Engineering Program**

**Educational Content**
Acquiring the basic knowledge of the field of electrical and electronic engineering, as well as more advanced, highly specialized knowledge, practical skills, and applied skills to flourish internationally.

**Research Content**

<table>
<thead>
<tr>
<th>Electric Energy and Plasmas</th>
<th>High voltage engineering and discharge phenomena (Insulation design, discharge in super critical fluid, discharge on water, Silent discharge, Ozonizer)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plasma science and technology (Plasma processing, Plasma diagnostics)</td>
</tr>
<tr>
<td>Control Systems</td>
<td>Control theory and applications (Microcomputer control of inverter-fed induction motor and PM synchronous motor, power converter and control of distributed generation and power conditioner)</td>
</tr>
<tr>
<td>Electronic Circuits and Devices</td>
<td>Electric machinery and applications, Power electronics (Development and control of novel motor and generator, Design analysis of electric machinery, Vibration energy scavenging by mechanical pendulum, AC to AC power conversion system, High performance motor drive system, Full vehicle simulation)</td>
</tr>
<tr>
<td>Electromagnetic Waves and Communications</td>
<td>Power electronics for smart green systems, Switching power supply for green IT and HVDC systems, Digital control for DC-DC and AC-DC converters, Engine control systems for satellites, Intelligent signal processing, Image recognition, Sensing circuit system</td>
</tr>
<tr>
<td></td>
<td>Magnetics (Computer simulation of magnetic properties, Development of magnetic materials for Micro-machines, Application of magnetic materials)</td>
</tr>
<tr>
<td></td>
<td>Information and communications technology by electromagnetic wave (Optical communication, Development of high functional antennas such as multiband, wideband antenna)</td>
</tr>
<tr>
<td></td>
<td>Electromagnetic wave theory (Electromagnetic wave scattering, Inverse scattering, Metamaterials, etc.) and its applications (Microwave imaging, Microwave tomography, Concrete radar, Polarimetric synthetic aperture radar, Radar target classification, Target tracking, Monitoring of the living body)</td>
</tr>
</tbody>
</table>

**Computer and Information Science Program**

**Educational Content**
Acquiring a problem-solving ability with a deep knowledge of engineering theory of computer and information science, as well as knowledge of hardware, software, and applications related to a wide range of fields.

**Research Content**

| Computer Science | - Information extraction  
|                  | - Computer architecture  
|                  | - Real-time Information processing  
|                  | - Network performance evaluation  
|                  | - Distributed artificial intelligence  
|                  | - Programming languages  
|                  | - Network applications  
|                  | - Reconfigurable Computing  |
| Theoretical and Applied Software Science | - Computer vision and pattern recognition  
|                                           | - Sparse modeling  
|                                           | - Information retrieval and data clustering  
|                                           | - Pattern Information processing  
|                                           | - Algorithmic number theory and its application to cryptography  
|                                           | - Information security  |
| Applied Information System Engineering | - Image processing, image coding and digital watermarking  
|                                           | - Computer graphics  
|                                           | - Human computer Interaction  
|                                           | - Speech processing  
|                                           | - Remote sensing  
|                                           | - Machine learning and data mining  
|                                           | - Software architecture  |

Highly efficient FPGA implementation of human detection with a deep-pipelined stream architecture

Research of internet of Things (IoT); everything connects to the Internet.

Bayesian topic analysis of “The Nagasaki Shipping List and Advertiser”

Rehabilitation support system using virtual reality
Structural Engineering Program

Educational Content
This program fosters advanced professional engineers and researchers to correspond to the needs of the structural engineering field in an industrial society, by acquiring advanced specialized knowledge with an international perspective.

Research Content

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Systems</td>
<td>Research into development of structural materials, construction techniques, optimum planning and design of structures, for harmonizing structures between humans and the environment, by interpreting each structural system field (planning, design and construction) systematically.</td>
</tr>
</tbody>
</table>

Development of low-cost seismic retrofitting technology by concrete filled steel tublar brace acting in compression for old buildings.

Research on management of dwelling environment, landscape-control and preservation of traditional houses.

DEM ground anchor
Reinforcement by FRP
Development of repair and reinforcement methods

Optical measurement
Moseismic data
FEM analysis
Detection of mechanisms of degradation and disturbance of structures by using an optical measurement and FEM

Measured image
Loading process
Compressive plastic area
Unloading process

PV based displacement vector estimation around the fatigue crack tip

Civil and Environmental Engineering Program

Educational Content
Acquiring of certain basics of engineering, a broad expertise related to civil engineering, as well as story thinking ability and analytical capability.

Research Content

<table>
<thead>
<tr>
<th>Geoenvironmental Engineering</th>
<th>- Dynamic characteristics of geomaterials - Design and maintenance management of geotechnical and rockmass structures - Numerical analysis and model tests for evaluation of slope stability under heavy rainfall - Evaluation of soil stabilizer with various recycled materials for ground improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Engineering</td>
<td>- Static and dynamic analysis of civil structures - Techniques for design and maintenance management of structure - Remote on-line monitoring of physical phenomena on civil structures - Controlling techniques for structural vibration</td>
</tr>
<tr>
<td>Space Engineering and Planning</td>
<td>- Urban and regional planning based on history and townscape - Remote sensing of hydrology and its application to disaster prevention</td>
</tr>
<tr>
<td>Hydraulic Engineering and River Engineering</td>
<td>- Environmental assessment and improvement of enclosed coastal seas and lakes, performance of hydraulic structures - Numerical analysis of change of water environment, evaluation of pollution load and its reduction, water quality improvement technologies</td>
</tr>
</tbody>
</table>

ASTER: Chao Phraya River image
River Flooding of Chao Phraya in 2011
Learning construction techniques via field visit
Remote sensing and monitoring of infrastructures
Urban maintenance in consideration of natural environment
Chemistry and Materials Engineering Program

Educational Content
This program provides a quality education that prepares students for the challenges and opportunities in modern society, in which technology for efficient creation of new substances and transformation of energy is necessary and requires an interdisciplinary effect. Rigorous classroom instruction and laboratory experiences enhance the student’s fundamental knowledge of nature science and expertise knowledge in molecular, materials engineering and bioengineering, so that they can play active roles in the interdisciplinary area and be globally competitive in academia and industry.

Research Content

Water and Environmental Engineering Program

Educational Content
The program in this course emphasizes a practical and multidisciplinary approach to solving environmental problems. The course comprises lectures, practicums and an individual research project. Teaching in the course focuses on fundamental understanding in water treatment technologies, monitoring of water environment and numerical modeling of water environment such as lake or ocean. Students learn more practical techniques for water treatment and monitoring thorough practicums at the same time. Moreover, an internship program in a private company or a water treatment facility will be carried out for students.

Research Content
- Water treatment, water reuse and wastewater treatment
  Our course will provide you with a fundamental and practical knowledge about conventional and advanced water and wastewater treatment technologies. You will study on advanced water treatment and re-use technologies using membrane separation systems such as nanofiltration systems. Development of advanced materials such as new photo-catalysts and polymer materials for water treatment is an important topic in our course. Moreover, appropriate water and wastewater treatment technologies for developing countries will be studied collaborating with South East Asian and African countries.
- Monitoring and simulation on water environments and aquatic ecosystem
  Our course will provide you with a theoretical background and a practical knowledge about water quality, monitoring and computer simulation of water environment. You will study about coastal environment, inner bay and freshwater environment by several advanced monitoring techniques and eco- hydraulic computer simulation models. Hydrology and water resources analysis using satellite data are remarkable research topics in our course. Moreover, development of water purification systems for eutrophication lakes and reservoirs will be studied using mechanical, biological and ecological methods, especially for a countermeasure of harmful cyanobacteria.

High resolution TEM image of β-ZnSb
Transmission electron microscope (TEM)
TEM image of porous SiOx powder
Organic synthesis
Spectroelectrochemistry
Phosphorescent materials
Experiment on an advanced water treatment
Microscopic observation and isolation of phytoplankton collected from reservoirs (Nagasaki, Japan)
Appropriate water treatment system for Lake Victoria (Kenya)
Hydraulic computer simulation of water current of Nyarage gulf in Lake Victoria (Kenya)
Department of Advanced Technology and Science for Sustainable Development
(5 Year Doctoral Degree Program)

Educational Content
Our department will provide a broader and deeper educational and research environment to highly motivated students in the area of energy systems (Next Generation Energy System Program) and high performance materials (Advanced Functional Materials Program). We will provide students with opportunities to realize sustainable development, to invent technology, and to discover materials that improve society’s access to clean and effective energy.

Research Content

Next Generation Energy System Program
- Analysis of Liquid Atomization Process
- Development of Smart Green Power Electronics Circuit
- Analysis of Damage and Fracture in Composites and Bio-materials
- Development of Rare-earth Less Motor and Novel Wind Turbine Generator
- Development of Energy Storage Device Materials via Nanomaterials Control
- Design of High-Reliability Insulation in Energy Transportation and Conversion System
- Fabrication of Functional Metallic Materials Using Electrodeposition Technique
- Development and Structural Analysis of Thermoelectric Materials

Advanced Functional Materials Program
- Development of Efficient Organic Synthesis for Functionalized Materials
- Advanced Design of Electrification Interfaces for Functional Molecular Assemblies
- Design, Control and Application of Functional Ceramic Materials
- Development of High-Performance Magnetic Materials via Control of Nanostructure
- Precise Control of Polymer Degradation and Synthesis of Green Polymeric Material
- Machining and Measurement of Functional Material
- Activation of Small Molecules by Transition Metal Complexes
- Analysis of Interaction between Plasma and Solid Surface

Off-campus research
All students of the Department of Advanced Technology and Science for Sustainable Development must participate in the “off-campus research” program during their 4th year of study. In this program, they are required to study abroad for at least 3 months under normal circumstances. The following map shows all institutions and universities that hosted our students during 2015-2017.

International Exchange Agreement of Academic Exchange with Oversea Institutes

International Students
(As of 1 May, 2017)