

Current research projects of the departments

Department	Course	Contents of Current Researches
Physics and Materials Science	Fundamental Physics	The goals of this course are: (i) to uncover the mechanisms of diverse phenomena in condensed matter physics, e.g. superconductivity and magnetism, (ii) to explore their possible applications toward future designs of materials, (iii) to establish theoretical descriptions of quantum many-body systems of quarks, leptons, and gauge particles, and (iv) to explain macroscopic properties of solids, liquids, and powders by microscopic methods of statistical and computational physics.
	Materials Engineering	This course focuses on characterizing microstructure and properties of materials from microscopic to macroscopic scales, in order to elucidate the relationship between materials microstructure and their properties. The scope of this course covers a wide range of engineering and electric materials from metals to semiconductors.
	Electronic Device Engineering	Functional materials, such as semiconductors, superconductors, magnetic materials, and transparent conductive materials, have various electric and magnetic properties. In this course, the mechanisms behind those properties are deeply investigated based on physics. Applying the obtained knowledge, this course aims to develop new devices with novel functions as well as to drastically improve the performance of already existing devices such as solar cells and light emitting diodes.
Chemistry	Basic Chemistry	Development of photo-organic synthesis and selective organometallic reaction. Development of catalytic asymmetric reactions and synthesis of optically active compounds. Development and functional elucidation of novel aromatic compounds. In-situ characterization of catalyst active sites using spectroscopy. Development and application of new photo-reactions and photophysical properties.

	Environmental Chemistry	Chemical limnology, geochemical study and development of analytical methodology of brackish water environment. Synthesis of new phthalocyanines and polymers containing metal-metal bonds. Synthesis of new metal-organic framework compounds and quantum chemical calculations. Fabrication and evaluation of environment-friendly ceramics. Development of emitting nanoscale materials and their applications to biomarkers.
	Functional Materials Chemistry	Design of advanced catalysts for organic resources. Synthesis of functional inorganic oxide particles and functional enhancement of inorganic oxide particles by surface and particle design. Synthesis and properties of functional polymers. Development of polymers and supramolecules with novel functions. Fabrication and study of the formation mechanism of nano-sized materials using novel photo- and laser-process. Experimental characterization of the mechanical properties of solid wood and wood-based materials. Effective utilization of untapped wood resources. Recycling of woody wastes and utilization of low quality woody biomass. Evaluation of mechanical, physical and chemical properties of Washi (Japanese papers) in Shimane Prefecture. Material design of organic-inorganic hybrid materials and CO ₂ reduction of construction materials.
Earth Science	Geoscience	Igneous and metamorphic petrology, Volcanology, Mineralogy, Geochronology, Petroleum geology and Hydrocarbon resource geochemistry, Organic and Inorganic geochemistry, and Geodynamics, i.e., researches for constituents of the earth's interior such as rocks, minerals and earth resources and the circulations including formation processes.
	Geoenvironmental Science	Environmental geology, Stratigraphy, Paleontology, Paleooceanography, Quaternary geology, Structural geology and Sedimentology, i.e., Geo-history of Japanese island arcs, Asia and Africa; Environmental geology of brackish lakes and deltas; and Tectonics of sedimentary basins.
	Geo-disaster Science	Mechanical properties and temporal changes of soil, rocks, and rock masses. Ground deformation analysis based on finite deformation elasto-plastic theory. Geotechnical properties of alluvial deposits and their

		environmental evaluation. Subsurface fluid engineering. Groundwater simulation. Studies of natural hazards and natural disasters including landslides.
Mathematics	Pure Mathematics	Ring theory. Number theory. Differential geometry. General topology. Geometric topology. Differential topology. Complex geometry. Ordinary and functional differential equations. Complex analysis.
	Applied Mathematics	Partial differential equations. Optimization theory. Mathematical statistics. Ergodic theory. Mathematical modeling and applications. Mathematical biology. Functional equations. Dynamical systems.
Information Systems Design and Data Science	Data Science	Information visualization. Simulation technology. Probability theory and statistics. Image processing. Sensor networks. Multimedia data engineering. Formal language theory. Information retrieval. Well-being information technology. Information-related education. Language processors. Model of computation.
	Information Systems Design	Programming languages. Formal verification, synthesis, and transformation. Intelligent information processing. Human-computer interaction design. Program analysis. Digital design and design methodology. Cryptography. Algorithm and complexity theory.
Mechanical, Electrical and Electronic Engineering	Mechanical Engineering	Mechanics and design of advanced materials and flexible structures. Active vibration control, transfer control and nonlinear control for mechanical systems. Sound and vibration measurement. Design and performance analysis of gear devices used as robot joints. Damping and transfer control for wheeled mobile robots and carts. Fluid dynamic design of vehicles and engines. Analysis of resonance phenomenon and reduction of vibration.
	Electrical and Electronic Engineering	Development of assisting system for developmental disorder. Development of communication aids. Development of optical metrology systems. Development of optical fiber sensing systems. Remote sensing using electromagnetic waves. Optical and

		<p>photonic systems. Image systems engineering and applied vision. Biomedical signal processing. Development of compressed sensing systems.</p>
Architectural Design	Building structure/Environmental engineering	<p>Experimental tests of seismic members or corroded steel members. Seismic design, analysis and optimization of building structures. Housing environment. Room acoustics.</p>
	Architectural planning and design	<p>Architectural Design. Theory of Architecture. Architecture planning. Urban design. City Planning Theory. The history of architecture. Renewal technology of a building. Planning history and heritage. Conservation of historical building. Traditional housing. Landscape. Wooden construction methods.</p>