Applied Physical Chemistry of Materials 2 credits Elective/Required Professor Shigeru Suzuki Professor Hiroyuki Fukuyama Associate Professor Satoshi Ito Associate Professor Shigeru Ueda Lecture on fundamental chemical reactions (chemical equilibrium and reaction rate) relevant to materials processing and various reactions of materials with chemical species in environment during service.	Computational Materials Science 2 credits Elective/Required Professor Tetsuo Mohri Professor Momoji Kubo Associate Professor Rodion Belosludov It is becoming possible to design high-performance materials using ab initio computer simulations. These developments have led to the emergence of computer simulations as the third branch of science and technology besides traditional experimental and theoretical studies. This lecture starts with an introduction of atomic level design of materials based on the first-principles simulation techniques, and finally aims to provide an understanding of the physical and chemical properties of complex materials by applying molecular dynamics, Monte Carlo method, and continuum mechanics. It also gives an introduction of necessary basic knowledge of numerical techniques to achieve efficient computer simulations. Finally this lecture would cover anticipated future trends, and by using actual examples of current interests, it tries to teach usefulness and limitations of the subject in general.
Applied Elasticity and Plasticity 2 credits Elective/Required Associate Professor Fumio Narita 1. Aim This lecture is aimed not only at the future structural engineer who of necessity must use this analysis in design, but at all future engineers in providing them with a basic introduction to the mechanical behavior of solid media. It can also be viewed as a suitable preparation to fracture mechanics and composite materials. 2. Outline Review of the basic equations of linear theory of elasticity. Fundamentals of theory of plasticity. Mathematical foundations of elastic-plastic fracture mechanics. Introduction to mechanics of composite materials. Numerical methods and design problems are included. 3. Scope This lecture is intended for the student, who has a good knowledge of the basic elements of mechanics of elastic-plastic materials, but who wishes to introduce more physics into the design and manufacture of products, with or without the help of computers, or in the safety analysis of material systems and structures. In the lecture the student will also find the treatment of fracture mechanics and composite materials.	Design and Control of Joining Interface of Materials 2 credits Elective/Required Professor Hiroyuki Kokawa Associate Professor Yutaka Sato Part-time Lecturer Yuji Inoue Design and Control of Joining Interface of Materials is the study of principles to control and design interfaces of joined materials to improve the mechanical and functional properties. It involves the metallurgy and materials science for joining design and grain boundary engineering, and is concerned with technically and economically feasible solutions to problems in joining and grain boundary control, relating to innovation, costs, quality, and reliability, and to societal and environmental concerns.
Physics of Electrons in Solids 2 credits Elective/Required Professor Junsaku Nitta Professor Tetsuo Taniuchi Associate Professor Makoto Koda This course is dedicated to understand the basis of phonons and electrons in solids by using the concepts of solid state physics, in addition to their related phenomena, which are origin of the functionality in materials.	Theory of Phase Transformations 2 credits Elective/Required Professor Ryosuke Kainuma Professor Hiroshi Ohtani Part-time Lecturer Kaneharu Okuda Objective: to promote understanding of the phase equilibria and transformations on the basis of thermodynamics and kinetics, and to study some basic concepts on the microstructural control and materials design.

Advanced Functional Materials 2 credits Elective/Required Professor Izumi Muto Professor Hisanori Yamane Professor Nobuyoshi Hara Associate Professor Takahiro Yamada The purpose of this course is to acquaint students with fundamental knowledge about metals and inorganic compounds used as component materials for the fabrication of functional devices. This course is arranged into three parts. In the first part, it describes the principle application of purification methods of metals and compound semiconductors. In the second part, it gives a basic description of thin film formation processes. The third part deals with the concepts of crystal chemistry of inorganic materials.	Theory of Phase Transformations 2 credits Elective/Required Professor Junichi Koike Professor Tadashi Furuhara Professor Kyosuke Yoshimi Professor Naoya Masahashi Associate Professor Yuji Sutou In this lecture, materials microstructure and various processes controlling microstructure are introduced, focusing on deformation by processing, formed microstructure, function and property of materials from the standpoints of micro and macro scale. Furthermore, basic concepts to design the materials and processes are lectured through showing practical examples.
Structural Characterization of Materials 2 credits Elective/Required Professor Kazumasa Sugiyama Professor Toyohiko Konno Professor Anpoh Tsai Professor Daisuke Shindo Associate Professor Takanori Kiguchi Associate Professor Satoshi Kameoka In order to understand the structure / property relationships of various advanced materials, it is important to make clear their internal structures on atomic scale. In this lecture, principles of structure analysis methods, such as X-ray diffraction (XRD), high-resolution electron microscopy (HREM) and electron diffraction are outlined. Also, advanced structure analysis methods, such as precise characterization of surface and interface structures by grazing incident X-ray scattering (GIXS) and determination of the environment of a particular constituent element by anomalous X-ray scattering (AXS) method will be explained. Furthermore, the analyses on composition and electronic structure by energy dispersive X-ray spectroscopy (EDS) and electron energy-loss spectroscopy (EELS) with an analytical electron microscope will be noted.	Processing of Device Materials 2 credits Elective/Required Professor Shunichi Sato Associate Professor Koji Mimura Introduce students to: 1) fundamentals, present and future of laser-related material processing, 2) fundamentals of lasers. 3) fundamentals of semiconductor devices
Process Metallurgy 2 credits Elective/Required Professor Tetsuya Nagasaka Professor Shinya Kitamura Professor Hiroshi Nogami Associate Professor Takahiro Miki Associate Professor Shigeru Ueda The fundamentals of process operations using metal smelting process especially iron and steel making process, in terms of oxidation, reduction, evaporation, solidification are lectured from the standpoints of chemical thermodynamics, reaction kinetics and solidification. By this lecture, basic methods to analyze and design the iron and steel making process can be studied.	Engineering and Technology in Materials Forming 2 credits Elective/Required Professor Kouichi Anzai Professor Katsunari Oikawa Professor Akihiko Chiba Associate Professor Masayuki Itamura The practical sides of the plastic forming processes, such as sheet bending, rolling, sheet forming, forging and extrusion are lectured according to the theory of plasticity and experimental phenomenon. Moreover, solidification phenomenon and defects formation in casting process is lectured with practical programming scheme.

Interfacial Control of Functionality Materials 2 credits Elective/Required Professor Yoshitaka Kasukabe Professor Akira Yoshikawa Surface and interface phenomena sometimes determine materials properties. In this lecture, fundamental aspects for surface and interface study, e.g., surface lattice structures and electronic properties, thermodynamics of surface and interface, surface chemical bonds, thin film fabrication methods including epitaxial growth, interface reaction, and several methods for surface and interface analysis, etc. are reviewed.	Electronic Devices and Materials 2 credits Elective/Required Professor Yutaka Oyama Professor Hitoshi Takamura One part of this course is dedicated to understand the basis of electronic devices, ex. transistor and laser diode, and then the physical properties of Si/compound semiconductors and the perfect crystal growth technology will be shown. Another part of this course will give you a precise understanding for defect chemistry of electroceramics, fundamentals of ionic conduction, and solid-state ionics devices such as fuel cells. Fundamentals and applications of hydrogen absorbing alloys will be also presented.
Magnetic Device Materials 2 credits Elective/Required Professor Satoshi Sugimoto Professor Koki Takanashi Associate Professor Nobuki Tezuka Associate Professor Masaki Mizuguchi Part-time Lecturer Seiji Mitani Magnetic materials have been developed using magnetic properties of various materials. Recently, spintronics is one of the attractive research areas, which is related to various kinds of magnetoresistance effects such as the giant magnetoresistance (GMR) effect and the tunnel magnetoresistance (TMR) effect. This course is dedicated to understand the basis of soft magnetic and hard magnetic materials and recent topics on nanomagnetic structures. In addition, the recent development of spintronics and its applications will be also presented.	Physical Chemistry of Biomolecular Systems and Biomaterials 2 credits Elective/Required Professor Makoto Suzuki Professor Takayuki Narushima Associate Professor Nobuyuki Morimoto <First part>, Prof. Suzuki Assoc. Prof Morimoto Water is the most abundant substance in living bodies. Various biomolecular interactions take place in water. In this lecture principles of molecular interactions in water and their fundamental properties will be explained to give basic understanding of biomolecular interactions, swelling phenomena of polymer gels and basic colloid science. <Second part>, Prof. Narushima The characteristics and processing of metallic and ceramic biomaterials for hard tissues are lectured. The topics for these materials, production processes, biocompatibility, corrosion resistance, mechanical properties, toxicity and interfacial reactions in human body, are included. The applications of titanium and calcium phosphate materials in medical and dental fields are introduced.
Physicochemical Properties of Melt and High Temperature Matter 2 credits Elective/Required Professor Hongmin Zhu Professor Hiroyuki Shibata Physical properties of solis and melts at high temperature play very important roles in the materials processing. In this class, microstructure and the macroscopic properties and their relationship of molten and solid states of metals, slags, ceramics etc. are lectured based on the behavior of interactions and the change of coordinations among the constituent atoms and/or ions related to the material processing. Also the measurement methods and the controll of various physical properties are reviewed.	Nonequilibrium Materials 2 credits Elective/Required Professor Akihiro Makino Professor Junji Saida Professor Hidemi Kato Associate Professor Kunio Yubuta The lecture introduces the features of non-equilibrium materials which include the amorphous alloys, i.e. the alloys containing a phase with no periodic long-range order in atomic structure, quasicrystals, and nanocrystalline alloys whose microstructure is occupied by a large volume fraction of grain boundaries. It also covers the introduction on the preparation methods of non-equilibrium materials, such as rapid/moderate solidification, vapor condensation, solid-state reaction, etc. and the characteristic & basic properties of the produced novel structures including their mechanical, physical, and chemical properties. This lecture also discusses the characteristics and properties of bulk metallic glasses, superplastic forming by Newtonian flow, and the novel applications as high-functional/structural materials, such as high strength and high toughness materials, soft and permanent magnetic, high-permeability magnetic and high-magnetostrictive materials, high-corrosion-resistant and fuel-cell materials as well as materials for catalysts.

Advanced Ceramic Materials 2 credits Elective/Required Professor Akira Kawasaki Professor Takashi Goto Professor Mingwei Chen Professor Hiroshi Masumoto Associate Professor Naoyuki Nomura In this class, the crystal chemistry and solid structure which are the foundation of ceramic material, are outlined. Properties and evaluation technologies of structural ceramics, functional ceramics and compound ceramics which are studied and applied, are introduced. The view for new ceramic material development is lectured.	Evaluation of Material Systems 2 credits Elective/Required Professor Atsushi Momose Professor Tsuyoshi Mihara Associate Professor Wataru Yashiro Associate Professor Kozo Shinoda We learn advanced knowledge on evaluation methods of material systems necessary to realize their desirable function and to keep their safety The goal is; To understand advanced methodology in ultrasonic flaw detection, acoustic microscopy, laser ultrasound, guided waves and nonlinear ultrasound. To be able to perform basic analysis on elasticity, wave motion, and contact problem.
Nanostructures and Function Control in Materials 2 credits Elective/Required Professor Junsaku Nitta Professor Junichi Koike Professor Koki Takanashi Professor Yasuo Ando In material science now, it is important to produce new functions by controlling structure in nanometer scale. In this class, starting with physical and metallurgical fundamentals on nanostructure control, new functions (mainly electric and magnetic functions) associated with different types of nanostructures are introduced; furthermore, device applications are also mentioned, crossing over the previous framework such as metals and semiconductors.	Bio-Material Multi-Functional Interface Technology 2 credits Elective/Required Professor Mitsuo Niinomi Professor Takayuki Narushima Associate Professor Nobuyuki Morimoto Associate Professor Masakazu Kawashita Associate Professor Masaaki Nakai The properties, reactions and performance of biomaterials are focused in this lecture. Prof. Niinomi and Assoc. Prof. Nakai will give lectures on alloy design, fabrication process, biological and mechanical biocompatibility, mechanical properties including tensile, fatigue, fretting fatigue and wear friction wear characteristics in air or simulated body environment, and bioactive surface modification of metallic biomaterials with focusing on biomedical titanium alloys, dental metallic materials, dental precision casting and characteristics of bone. The lectures will include a lot of examples of the advanced research work results. The purpose of the lecture is to understand the present state of the metallic biomaterials. Prof. Narushima: The outline, properties and applications of ceramic biomaterials will be lectured. The processing, surface reactions and modifications, and biocompatibility of bioinert, glass and calcium phosphate ceramic biomaterials are discussed to understand their present status and problems in biomedical fields. Assoc. Prof. Morimoto: General outline of applications and the properties of polymeric biomaterials will be lectured. Then the lecture will focus on design of biocompatible polymer surface, polymeric membranes and polymer particles for biomedical applications. Assoc. Prof. Kawashita: Tissue response to biomaterials and bioactivity of artificial materials will be lectured. Biofunctionalization of metallic and polymeric biomaterials will be discussed by introducing recent research achievements to understand biofunctionalization of biomaterials.

Advanced Steel Engineering 2 credits Elective/Required Professor Nobuyoshi Hara Part-time Lecturer Michitaka Sato Part-time Lecturer Yoshihiko Higuchi The following topics are covered by researchers most actively at work in the forefront of steel industries: Iron and steel making process, sheet steel, plate and pipe for automotive, shipbuilding and energy industries, anti-corrosion and surface-functional steels including zinc-coated steel, weathering steel and stainless steel, structural and chemical analysis of steels, computing science for steels, and environmental concerns of steel industry.	Internship training 2 credits Elective/Required A half ~ one month practical training will be scheduled in campany sites.
Special Lectures on Material Science and Engineering Elective/Required Special lectures will be provided in the relating and important research fields. You can learn a wide variety of scientific and industrial knowledges in your master course specialty, and then the relating academic science will be promoted and developed.	Special Seminar on Material Science and Engineering Elective/Required You attend seminars and/or practical training in your specialty and relating important research fields. Then, you can improve your abilities for solving the problems by the organization of wide variety of sophisticated expert knowledges.
Seminar on XXXX 4 credits Required In your relating specialty research fields, you show and discuss on the latest research results, and then you can improve your searching and presentation skills.	Master Course Seminar 6 credits Required Students engage in experiments and seminars, including research presentations, discussion and literature reviews.