

## Dept. of Mathematics

The Department of Mathematics offers excellent Graduate courses designed to meet the needs of students pursuing graduate work in mathematics and related areas leading students to professional excellence in mathematical research or applications of mathematics.

The Department of Mathematics offers programs leading to Master of Science (M.S.), the Doctor of Philosophy (Ph.D.) degrees, and Master's & Doctoral. Courses of study are available in algebra, analysis, topology, geometry, applied mathematics, cryptography, information mathematics, and probability theory.

The M.S. degree program is designed to prepare students for industrial, management or public service employment. It emphasizes the skills, attitudes, and knowledge needed for recognition, formulation and solution of real-world problems. It also encourages a more intensive program which emphasizes the skills needed for study of problems arising in areas related to mathematics. In addition, students are expected to undertake a project or problem-solving seminar as part of their studies.

The Ph.D. program consists of intensive course of study designed for the full-time student planning a career in research in academic or in a nonacademic setting. The program consists initially of the course work necessary to pass the Qualifying Examinations and then the research necessary to write an original piece of mathematics for a thesis and eventual publication in scholarly journals.

### **Courses**

#### Core Course1s

##### • **Reserch Ethic&Thesis Study(3)**

Graduate students will acquire an appreciation of the reasons for conducting ethical review of research and an awareness of some of the international codes of research ethics that have been developed in response to scandals and abuses in research. Finally, they will understand the nature and definition of research ethics and an appreciation of the importance of good research.

##### • **Modern Algebra (3)**

Elementary algebraic structure of Groups, Rings, Fields, Vector Spaces, Fundamental concepts of Category and Functions.

##### • **Real Function Theory (3)**

This lecture concerns the Lebesgue measure in 1-dimensional real space, integration and differentiation, Riesz representation theory, and existence and uniqueness of regular measure.

- **Basic Topology (3)**

An introductory course of general topology. Fundamentals of point set topology with a brief introduction to the fundamental group and related topics, topological and metric spaces. compactness and connectedness, separation properties, local compactness, completeness, introduction to function spaces, basic notions involving deformations of continuous paths.

- **Foundations of Geometry (3)**

Deals with basic theories in various areas of Geometry on 3 dimensional Euclidean space.

- **Mathematical Statistics (3)**

This course deals with Distribution theory of Random variables, estimation, statistical test, nonparametric statistical methods.

- **Introduction to Applied Mathematics (3)**

Introductory course of applications of mathematical theories and methods in many areas of Science & Engineering.

- **Introduction to Information Security (3)**

Topics covered include need for security services in computer networks, basic concepts of cryptology, historical ciphers, modern symmetric ciphers (DES, IDEA, RC5), Advanced Encryption Standard (AES), public key cryptography (RSA, elliptic curve cryptosystem), hash functions. digital signature.

- **Topics in Modern Algebra (3)**

A Study on the structure of groups, rings, fields and modules.

- **Real Analysis (3)**

In this course, we consider the Lebesgue measure in 1-dimensional real space, integration and differentiation, Banach space, functional space, general function theory, and integration and measure in abstract space.

- **Modern Differential Geometry (3)**

Deal with Tensor analysis, concept of the modern differential geometry and topological properties.

- **General Topology (3)**

Fundamentals of point set topology, topological and metric spaces. compactness and connectedness, separation properties, local compactness,

completeness, Topology of Euclidean spaces, winding number and applications, the fundamental group and covering spaces.

- **Topics in Statistics and Probability (3)**

Seminar on topics of modern statistics and probability theory.

- Mathematics Major Courses

- **Probability Theory (3)**

This course deals with conditional probability, concept of probability process, Limit actions, Markov chain, Markov process.

- **Topics in Abstract Algebra (3)**

Topics in abstract algebra.

- **Functional Analysis (3)**

We study the linear topological space, Banach-Steinhaus theorem, Open mapping theory, Closed graph theory, Hahn-Banach theorem, and duality in Banach space.

- **Topology (3)**

Topological and metric spaces. compactness and connectedness, separation properties, Euler characteristic, simplicial complexes, the classification of two-dimensional manifolds, vector fields, and introduction to three-dimensional topology.

- **Actuarial Mathematics (3)**

This course assumes basic theory of probability and deals with death rules, life insurance and annuity, reserve fund, continuous and discrete insurance theory.

- **Topics in Financial Mathematics (3)**

Derivatives and options in modern financial market based on probability and probability process, probability differential equations, Black-Scholes model, Hull-White models.

- **Topological Geometry (3)**

This lecture is an account of the elementary theory of topological spaces and of continuous and differentiable maps leading up to the smooth manifolds and their tangent spaces and Lie groups and Lie algebras. Here the geometric algebra provides numerous significant examples.

- **Topics in Topology (3)**

Studies on recent papers relative to the subject general topology, algebraic topology, combinatorial topology, and their applications.

- **Differential Geometry (3)**

Deal with theory of curve and surfaces and the basic of the transformation.

- **Differentiable Manifolds (3)**

Deal with Stokes theorem, Frobenius theorem, Affine connection, Lie group, Cohomology on manifold.

- **Topics in Geometry (3)**

Introduce the recent topics concerning papers.

- **Multivariate Statistical Analysis (3)**

Topics includes discriminant functions, factor analysis, principal components, canonical correlations, and cluster analysis. maximum likelihood and Bayesian methods, robust estimation and survey sampling.

- **Theory of Probability (3)**

Deals with Random spaces, random variables, expectations, moment generating functions, characteristic functions.

- **Topics in Numerical Analysis (3)**

Deals with numerical methods to find approximate solutions for mathematical problems in science or engineering.

- **Applied Differential Equations (3)**

We consider the applications of differential equations and related examples and their solutions in Engineering.

- **Topics in Scientific Computations (3)**

This course deals with computational theory and algorithms based on mathematical theory.

- **Theory of Field (3)**

Structure of Finite Fields, Polynomials over Finite Fields, Theoretical Applications of Finite Fields, Finite Extension Fields, Galois Theory, Ordered Fields, Theory of valuations, artin Schreier theory.

- **Commutative Algebra (3)**

Rings and Ideals, Modules, Localizations, Primary Decomposition, Integral Dependence and Valuations, Chain Conditions, Noetherian Rings, artin Rings, Discrete Valuation Rings and Dedekind Domains, Completions, Dimension Theory.

- **Algebraic Number Theory (3)**

Principal Ideal Rings, Elements integral over a ring, Integrally Closed Rings, Norms and Traces, Noetherian Rings and Dedekind Rings, Ideal Classes and the Unit Theorem, The splitting of prime ideals in an extension field, Galois extensions of number fields.

- **Group Representation Theory (3)**

An introduction to Group representations and character theory, Modular representations, Integral representations.

- **Advanced Algebra (3)**

Topics covered include advanced algebraic theory of elliptic curve cryptosystem and cryptography over Number-Field for public key cryptosystems.

- **Complex Analysis (3)**

This lecture considers analytic function, infinite series, line integral, conformal mapping, Dirichlet problem, and elliptic functions in Complex analysis.

- **Partial Differential Equations (3)**

The purpose of this lecture is the classification, boundary value problems, initial value problems of second ordered partial differential equations as well as the existence and regularity of general linear partial differential equations.

- **Topological Vector Space (3)**

Local Convexity, Hahn-Banach Theorem, Compactness, Klein-Milman Theorem, Conjugate space, Polar Set.

- **Operator Theory (3)**

This course deals with Banach Algebras, topology and density theorem in operator algebra, Von Neumann Algebras.

- **Introduction to Inverse Problems (3)**

We study the concept of layer potential, Neumann and Dirichlet functions, and Generalized Polarization Tensors, and consider the detection algorithm of inhomogeneities embedded in a material by using the asymptotic expansion formula.

- **Topics in Inverse Problems (3)**

We consider the concept of Multiple Signal Classification (MUSIC) algorithm, linear sampling method, topological derivative, and Newton's method by using Frechet derivative in inverse problems, and study the method of numerical simulations.

- **Elements of Differential Geometry (3)**

Deal with Tensor analysis, classical and modern differential geometry.

- **Submanifold Theory (3)**

Deal with Riemannian manifold, submanifold, complex and contact manifold.

- **Differential Manifolds (3)**

Deal with the fiber bundle on manifolds, connection theory, Green theorem and the integral formula, geometric transformation, Laplace operator, complex and contact manifolds.

- **Riemannian Geometry (3)**

Deal with structure transformation, differential forms, submanifold theory.

- **Topics in Differential Geometry (3)**

Deal with recent topics on the differential geometry concerning to the high level course.

- **Differential Topological Geometry (3)**

Deal with the differential structure using the topological property on differential geometry.

- **Algebraic Topology (3)**

An introductory course with emphasis on the algebraic topology of manifolds. Topics include singular homology theory, Eilenberg-Steenrod axioms, simplicial and cell complexes, elementary homotopy theory, Lefschetz fixed point theorem.

- **Homology Theory (3)**

This lecture is to present as a clearly and concisely as possible the basic techniques and application of homology theory. The subject matter includes singular homology, attaching spaces and CW complexes, cellular homology, cohomology, products, and fixed point theory for the topological manifolds.

- **Homotopy Theory (3)**

This lecture is an introductory course to the algebraic topology from the point of view of a homotopy theorist. In first few sections are introductory in nature. These are followed by a discussion of the fundamental group, covering spaces, and Van Kampen's theorem. Many results which are most often state in the category of CW complexes are valid in this generality. The key result we used to make calculation is the Blakers-Massay theorem. This is strong enough to imply the suspension theorem and Serre exact sequences.

- **Differential Topology (3)**

We prove embedding, isotropy and transversality theorems, and discuss, as import techniques, Sard's Theorem, Morse functions, partition of unity, dynamical systems. We also consider connected sums tubular neighborhoods and so on.

- **Fuzzy Topology (3)**

This lecture is to present the basic techniques and application of fuzzy topology. The subject matter includes operations on lattices, fuzzy topological spaces and convergence theory, connectedness, separation and compactness. Metric spaces and relations between fuzzy topological spaces and locales are also included in the subject.

- **Theory of Discrete Distribution (3)**

Probability generating functions, Poisson distribution, mixed discrete distribution, multivariate discrete distribution.

- **Nonparametric Statistics (3)**

This course deals with locally most powerful rank tests, regression and analysis of variance using ranks, asymptotic power and efficiency, goodness of fit tests, permutation tests and randomization.

- **Analysis of Time Series (3)**

Decomposition of series, trends and regression as a special case of time series, cyclic components, smoothing techniques, stochastic difference equations autoregressive schemes, moving average, covariance structure and spectral densities.

- **Analysis of Regression (3)**

Correlation theory, distributions of correlation coefficients, Least square method, linear and nonlinear regression, optimal curves.

- **Statistical Decision Theory (3)**

Utility theory, Loss theory, Bayesian analysis, minimum and maximum analysis.

- **Data Analysis and Statistics Laboratory (3)**

Deals with theories and methods for data analysis including linear and nonlinear regression, Time series analysis and Computer experiments.

- **Numerical Methods for Differential Equations (3)**

We study the numerical solution for ordinary differential equations of n-th order, Laplace, Heat, and wave equations with initial-boundary conditions.

- **Finite Difference Methods (3)**

This course deals with theories of finite difference methods focused on the stability, convergence and their applications in initial value problems or boundary value problems.

- **Introduction to Image Processing (3)**

Throughout the level set, calculus of variations, Euler-Lagrange equation, total variation minimization problems, regularization, and CFL conditions, we understand the structure of partial differential equations and theory of numerical analysis and study the application of image processing such as image denoising and segmentations,

- **Computational Fluid Dynamics (3)**

This course deals with theories of dynamical fluids and computational methods for models that can not be solved analytically.

- **Chaos and Dynamical Systems (3)**

This course deals with iterations, graphic analysis, chaos, stability.

- **Topics in Mathematical Models (3)**

This course deals with theories, mathematical and numerical methods for various mathematical models.

- **Finite Element Methods (3)**

This course deals finite element methods in one and two dimension spaces and error analysis.

- **Option Pricing (3)**

Deals with evaluations of options, futures, swaps derived from Stocks, Bonds



and VaR.

- **Mathematical Models for Computation (3)**

Deals with Finite automata , Pushdown automata, Turing machine, Recursive Functions and introduce various mathematical models for computation.

- **Queueing Theory (3)**

Deals with Single server queues, M/M/1, M/G/1, G/M/1, G/G/1, Heavy traffic, Networks of queues.

- Information Security Major Courses

- **Cryptomathematics (3)**

Topics covered include finite fields for information security. The structure of finite field, polynomials over finite field, factorization of polynomials, applications of finite fields, ECC over finite fields.

- **Crypto-Algorithm (3)**

Topics covered include classical cipher, stream cipher based on Shannon's theory, block cipher and their security issues.

- **Advanced Crypto-Algorithm (3)**

Topics covered include the design and implementation of public key cryptosystem, symmetric key cryptosystem, digital signature schemes, hash functions.

- **Logic of Information Flow (3)**

Topics: languages and models of the first order, terminological representation languages, logical models for solving scheduling problems

- **Mathematics and Information (3)**

Deals with uncertainty, Entropy, Coding Theory based on Statistics and Probability.

- **Information Security Protocol (3)**

Topics covered include an introduction of information security protocol, key distribution, identification, message authentication code, secret sharing, pseudo-random number generation, zero-knowledge proof, electronic elections.

- **Key Management System (3)**

Topics covered include the key generation, key management, and key recovery schemes.

- **Electronic Commerce Security (3)**

Topics covered include information security schemes to protect the electronic commerce, especially electronic cash, electronic payment, electronic wallet.

- **Hash Function and Message Authentication (3)**

Topics covered include the design principle of collision free hash functions and the generation of MAC.

- **Cryptanalysis of Public - Key Cryptosystem (3)**

Topics covered include the cryptanalysis of public key cryptosystem based on the mathematical methods such as factorization of numbers, discrete logarithm problems.

- **Complexity and Algorithms (3)**

Topics: running time analysis, efficient algorithms, the class P, the class NP, computability theory, complete theories.

- **Provable Security (3)**

Deals with Computational complexity, Unconditional security, Complexity theoretic security, Provable security under assumptions, Ad hoc security.

- **Steganography and its Applications (3)**

We study the implementation Technology and Principle of Steganography, and Information Hiding Application Method, such as Watermarking and DRM, etc.

- **Networks Security (3)**

Deals with Authentication systems, Entity authentication, Security handshake pitfalls, Strong password protocols, Kerberos system, Public key infrastructure, IPsec.

- **Financial Information Security (3)**

We study the information Security Technology in Financial Field, such as Electronic cash, Secure Electronic Transaction, and Internet Banking Systems, etc.

- **Topics in Symmetric Key Cryptanalysis (3)**

We study the security analysis on the block ciphers and stream ciphers.

- **Implementation of Cryptographic S/W (3)**

Acquire the software implementation technologies of International standard Symmetric Key Encryption Algorithm and public key Encryption Algorithm.

- **Implementation of Cryptographic H/W (3)**

Studying about current technology for H/W structure and optimal implementation on crypto-device.

- **Evaluation and Validation of Cryptographic Module (3)**

Studying about the knowledge necessary to perform the evaluation verification guideline on the basis of understanding for the Cryptographic Module Validation Program (CMVP).

- **Implementation of Parallel Cryptography (3)**

Studying about the High Speed Implementation technology on crypto algorithm using the GPU or Parallel systems, and its applications.

- **Mobile Security (3)**

Studying about the latest mobile networks security architecture and technology.

- **Wireless Security (3)**

Studying about the latest wireless communications technology, and the security technology of the applications.

- **IT Convergence and Security (3)**

Studying about Convergence Technology on IT field and other fields, and the security technology of the applications.

- **Smartgrid Security (3)**

Studying about structure and security required for application on SmartGrid.

- **Internet Security (3)**

Studying about structure of Wired and wireless Internet, and its security technology.

- **Side Channel Attacks (3)**

Studying about physical security analysis of the smart devices.

- **Countermeasures of Side Channel Attacks (3)**

Secure implementation of the side channel attack countermeasures based on S/W and H/W

- **Secure Multiparty Computation (3)**

Studying about technology that can protect the privacy of the participating entity under an environment that does not assume the existence of a trusted server.

• **Pseudorandomness (3)**

Studying about the theory of Pseudorandom Number which is a basic Security factor Of cryptographic algorithms, and the Method of Statistical Randomness Test.

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## Dept. of Physics

Physics is a fundamental science aimed at discovering the basic principles governing our universe, and applying these to the everyday life. Most of today's scientific knowledge is based on the laws of physics, and therefore Physics is considered to be one of the most fundamental fields in the science and engineering and has broad impacts in the real world. The education and research goal of the Department of Nano and Electronic Physics is to explore the quantum phenomena in the nanometer scale, to apply the principles of Physics to the electronic systems, and to cultivate the manpower needed in the 21st century industry. The research and education within the department will be performed by carrying out the cutting-edge experiments and developing new methods to overcome the limitations of the conventional methodologies in nanometer scale. The department also focuses on the theoretical and numerical studies on the physical phenomena in the nanometer region.

The department of Physics consists of 11 faculty members who are actively pursuing researches on many forefront fields in physics and providing high-quality education. The main research topics include physics of magnetic material, geometrical optics, plasma physics, computational condensed matter physics, semiconductor physics, surface physics, and nanoelectromechanical systems. The department offers the educational program which encourages the students to study the multidisciplinary aspects of nanoscience through the various courses offered by the department. Also for students, many research opportunities will be available through on-going research programs in the department.

### Courses

#### Core Courses

##### • **Classical Mechanics (3)**

Classical Mechanics is a field of physics which describes the motion of the macroscopic bodies including celestial objects like star and everyday machineries. In this course, Lagrangian and Hamilton mechanics based on Hamiltonian theory in the classical mechanics will be studied in depth. The scope of the subject will include not only the typical aspects of classical mechanics area but also small oscillation, collision of two particles and relativistic theory.

##### • **Electrodynamics (3)**

Electrodynamics deals with the physical phenomena related to electric and magnetic field and related dynamics of the fields and the dynamics of the charged particles. The scope of the subject includes time independent and

dependent electric fields in vacuum and in dielectrics, magnetic fields associated with constant and variable currents, magnetic materials, Maxwell's equations, electromagnetic wave propagation in medium, generation of electromagnetic wave, relativistic 4-vector treatment of electromagnetic entities.

- **Quantum Mechanics (3)**

Quantum Mechanics is a fundamental subject which is backbone of the modern science. The course will introduce quantum mechanical concepts like operators, expectation value, wave function, etc. The course will also discuss angular momentum operators, harmonic oscillator problem, atomic hydrogen problem, perturbation theory, scattering theory, identical particles, radiation, second quantization, etc.

- **Physics Research Ethics & Thesis Study (3)**

Survey& overview the impact of Physics and Physics research result on society and scientific community with ethical point view. And Suggest sound research approach.

- Physics Major Courses

- **Solid State Physics (3)**

Solid State Physics deals with the many aspects of the solid state materials, including semiconductors, magnetic material. Physical properties of solid state material will be discussed with both classical and quantum mechanical theories. The scope of the course will cover atomic, molecular and crystal structure, energy levels of electrons, and binding energies in molecules and solids, etc.

- **Advanced Solid State Physics (3)**

Advanced Solid State Physics is an advanced course for the student who has background on the graduate level solid state physics. The course will mainly focus on the quantum mechanical phenomena in the solid state material. The scope of the course will include band theory, superconductors, magnetism of matter, heat capacity of materials and optical properties of solids, etc.

- **Statistical Mechanics (3)**

Statistical Mechanics is a fundamental subject in the physics which deals with collective many-body phenomena in nature. The course will introduce the concepts of micro-canonical ensemble, canonical ensemble, grand-canonical ensemble, free energy, entropy, chemical potential, partition function, etc. Also, the course will introduce the equilibrium thermodynamics and elementary

statistical mechanics. The knowledge of Statistical Mechanics is essential to the understanding of the modern solid state physics of semiconductor and magnetic material.

- **Advanced Statistical Mechanics (3)**

Advanced Statistical Mechanics is for the student who are familiar with the basic Statistical Mechanics. In the course, the advanced subjects of statistical mechanics like advanced thermodynamics, superfluids, Ising model, phase transition and Landau theory will be studied. Introductory non-equilibrium theory is also another topic to be discussed in the course.

- **Mathematical Physics (3)**

Firm knowledge of mathematics is very important in the study of the physics since many theoretical works on physics are expressed in mathematical equations, graphs, and mathematical models. This course is to provide the basic background and skills in mathematical physics which is needed for the further study and research in physics. The scope of the course will include Ordinary Differential Equation, Complex Variable, Calculus of Variation, Numerical Method, etc.

- **Advanced Mathematical Physics (3)**

This course presents the advanced topics in mathematical physics which is essential for the understanding of the current researches in Physics. The course is for students who are familiar with the basics of graduate-level mathematical physics. Especially, the students majoring in theoretical physics are required to take this advanced course. The scope of the course will include Special Function, Integral Transforms, Integral Equation, Green's Function, group, etc.

- **Computational Physics (3)**

The course presents the computational techniques and software development skills. Also, the students will learn network and software development tools including parallel batch processing systems, code management systems, debuggers and optimizers, auto documentation generators, and web utilities. Computational Physics is closely related to the success of the modern computational material physics.

- **Semiconductor Physics (3)**

Semiconductor is very essential to the success of the modern solid state electronic devices including integrated circuits, transistors, diodes, LEDs, etc. The physical properties of the semiconductors are subjects of study in

Semiconductor Physics course. Since semiconductor is also a solid state material with well defined crystal structure, basic knowledge of solid state physics is required. The scope of the course will include lattice vibration, band structure and conductivity of semiconductor, etc.

- **Advanced Semiconductor Physics (3)**

Advanced Semiconductor Physics course is for the students who have graduate level knowledge on the semiconductor physics. The topics covered in the course are interface of semiconductor, optical absorption, semiconductor laser, amorphous semiconductor and doping effect. Forefront research topics and issues of the semiconductor physics will be also discussed in the course.

- **Nuclear Physics (3)**

This is an introductory course for the graduate student who are interested in the nuclear physics. The physical phenomena in the nuclei will be understood with the aid of quantum mechanics and other theories. Angular momentum, decay of nucleus, energy level of nuclei, transition, gamma ray and other nuclear physics topics will be discussed in the course. Not only the theories but also the experiments and experimental techniques will be discussed in the course.

- **Advanced Nuclear Physics (3)**

Main purpose of advanced nuclear physics course is to introduce the nuclear structure. Nuclear reaction, scattering theory, nuclear reaction model will be discussed. Especially, this course will focus on the theory of nuclear force, ground state neutron, proton scattering. Also, topics on nuclear fission and fusion with reactor theory and power generation by fusion will be presented.

- **Advanced Classical Mechanics (3)**

In this course further canonical formalism development begins by introducing Hamilton-Jacobi theory. Classical theory of fields is also presented. Examination and comparative understanding of classical field concept will be discussed to provide a unified view of classical and quantum mechanics. The prerequisite for this course is at least one semester of post graduate level classical mechanics.

- **Advanced Electrodynamics (3)**

The main topic of this course is electromagnetic radiation and its interaction with matter. Outline of the course is electromagnetic wave generation, propagation in a medium, its interaction with medium, dielectric loss, electromagnetic properties and various phenomena in optics. Four vector



formalism and covariant vector of relativity will also be presented.

- **Advanced Quantum Mechanics (3)**

Main purpose of this course is to put together the principles of relativity and quantum theory that are necessary to perform calculations of the electromagnetic scattering of electrons and positrons, as well as, the emission and absorption of photons. Second quantization, Dirac equation, calculation of covariant perturbation, elementary process of scattering will be presented. At least one semester of post-graduate level quantum mechanics is prerequisite to this course.

- **Spin-spectroscopy (3)**

The interpretation of micro spin structure of materials will be introduced. The role of the microscopic spin structure in the nonvolatile data storage, quantum computer, magnetic sensor are studied. Application of spin technology for micro electronic devices and nano electronic devices is manipulated.

- **Spin and Nano Physics (3)**

Spin and Nano Physics is a course designed to introduce the basics of the nano materials and devices. Following the brief introduction of the nano materials and device, the course discusses the theoretical and experimental works on the physical phenomena in nanostructures and their applications in the field of spintronics.

- **Advanced Material Physics (3)**

This course discusses the advanced topics in material physics, which is not covered in post-graduate level material physics and its goal is to help students to be familiar with fore-front of material physics. Topics are new magnetic materials, ferroelectric materials, optical device materials, nano-structured material and left-handed materials. Prerequisite is graduate course on material physics.

- **Magnetism (3)**

This course begins with the basic concept of magnetism. Topics of this course covers diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, Curie-Weiss law, Zener's super exchange model, Anderson's double exchange model and application to oxide materials. Basic of magnetic spectroscopy with neutron and X-ray is also presented. Prerequisite for this course is undergraduate course of solid state physics.

- **Advanced Magnetism (3)**

This course presents the advanced topics in magnetism, which is not covered in post-graduate level magnetism course and its goal is to help students to be familiar with fore-front works on the field of magnetism. Topics are new magnetic materials such as GMR, CMR, diluted semiconductor, Multi-ferroic materials, and nano-magnetic particles. Prerequisite is graduate course of magnetism.

- **Plasma Physics (3)**

This course provides the student with the basic theory of plasma, which covers atomic collision, Maxwell Boltzman distribution, Debye screening, glow discharge process, frequency dependence of plasma, interaction with electromagnetic waves, plasma-solid interaction and Beam plasma. Prerequisite for this course is one semester post-graduate level classical electrodynamics.

- **Methods in Experimental Physics (3)**

This is the lecture about the methodology in physics experiments. In this lecture, students are asked to study various fields in experimental techniques including electrical circuits, vacuum technique, glass work, machining job. etc. Various kinds of electrical instruments are utilized in modern physics experiments. Thus thorough understanding of the electrical instruments and electrical circuits used in physics experiments is very important and it will be discussed in detail. Other techniques like vacuum technology will also be reviewed. Typical experimental methods in physics will also be presented and discussed.

- **Advanced Plasma Physics (3)**

This course discusses the advanced topics in plasma physics, which is not covered in post-graduate level plasma physics and its goal is to help students to be familiar with the fore-front of plasma research. Some topics on Magneto hydrodynamics (MHD) and instability theory, fusion plasma, space plasma will be presented. Special emphasis on plasma reactor design for low temperature semiconductor process is discussed.

- **Modern Optics (3)**

This course covers reflection, refraction, Snell's law, paraxial approximation, converging and diverging lens, thick lens, thin lens, magnification, mirror, design of an Achromatic Doublet, Driving mirror, magnifying glass, spectacles glass, camera, telescope, and microscope. Special emphasis on optical

instrument design with commercial simulation package is spared.

- **Quantum Optics (3)**

This course begins with basic tools of quantum optics such as Atom-field interaction

- **Quantum Field Theory (3)**

This course covers quantum electrodynamics, Feynman diagram and gauge field theory from the classical theory of fields describing field aspect of electromagnetic coupling, Yukawa coupling, Feynman rules, renormalization, non-abelian gauge field theory. Prerequisite to course is one semester post-graduate level quantum mechanics and advanced quantum mechanics.

- **Physics of Crystal Diffraction (3)**

This course covers basic crystallography, classification of solids, group theory, basic theory of X-ray diffraction, kinematic theory, dynamical theory, Debye Waller line broadening, Reliability factor, diffuse scattering, and neutron diffraction to crystalline solid. Prerequisite to course is one semester undergraduate level solid state physics and electromagnetism.

- **Physics of Thin Films (3)**

This course focuses on the physical aspect of thin films. Thin film has different characteristics, which cannot be found in bulk. Starting from the basic principle of various growing, the course discusses modern thin film growing method such as PECVD, LPCVD, MOCVD, ALE and its physical, chemical and mechanical properties. Important analytical tools for film characterization (XPS, AES, SIMS, and XRD) are also presented.

- **Advanced physics of Thin Films (3)**

This course is intended to serve as an advanced course on thin films and their properties as well as their applications. In addition, the growth mechanism of thin films and various film growth techniques such as PECVD, LPCVD, and MOCVD will be discussed in depth. Especially, this course focuses on various physical properties of superconducting, metallic, semiconducting, magnetic thin films.

- **Crystal Growth (3)**

This course introduces the theory of crystal growth. The topics include Czochralski crystal growth, float zone crystal growth, epitaxial crystal growth, and atomic layer crystal growth as well as general introductions to crystal and

crystal growth. We will look at the physical mechanisms of crystal growth in light of modern technologies with emphasis on their applications in nanotechnology.

- **Topic in Solid State Physics (3)**

This is a special course on solid state physics. Rather than discussing the general theories of solid state physics, this course focuses on topics in solid state physics, which are not covered in regular courses on solid state physics. This course also discusses the advanced topics on modern solid state physics theories and experiments with emphasis on mesoscopic and microscopic systems.

- **Topic in Magnetism (3)**

This is a special course on the physics of magnetism and magnetic materials. Rather than discussing the general theories of magnetism, this course focuses on topics in magnetism, which are not covered in regular courses on magnetism. This course also discusses the advanced topics on modern physics of magnetism and magnetic materials such as spintronics and multiferroic materials as well as their applications.

- **Topic in Semiconductor (3)**

This is a special course on the physics of semiconductor and semiconducting materials. Rather than introducing the general theories of semiconductor, this course focuses on topics in semiconductor, which are not covered in regular courses on semiconductor. This course also discusses the advanced topics on modern physics of semiconductor and semiconducting materials with emphasis on applications in the field of nanotechnology.

- **Topic in Plasma (3)**

This is a special course on physics of plasma. Rather than introducing the general theories of plasma physics, this course focuses on topics in plasma physics, which are not covered in regular courses on plasma physics. This course also discusses the advanced topics on current plasma physics theories and experiments with emphasis on their applications in modern technologies.

- **Research in Magnetism (3)**

This course presents the current topics in physics of magnetism. This course introduces current theories in the field of magnetism and offers chances to review some of experiments such as spintronics and dilute magnetic semiconductors. This course is intended for a small group of students involved

in various research projects to discuss the current topics in magnetism, which are actively pursued in the field of magnetism and their applications.

- **Seminar in Solid State Physics (3)**

This course consists of a series of weekly presentations of current research topics in solid state physics. This course is designed to expose students to the topics and excitement of the research frontier. Each lecture will be given by a different researcher who will describe his/her field and his/her own work. Also each student will be given a chance to present a research paper related to solid state physics.

- **Applied Optics (3)**

This course is intended to serve as a graduate level introductory course on optics. This course focuses on introducing general theories of optics such as geometric and physical optics, aberrations, optical instrumentation, interference, and polarization in optics. In addition, brief description of current researches in optics and their applications in modern technologies will be presented.

- **Advanced Applied Optics (3)**

This course is intended to serve as a graduate level advanced course on optics. Based on general theories of optics such as geometric and physical optics, aberrations, optical instrumentation, interference, and polarization in optics, this course will discuss the advanced topics in optics research. Also, this course will present applications of optics in the fields of nanotechnology and biotechnology.

- **Mossbauer Spectroscopy (3)**

The Mossbauer spectroscopy has been one of the key research techniques in the field of magnetism. The Mossbauer spectroscopy allows the understanding of fundamental physical processes in magnetic materials. This course introduces basic theories of Mossbauer spectroscopy and its applications. This course is intended for students, who are planning to research in the field of magnetism.

- **Advanced Mossbauer Spectroscopy (3)**

This is an advanced course on Mossbauer spectroscopy. This course discusses the advanced topics on Mossbauer spectroscopy and its applications in the field of magnetism. This course describes the fundamentals of Mossbauer effect and operation principles of Mossbauer Spectroscopy. This course also teaches the interpretation of Mossbauer measurements.

- **Surface Physics (3)**

This course is intended to serve as a graduate level course on the surface physics. This course describes the fundamental physical processes on surfaces. Also, this course covers the basic theories of surface physics and their applications. In addition, this course describes the various analysis methods on the solid surface using ARS, SIMS, XPS, AFM, SEM, TEM and RBS.

- **Semiconductor Process (3)**

This course introduces the physical properties of semiconductor devices and fabrication processes of amorphous and crystalline semiconductor devices. In addition to the introduction of the basics of semiconductor physics, this course presents technological aspects of semiconductor processes such as crystal growing, vacuum technology, diffusion barrier and amorphous process.

- **Quantum Solid State Physics (3)**

This is an advanced course on solid state physics. This course is intended for students, who are planning to research in the field of both theoretical and experimental solid state physics. Especially this course focuses on the quantum theories of solid and reviews some of experiments in light of those. The topics include phonons, lattice specific heat, neutron scattering in solids, Landau diamagnetism, de Hass Alphen effect, and energy band theory.

- **Topic in Surface Physics (3)**

This is a special course on surface physics. Rather than introducing the general theories of surface physics, this course focuses on topics in surface physics, which are not covered in regular courses on solid state physics. This course also discusses the advanced topics on current surface physics theories and experiments with emphasis on their applications in modern technologies.

- **Topic in Optics (3)**

This is a special course on optics. Rather than introducing the general theories of optics, this course focuses on topics in optics, which are not covered in regular courses on optics. This course also discusses the advanced research topics on current theories and experiments in the field of optics, with emphasis on their applications in modern technologies.

- **Research in Semiconductor (3)**

This course presents the current topics in physics of semiconductor. This course introduces current theories in the field of semiconductor and offers

chances to review some of experiments. This course is intended for a small group of students involved in various semiconductor research projects to discuss the current topics, which are actively pursued in the field of semiconductor research and their applications.

- **Research in Plasma (3)**

This course presents the current topics in physics of plasma. This course introduces current theories in the field of plasma and offers chances to review some of experiments. This course is intended for a small group of students involved in plasma research projects to discuss the current topics in plasma physics, which are actively pursued in the field of plasma research and their applications.

- **Seminar in Semiconductor (3)**

This course consists of a series of weekly presentations of current research topics in semiconductor physics. This course is designed to expose students to the topics and excitement of the research frontier. Each lecture will be given by a different researcher who will describe his/her field and his/her own work. Also each student will be given a chance to present a research paper related to semiconductor physics.

- **Seminar in plasma (3)**

This course consists of a series of weekly presentations of current research topics in plasma physics. This course is designed to expose students to the topics and excitement of the research frontier. Each lecture will be given by a different researcher who will describe his/her field and his/her own work. Also each student will be given a chance to present a research paper related to plasma physics.

- **Magnetic Hyperfine Spectroscopy (3)**

This course consists of a series of weekly presentations of current research topics in nuclear solid state physics. This course is designed to expose students to the topics and excitement of the research frontier. The energy splitting of hyperfine interaction related to zero phonon state, Debye temperature, gamma ray resonance will be introduced. Also each student will be given a chance to present a research paper related to solid state physics.

- **Research and Seminar in Magnetic hyperfine (3)**

This course presents the current topics in physics of hyperfine interaction on magnetism. This course introduces current theories in the field of magnetism

and offers chances to review some of experiments such as magnetic semiconductors and multifunctional materials. This course is intended for a small group of students involved in nano?magnetism research projects to discuss the current topics in magnetism. Each lecture will be processed by seminar and discussion on current special topics.

• **Research in Optics (3)**

This course presents the current topics in physics of optics. This course introduces current theories in the field of optics and offers chances to review some of experiments. This course is intended for a small group of students involved in optics research projects to discuss the current optics topics, which are actively pursued in the field of optics research and their applications.

• **Seminar in Optics (3)**

A series of weekly presentations of current research topics in optics. This course is designed to expose students to the topics and excitement of the research frontier. Each lecture will be given by a different research who will describe his/her field and his/her own work and each lecture will be processed by seminar and discussion on current special topics.

• **Seminar in Nano Solid Spectroscopy (3)**

This course will introduce emerging nano materials and structures as well as measurement and spectroscopy techniques in sub-micron region.

• **Advanced Magnetic Field Theory (3)**

Magnetic field theory will be explored for application of magnetic properties of a solid. Molecular field theory, direct exchange interaction, super exchange interaction, double exchange interaction will be introduced. On basis of those theories, ferromagnetic, anti ferromagnetic, ferrimagnetic order will be studied.

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## Dept. of Chemistry

The department offers a full range of courses in physical & analytical, organic, inorganic, nano and biochemistry. In response to the changing nature of chemistry, our department provides outstanding opportunities for advanced study in chemistry. In addition to our interests in education, chemistry faculty members pursue vigorous and productive research in many chemistry-related applied fields, such as sensors, displays, nano electronic materials, industrial application of biomolecules, and etc. The link between teaching and research is a vital factor in a continuously evolving scientific subject; it ensures that students will be provided with optimum information and concepts, and provides opportunities for students to participate in practical research.

### ☐ Physical and Analytical Chemistry Major

Physical and Analytical Chemistry is a subject dealing with the physical properties and analyses of all matter. Physical Chemistry is concerned with microscopic/ macroscopic, atomic/subatomic and particulate phenomena in chemical systems with respect to physical science. It generally uses the principles, practices and concepts of thermodynamics, quantum chemistry, statistical mechanics and kinetics. Analytical chemistry is the science to analyze morphologies, compositions, and quantities of analytical targets. It also deals with a variety of practical applications, such as biomedical applications, environmental monitoring and quality control of industrial manufacturing.

### ☐ Organic Chemistry Major

The graduate program 'Organic Chemistry' has several purposes. First, it provides the basic understanding of organic molecules properties which lead to synthesis, isolation, and characterization. Second, it offers the research experience and course work required for careers in teaching, chemistry-related industry, government laboratories, or other postgraduate professions. Third, it gives students the opportunity that relate with biological sciences.

### ☐ Inorganic Chemistry Major

Inorganic chemistry is a subject dealing with the chemistry concerned with the synthesis, properties and behavior of inorganic compounds. This field covers all chemical compounds except the organic compounds (compounds containing hydrocarbons). Major areas of inorganic chemistry include Solid-State and Materials Chemistry, Organometallic Chemistry, Bioinorganic Chemistry, Coordination Chemistry and Nanoscience.

## □ Biochemistry Major

The program in Biochemistry major in the Department of Chemistry is committed to achieving excellence in graduate studies and research. The lectures and seminar courses in the biochemistry major covers in-depth understanding as well as industrial application of biomolecules. In addition, emerging techniques and knowledge in life science are discussed with special focus on drug development, biotechnology, and nano-bio chemistry.

## □ Nano Chemistry Major

Nanochemistry is a subject dealing with the chemistry of making, analyzing, and applying substances that are active in the nanoscopic world in which substances are measured in one billionths of a meter. Nanochemistry, while serving as the basis for various sciences and technologies, is a very broad field involving life sciences, energy, electronics, environment, and materials. So, the new discipline of nanochemistry has already made it possible for us to step into the world of superfine substances, first-hand observations of and work with molecules and atoms on a nano-meter scale, including biomolecules and other functionally advanced materials.

## □ Courses

### □ Core Courses

#### • **Advanced Organic Chemistry (3)**

Elementary general molecular orbital theory. Reaction Mechanism. Carbocation and carbanion reactions. Carbonyl addition. Oxidation, reduction, rearrangements. Organic photochemistry.

#### • **Advanced Analytical Chemistry (3)**

This is a lecture designed to explain the most important issues in modern analytical chemistry. Topics include the principles, instrumentations, and applications of spectroscopy, electro-chemistry, separations, mass spectroscopy and chemical sensing.

#### • **Advanced Inorganic Chemistry (3)**

Topics include atomic and molecular structure, chemical bonds, solvent systems, reactions of the elements and their compounds.

#### • **Advanced Physical Chemistry (3)**

This is a course meant for graduate student majoring physical chemistry related fields. The course will develop a fundamental understanding of the principles of

thermodynamics, kinetic theory, statistical mechanics, quantum chemistry and molecular spectroscopy.

- **Advanced Biochemistry (3)**

This subject gives an opportunity to understand the life science by dealing with Enzyme structure and mechanism, protein modification, signal transduction in sensory systems, DNA and RNA biochemistry, and biochemistry of disease.

- **Research Ethics & Thesis Study (3)**

In this Subject, students study all the possible ethical issues in scientific researches and how the researchers deal with social responsibilities.

- Physical and Analytical Chemistry Major Courses

- **Introduction of Photoelectrochemistry (3)**

This course introduces the fundamental concepts of photoelectrochemistry and demonstrates various applications.

- **Advanced Photoelectrochemistry (3)**

The goal of this course is understanding the advanced theoretical concepts in photoelectrochemistry on the basis of prerequisite subject.

- **Special Topics in Photoelectrochemistry (3)**

This course introduces state-of-the-art research trends in the field of photoelectrochemistry.

- **Energy Chemistry (3)**

This course introduces the concept and theory about the change and accumulation of energy especially placed in the electrochemical reaction. Students can learn the manufacture and analysis of related in an element.

- **Chemical Instrumentation (3)**

This course is designed to developing the knowledge and skills of instrumental analysis. Students are qualified to learn electronics / machining / optics / data analysis.

- **Applied Analytical Chemistry (3)**

This course is designed to apply the analytical methods to real issues including environmental science, forensic science, and food analysis.

- **Spectrochemical Analysis (3)**

Students will fulfill the determination of chemical structures on the basis upon the interpretation of infrared absorption, Raman scattering, UV/Vis absorption, nuclear magnetic resonance, and mass spectra, comparing with the chemical literature.

- **Statistical Thermodynamics (3)**

This course deals with the concepts of microstates, ensembles, partition functions, and fluctuations in quantum statistics. The issues are related to thermodynamic properties of ideal gases and crystals, chemical equilibrium, and phase transitions.

- **Special Topics in Advanced Quantum Chemistry (3)**

This lecture is designed to explain the concept of quantum chemistry extensively. Students are required to solve the Schrodinger's equation, and to understand the electronics structure of atoms and molecules.

- **Molecular Spectroscopy (3)**

The course will explore the interaction of light with matter. We will start with the quantum mechanical foundations of spectroscopy and follow with a detailed treatment of a variety of different spectroscopies, including the study of rotation, rotation and vibration, and electronic spectra for simple molecules as well as polyatomics.

- **Chemical Kinetics (3)**

Topics include relation between rates and mechanisms of chemical reactions, collision theory of reaction rates, activated complex theory, theory of unimo-lecular processes, classical dynamics of reactive scattering, elastic scattering, quantum theory of inelastic scattering or equivalent curve crossing processes, and experimental methods.

- **Electrochemistry (3)**

Students will learn the theories and applications of electrochemical methods including chronoamperometry, chrono-potentiometry, cyclic voltammetry, coulometry, polarography, and potentiometry.

- **Special Topics in Physical Chemistry (3)**

Students will learn the classical topics such as kinetics and photochemistry, macromolecular and surface chemistry, molecular spectroscopy, electric and magnetic properties of matter.

- **Research in Physical Chemistry (3)**

An upper-level student in good standing is urged to pursue an experimental research in physical chemistry with the guidance of any member of the chemistry faculty chosen.

- **Research in Analytical Chemistry (3)**

An upper-level student in good standing is urged to pursue an experimental research in analytical chemistry with the guidance of any member of the chemistry faculty chosen.

- **Seminar in Physical-Analytical Chemistry (3)**

To aid students in learning to speak well publicly. The focus is on discussing in physical and analytical chemistry topics from journal articles appeared in recent year.

- Organic Chemistry Major Courses

- **Organic Synthesis (3)**

Systematic consideration of reaction which allows carbon-carbon bond formation or cleavage, as well as the introduction, removal, interconversion, or transposition of functional groups.

- **Organic Reaction Mechanism (3)**

Understanding of bond and structure changing in organic chemistry.

- **Stereochemistry (3)**

Configurational and conformational analysis of molecules: the steric course of organic chemical reactions.

- **Heterocyclic Chemistry (3)**

Fundamental understanding of heterocyclic reactivity and synthesis, particularly aiming at recent works.

- **Natural Products Chemistry (3)**

The logic which may be applied to designing synthesis of complex molecules in the context of a comparison of in vivo and laboratory synthesis of natural products synthesis including alkaloids, amino acids, fatty acids, macrolides, porphyrins, prostglandins, sreroids, and terpenoids.

- **Advanced Polymer Chemistry (3)**

Mechanism of polymer reactions, preparations of addition and condensation polymers, properties of polymer, and the chemical reactions of polymers.

- **Free Radical Chemistry (3)**

Focusing on new development of radical chemistry. Bond formation, rearrangement, electron transfer, addition, elimination, and substitution reaction will be discussed.

- **Organic Analysis (3)**

Lectures on determination of structure of organic compounds involving separation techniques and the application of FT-IR, UV, and visible spectroscopy, nuclear magnetic resonance spectroscopy, mass spectrometry, and other modern instrumental techniques.

- **Special Topics in Organic Chemistry (3)**

Lectures on advanced topics in organic chemistry presented by staff or visiting lecturers.

- **Research in Organic Chemistry (3)**

Independent research for graduate students for degree in chemistry.

- **Seminar in Organic Chemistry (3)**

Detailed study of a special topic in organic chemistry under the guidance of a faculty member.

- Inorganic Chemistry Major Courses

- **Science and Technology for reduction of Green house gases (3)**

The character of green house gases and method of detecting it.

The chemical method about isolation and purification from emission source.

The production method of fuel and high added-value chemical production from exchanging Green house gases.

- **Current Research topics: Energy (3)**

This lecture involved in many seminar about the problem of energy which human encounter today. The invited lecturer and professor will discuss how to resolve the problems via conference.

- **X-Ray Diffractometry (3)**

The principles and practice of the determination of structures by single crystal x-ray diffraction techniques. Crystal symmetry, diffraction, structure solution and

refinement. Opportunities for hands-on experience in structure determination.

- **Organometallic Chemistry (3)**

Principles of electronic structure and bonding in organometallic species will be handled, related to reactivity patterns in common systems. Preparation and characterization methods of organometallic compounds, having applications to catalytic and stoichiometric organic syntheses, will be presented.

- **Special Topics in Inorganic Chemistry (3)**

A lecture course in inorganic chemistry in areas of specialization of the faculty, with emphasis on current developments. Specific topics will be changed from semester to semester, so a student may take the course for credit more than once.

- **Research in Inorganic Chemistry (3)**

An upper-division student in good academic standing is urged to pursue an experimental research in inorganic chemistry with the guidance of any member of the chemistry faculty chosen.

- **Seminar in Inorganic Chemistry (3)**

To aid students in learning to present well publicly, the class is focused on discussing in inorganic chemistry topics from journal articles appearing in recent years.

- Biochemistry Major Courses

- **Biotechnology for Conservation Ecology**

The foundation of Biotechnology

The comprehension to photosynthesis that is a immobilization process of CO<sub>2</sub>

The comprehension to CA enzyme related to production of carbonic acid and of process of CO<sub>2</sub> collection from using it.

The comprehension to methane monooxygenase (methane switch enzyme).

The comprehension to methane switch strain and of the process of methanol production.

The comprehension to enzyme and strain of alcohol production from switching alkane.

The comprehension to Conservation Ecology Skill via the reduction technology of green house gases using enzyme and strain.

- **Enzyme Chemistry (3)**

This subject studies general properties of enzyme reactions such as enzyme



activity, substrate specificity, and biocatalysis using an enzyme as a biocatalyst in chemical reaction.

- **Bioscience (3)**

The aim of this subject provides information of principle of life phenomenon taking place in animal, plant, and microorganisms.

- **Protein Engineering (3)**

This subject will provide essential knowledge for understanding various protein engineering techniques to create novel and improved protein functions, recent trends of protein engineering, and applications of engineered proteins for scientific, medical and industrial purposes.

- **Proteomics (3)**

This subject studies combinatorial function network of total proteins in organisms on the basis of interpreting the relationships between proteome and its functions.

- **Chemical Biology (3)**

This subject deals with physiological functions of small chemical compounds.

- **Structural Genomics (3)**

This subject deals with functional analysis of life on the basis of structure interpretation of proteins translated from genome.

- **Research in Biochemistry (3)**

Graduate students in good standing are urged to pursue an experimental research in biochemistry with the guidance of any member of the chemistry faculty chosen.

- **Seminar in Biochemistry (3)**

To aid students to give a speech publicly in classes. The focus is discussions of biochemistry topics from journal articles published in recent years.

- Nano Chemistry Major Courses

- **Display Material Chemistry (3)**

This course teaches how to deal with chemical methods used in developing display material.

- **Advanced Material Chemistry (3)**

This course teaches how to deal with advanced chemical methods used in developing new advanced materials as an advanced course of material chemistry.

- **Material Chemistry (3)**

Chemistry has a vital role to play in materials processing and in the development of new materials. This course is concerned with the basic underlying principles and the technological relevance of major topics in advanced material chemistry. This course includes organic, inorganic, solid-state, and surface chemistry as well as polymer and materials science.

- **Thin Films (3)**

This course includes the developments in the physical and chemical sciences that have changed the design, manufacture, and analysis of thin films, and their applications, especially in communications and information processing, storage, and display.

- **Electronic Materials (3)**

This course is concerned with the basic underlying principles and the technological relevance of major topics in electronic material chemistry. This course deals with various electronic materials such as organic, inorganic, and polymers.

- **Solid State Chemistry (3)**

Solid state chemistry has emerged as a very important element of mainstream chemistry and modern materials science. This course is concerned with the synthesis, structure, and properties and applications of solid-state materials. Understanding of solid-state chemistry is also essential in materials design.

- **Surface Nano Chemistry (3)**

Introduction to the behavior of molecules adsorbed on solid surfaces: the structure of surfaces and adsorbate layers. The bonding of molecules to surfaces: adsorbate phase transitions: trapping and sticking of molecules on surfaces. An introduction to surface reactions: kinetics of surface reactions. A review of principles of chemical reactivity: reactivity trends on surfaces: prediction of rates and mechanisms of reactions on metals, semiconductors, and insulators.

- **Research in Nano Chemistry (3)**

Upper division students in good standing are urged to pursue an experimental

research in nanochemistry along with the guidance by faculty members.

• **Seminar in Nano Chemistry (3)**

The course focuses on discussing in nanochemistry topics from journal articles appearing in recent years. This course can provide much opportunity to learn how to efficiently communicate scientific knowledges to the public.

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## Dept. of Foods & Nutrition

The Dept. of Foods and Nutrition offers academic programs regarding healthier living. The program involves technological aspects of high quality and safe food production and a wide variety of subjects linked to human nutrition. The MS and Ph.D programs in the department of Foods and Nutrition are specialized for nutritional science and food biotechnology. The areas of study include nutrient metabolism, nutritional requirements, nutrient-gene interactions, clinical nutrition, and a variety of bioactive compounds in food and natural resources. Students will develop a strong background and practical skills through research projects. Graduates from this program possibly construct a career as a nutritionist and a researcher in the field of product development, evaluation, and analysis.

### Food and Nutrition Major

The graduate program in Food and Nutrition major is a continuation of the undergraduate degree program, but with further development of research skills in specific areas of nutrition and food science as well. Food and Nutrition major provides students with training in normal and therapeutic nutrition, biological and social sciences, biochemistry, physiology, food science, nutrigenomics, food service management, communication, public policy, experimental design and statistics, and epidemiology.

### Food Biotechnology Major

Food Biotechnology major emphasizes the integrated application of several disciplines of chemistry, microbiology, and biotechnology to the processing and manufacturing of foods. This program also provides a strong research background for biological sciences and engineering to food systems.

### Courses

#### Core Courses

##### • **Advanced Nutrition (3)**

Literature of human nutrition related to macronutrients and micronutrients covers metabolism, genetics, physiology, biochemistry, endocrinology, and epidemiology.

##### • **Advanced Food Science (3)**

The course deals with chemical, physical, and biological properties of food components and their application in food system.

- **Experimental Design and Statistics (3)**

The course covers sampling theory, sample survey design, experimental and epidemiological study designs, descriptive statistics, statistical distributions and estimation, and statistical inference and tests including z-test and t-test for one sample, analysis of differences in two means, simple linear regression, and a chi-square goodness of fit test.

- **Seminar in Foods and Nutrition (3)**

The course deals with issues in area of food and nutrition based on current literature.

- **Research Ethics & Thesis Research (3)**

Graduate students will develop an understanding of the nature of ethical decision-making and its role in research ethics. In particular, students, who participate in researches using animal models or human biospecimens or whose researches include human participants as study subjects, will acquire information on the Enforcement Decree of Bioethics and Safety Act and Animal Protection Act. They will also acquire an appreciation of the reasons for conducting ethical review of research and an awareness of some of the international codes of research ethics that have been developed in response to scandals and abuses in research.

- Food & Nutrition Major Courses

- **Advanced Biochemistry (3)**

A comprehensive treatment of biochemistry and molecular biology stressing structures of biological molecules, including proteins, nucleic acids, carbohydrates, and lipids, enzymology, and selected aspects of metabolism and bioenergetics.

- **Nutrient Metabolism (3)**

Regulatory mechanisms of nutrition and metabolism, including current genetic theories on metabolic controls and their dysfunction in human health.

- **Nutritional Physiology (3)**

The course deals with the effects of nutrients on human organs including nervous, muscular, respiratory, circulatory, digestive, renal, endocrine, and reproductive systems.

- **Nutrition in Disease (3)**

The course covers epidemiological, clinical, animal, molecular, and cellular studies linking diet and diseases including cancer and heart disease. Biochemical and physiological mechanisms by which nutrients prevent disease are dealt with.

- **Nutrition and Development (3)**

Relationship of nutrition to growth and development of brain and other human organs. The course covers the application of basic principles of nutrition to nutritional and physiological needs throughout the life cycle from prenatal to aging. The interaction between physical and behavioral or psychological factors is emphasized.

- **Lipid and Carbohydrate (3)**

Literature of human nutrition related to lipid and carbohydrate covers metabolism, genetics, physiology, biochemistry, endocrinology, and recent nutritional problems.

- **Protein and Amino Acids (3)**

Literature of human nutrition related to protein and amino acids includes metabolism, physiological function, biochemistry, endocrinology, and recent nutritional knowledge.

- **Vitamins and Minerals (3)**

Literature on human mineral nutrition includes molecular biology, physiology, and epidemiology with special emphasis on the role of minerals and vitamins in optimal health.

- **Advanced Clinical Nutrition (3)**

Critical examination of nutritional intervention strategies used in clinical settings. Emphasis is placed on systematic analysis of nutrition-related disease problems and interventions designed to address the problems.

- **Topics in Nutritional Assessment (3)**

Interpretation of information obtained from dietary, biochemical, anthropometric, and clinical techniques as well as physical examination: principle of precision, accuracy and interpretation of results for individuals and populations.

- **Nutrition and Environment (3)**

Understanding of nutritional ecology. Topics include interactions between human and environment, population growth and regulation, interaction of genetic and

ecological processes, and ecosystems.

- **Topics in Nutrition Counseling (3)**

Advanced study of nutrition counseling in health and disease care with nutrition professionals and counseling tools for successful management and delivery of nutrition services, including knowledge of nutrition assessment, planning, implementation and evaluation as related to nutritional care.

- **Topics in Food Preparation (3)**

The course deals with basic knowledge of food components and applied scientific principles in food preparation and production.

- **Food Service Industry (3)**

The course deals with factors affecting food production and service in the food service industry emphasizing adherence to food quality and service.

- **Nutrition and Immunity (3)**

Cellular and molecular mechanisms underlying interactions of nutrition and immune function, including modulation of immuno-competence by diet and effects of immune responses on nutritional needs. Lectures and discussion explore implications for resistance to infection, autoimmunity, and cancer.

- **Cultural Aspects of Foods and Nutrition (3)**

Historical and contemporary overview of culture, food habits, and diet: exploration of the major themes in food habit research: origins and development of dietary practices: the anthropological approach to food and diet: field work methods: case histories that explore food patterns and their nutritional implications.

- **Society and Nutrition (3)**

Nutrition problems in contemporary communities and of selected target groups. Nutrition programs and policy, principles of nutrition education issues and problems related to community-based nutritional assessment: ethical issues in human investigation.

- **Aging and Elderly Nutrition (3)**

Interaction between nutrition and aging. Topics include physiological/biochemical basis of aging, age-related changes affecting nutritional requirements, assessment of nutritional status in the elderly, and relationship between developmental nutrition and the rate of aging.

- **Nutritional Epidemiology (3)**

Epidemiological methodology in relation to nutritional measures of human populations: review of the current state of knowledge regarding diet and other nutritional indicators as etiologic factors in disease. Topics include study design, sources of inaccuracy in experimental and observational studies, the methodology of data collection, and an introduction to the statistical evaluation of epidemiological data.

- **Interaction of Nutrients (3)**

Study of nutrient-nutrient and nutrient-drug interactions in metabolism. The course covers physical nutrient-drug complexation, effects of drugs on nutritional status, nutrient-induced drug toxicity, and drug-induced nutrient depletion.

- **Policy of Foods and Nutrition (3)**

Practical and theoretical basis for analyzing, critiquing and designing a variety of policies and programs aimed at tackling food supply, nutrition and hunger problems. Major areas of change in food consumption pattern and dietary habits is explored under different socio-economic and political conditions.

- **Food Service Organization (3)**

The course deals with application of management functions and principles to food service organizations. The course also covers evaluation of food products and commercial equipment.

- **Advanced Food Service Management (3)**

The course deals with principles of menu development, food production, service, delivery, procurement, sanitation, safety, and equipment selection in food service management.

- **Mass Media and Dietary Behavior (3)**

The course deals with skills and methods to analyze information concerning nutrition and life science in the media.

- **History of Food & Dietary Behavior (3)**

The course deals with basic knowledge of the food consumption and food culture in geographical and historical insights. Students will study food economically, behaviorally, socially and culturally, looking at how different societies have procured sustenance and how they have attached different meanings to what they consume.



□ Food Biotechnology Major Courses

• **Fermentation Technology (3)**

The study of microorganisms associated with food fermentation and principles in the processing of fermented foods.

• **Advanced Food Chemistry (3)**

The course deals with various aspects of food components and consequences of the properties on food processing. The course also covers mechanism of physical?chemical reaction affecting food qualities and their reaction products.

• **Advanced Food Microbiology (3)**

Review on the recent progress in microorganisms associated with natural and processed foods. Topics include characteristics of bacteria, fungi and yeasts associated with foods, foodborne disease, utilization of microorganisms for food processing.

• **Food Quality Management (3)**

The course deals with principles, methods and techniques involved in evaluating food quality and management.

• **Topics in Food Hygiene (3)**

Food service sanitation, providing training in the regulation and procedures necessary to prevent food poisoning and foodborne diseases in a food service establishment.

• **Advanced Food Preservation (3)**

The course deals with major causes of food degradation and fundamental principles of food preservation. The course also covers methods of shelf-life testing and ways to improve shelf life.

• **Topics in Food Products (3)**

The course deals with unit operations used in food processing and physical?chemical changes of food undergoes during processing.

• **Food Toxicology (3)**

The course deals with principles of food safety and toxicology including foodborne infection and poisoning. The course also covers food protection criteria and regulations surrounding food additives.

- **Instrumental Analysis (3)**

The course deals with principles and application of modern instruments used for the analysis of biological substance.

- **Food Quality Evaluation (3)**

The course deals with objective and subjective methods for sensory evaluations of foods and application of statistics in food quality control.

- **Assessment of Food Safety (3)**

The course deals with chemical, microbiological, physical hazard associated with food consumption. The course also covers issues on microbiological risk assessment(MRA).

- **Functional Foods (3)**

The course deals with definitions of functional foods and regulatory arena surrounding functional foods, as well as the efficacy and safety of selected functional substance. The course also covers application of functional substance in variety of functional food products.

- **Food Products Development (3)**

The course deals with interrelationships of processing principles and chemical and physical properties in the development of new and improved food products.

- **Food & Consumers (3)**

The course deals with factors affecting the food supply and management of consumer resources from the perspectives of food consumer.

- **Food Enzymology (3)**

The course deals with the nature, role, and applications of enzymes in food industry. The course also covers production, isolation and kinetic behavior of enzymes in food processing.

- **Sensory Evaluation of Foods (3)**

The course deals with detail sensory evaluation methods from panel selection to consumer testing methods. The course also covers basic experimental design and statistical analysis.

- **Advanced Molecular Biology (3)**

The study focused on gene structure and function at the molecular level, including gene structure, replication, transcription, translation and regulation of gene expression.

• **Food Biotechnology (3)**

Study on applications of various biotechnology to food processing, including genetic engineering, enzyme technology, cell culture technology and biochemical engineering.

• **Gene Manipulation (3)**

The course deals with basic concepts of DNA manipulation and their application in food industry.

• **Research Method in Foods and Nutrition (3)**

The course deals with principles and methodologies of recent research related to foods and nutrition.

• **Advanced Sensory Science (3)**

This class deals with current and advanced topics in sensory science area, such as sensometrics, psychophysics, mechanisms of sensory perception and cognition, and consumer studies. Students will be encouraged to read the latest research papers, and participate in the discussion in class.

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## Dept. of Bio and Fermentation Convergence Technology

Bio and fermentation technology generally deals with the production of functional biomaterials by mass cell culture and thus is related to many disciplines. It is one of main subjects of green industry which is recently gaining much attention as a driving force for the future. Although some courses of bio and fermentation technology have been offered by many related departments, they are supporting general subjects of the main discipline of the department. The Department of Bio and Fermentation Convergence Technology at Kookmin University is unique in offering the program that focuses on every aspect of bio and fermentation technology. The program is organized multidisciplinary and covers not only biological sciences but also engineering, design and human sciences. Specific area include bio- and medicinal-material technology, microbial fermentation technology, food biotechnology, bioenergy engineering, cold preservation technology, systems biology and advanced physiology. The Department has exchanging and collaborative education and research programs with the Robert Mondavi Institute for Wine and Food Science (RMI) at University of California at Davis (UCD) and Korea Research Institute of Bioscience and Biotechnology (KRIBB).

### Courses

#### Bio and Fermentation Convergence Technology Major Courses

##### • **Advanced Biochemistry (3)**

This subject studies the bio-chemical process in living organisms. It deals with the structure and function of cellular components and metabolism such as bio-molecules, amino acids, peptides, proteins, carbohydrates, lipids, and nucleic acids.

##### • **Advanced Biotechnology (3)**

This course covers the recent research trend and technology in the area of bio informatics, gene cloning, construction of genetically modified microorganisms, production of recombinant enzymes in microbial systems and kinetic analysis of recombinant enzymes.

##### • **Advanced Microbiology (3)**

Studies and discuss on the current research trend in the nutrition, growth, metabolism, physiology, molecular genetics, genomes of diverse microorganisms.

##### • **Seminar in Bio and Fermentation Convergence Technology I (3)**

Students will not only learn the current issues in bio and fermentation convergence technology but also have an opportunity to practice how to give a scientific talk. The focus will be on the review of journal articles, technical reports, and historical science references concerning bio and fermentation convergence technology.

- **Seminar in Bio and Fermentation Convergence Technology II (3)**

This is the continued course of Seminar in bio and fermentation convergence technology I. However, this differs from I by requiring students' oral presentation of their own research.

- **Advanced Enzymology (3)**

This subject studies general properties of enzyme reactions such as enzyme activity, substrate specificity, and enzyme catalysis.

- **Advanced Microbial Physiology (3)**

Studies and discuss on the current research trend in microbial cell structures, nutrition and growth of microorganisms, strain improvement and development for the production of useful fermented products.

- **Advanced Bioanalytical Chemistry (3)**

The aims of this class are to introduce analytical chemistry and its application in a variety of science disciplines. Topics covered include GLP, GMP, solution chemistry, spectroscopy, chromatography, advanced microbiology techniques and DNA and protein purification/separation techniques. This course emphasizes laboratory skills and knowledge essential for employment in analytical laboratories.

- **Advanced Neuroscience (3)**

The nervous system -the brain, spinal cord, and nerves of the body-is crucial for life and enables you to sense, move, and think. General knowledge in neurobiology, sensory and motor systems, the brain and behavior, and the cellular and molecular basis of learning and memory will be studied.

- **Advanced Molecular Biology (3)**

Studies and discuss on the current research trend in replication, transcription, translation, gene expression, regulation, chromatin structure at molecular level.

- **Advanced Cell Biology (3)**

Studies and discuss on the current research trend in cell structure, organelle function, cellular signal transduction, and tumorigenesis at molecular level.

- **Advanced Immunology (3)**

Studies and discuss on the current research trend in cells and biomolecules that constitute an immune system and their physiological function, and in the development of new immune materials and vaccine.

- **Advanced Mechanical Engineering for Refrigeration System (3)**

This course covers the current status and technology in the area of thermodynamics about food preservation and refrigeration, advanced principles of freeze cycle and design of refrigerator.

- **Advanced Fermentation Process Engineering (3)**

This course introduces recent technology in fermentation process design including various downstream processes. Especially, separation of fermentation products, purification and commercial product manufacturing will be taught.

- **Advanced Fermented Food Processing and Preservation (3)**

Cutting-edge technologies of food safety covering from food production to consumption focusing on various chemical changes during food-fermentation processes will be taught.

- **Advanced Bioenergy Engineering (3)**

This course presents the principles of biomass composition and structures, and various advanced technology for conversion of natural biomass to fermentable sugars and then bioenergy. Especially, new technology including microbial fermentation and enzymatic bioconversion technology for bio-ethanol and bio-diesel production will be taught and discussed.

- **Advanced Bioprocess Design and Management (3)**

New and advanced technology for bio-process design and management will be presented and discussed, which is important for efficient production of bioproducts using biotechnology. By this course, various technology to operate the bioprocesses in biotechnology companies will be learned.

- **Studies on Fungi (3)**

Studies and discuss on the current research trend in physiology, metabolism, genetics, and industrial application of fungi.

- **Special Topics in Metabolic Engineering (3)**

Studies on the basic principles and applications of metabolic engineering for efficient production of value-added biochemicals by modulation of metabolic pathways.

- **Current Topics in Bio Medicinal Materials (3)**

Studies and discuss on the current research trend in pharmaceutical and medical applications.

- **Advanced Bio New Material Technology (3)**

This subject studies the development of bio new materials from GRAS resources for industrial applications.

- **Special Topics in Medicinal Biotechnology (3)**

This lecture covers the state-of-art of the development, evaluation and mass production of new medicinal materials through in-depth understanding of human diseases.

- **Advanced Thermodynamics (3)**

This course covers principles of thermodynamics, and application of these principles to problems of reaction and phase equilibria in pure and mixtures in order to provide insight into physical and chemical phenomena associated with engineering analysis.

- **Advanced Physiology (3)**

Homeostasis refers to stability, balance or equilibrium. It is the body's attempt to maintain the stability of the human body's internal environment in response to changes in external conditions. Nervous System, Endocrine System, Cardiovascular System, Digestive System, Respiratory System and Circulatory System will be studied.

- **Advanced Systems Biology (3)**

Inter-disciplinary field of study that focuses on complex interactions within biological systems, using a more holistic perspective approach to biological and biomedical research

- **Research in Fermentation Convergence Technology (3)**

Researches by convergence of fermentation technology and emerging biotechnology

- **Research in Bioengineering (3)**

Researches by combination of biotechnology and engineering concept

- **Research in Bioconvergence Technology (3)**

Researches by convergence of bioscience and various new technology

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## Dept. of Forest Resources

The science of Forest Resources is an essential basis for economy, environment, and other social and cultural assets in Korea, where 64% of the land is occupied with mountainous forests. In association with enormous benefits produced from the forests, graduate students will find wide and substantive strata for studies on the values, services, and products of the forests. Educational goal for the Department of Forest Resources is to teach students for them to learn professional skills and knowledge that would help to maintain Korea's forest ecosystem healthy in a sustainable manner. The department takes full advantage of the state of the art knowledge and science to achieve this goal. To list a few, biotechnology, remote sensing, GIS (Geographic Information System), ecosystem approaches, and most up-to-date forest survey methods are the disciplines to attain the goal.

**One of the main objectives of the Master and Doctor of Science program in the Forest Resources Major** is to provide ample opportunities for students who aspire to have professional careers. The curriculum offers them a variety of knowledge from the basic to the applied aspects for their specialization, as well as interdisciplinary and global environmental issues such as climate change from ecological and social perspectives. The graduates of the department, in general, are working as public foresters, researchers, or managers of forestry, to name a few.

### Courses

#### Forest Resources Major Courses

##### • **Administration of Forestry & Environmental Organization (3)**

The subject is divided into two parts. Part one is that administration in forestry treats of the performance, business operation and implementation policy about public forestlands. Part two provides governmental and non-governmental organization on how environmental policy should be managed in Korea and the related nations.

##### • **Forestry Biology and Silviculture (3)**

Discussion of individual tree structure and growth, physical environment of trees and forests, and introduction to different regional forest communities. Manipulation of forest vegetation based on natural regeneration for the production of goods and services.

##### • **Forest Management (3)**

In this course, principles of forest management for sustained yield system are mainly dealt with. The methodologies of both stand-level management planning and forest-level management planning are presented. The stand-level management planning includes growth and yield modeling, management

decisions, and decision criteria for managing future and current even- and uneven-aged forest stands. In the forest-level management planning, traditional forest regulation concepts, harvesting scheduling, and multiple-use management are discussed.

- **Special Topics in Ecosystem Ecology (3)**

Theories on the structure, function, and development of ecosystems are taught and studies on the energy flow and nutrient cycling are reviewed for further discussion in sustainable management of forest resources.

- **Research Planning in Forest Science (3)**

Students will learn an overall process and system of methodologies in conducting forest science research. Topic selection, research design and planning, literature search and review, actual analysis, delivery and review of results will be covered in this lecture. Students will have an opportunity to practice writing scientific proposals and reports through critical group review.

- **Topics in Forest and Humanity (3)**

Analyzing the impact of forest on cultural development and civilization. Areas of emphasis in history, philosophy, literature, art and religion.

- **Forest and Nature Interpretation (3)**

Development explanation skills about forest and nature, including view of culture, ecology, geography, and scenery. Examination and analysis of overall process required to become 'forest interpreter' and 'nature interpreter'.

- **Tree Growth Development (3)**

Integration of vascular plant anatomy, nutrition, metabolism, and growth regulation specific to wood plants. Major topics include woody plant meristems, structure and function, water relations, internal carbon cycle, and growth regulation.

- **Social Forestry (3)**

Detailed analysis of the influence of the forest on civil society. View of social relation between civil society and forest.

- **Geoinformatics in Forest Resources (3)**

Focuses on the required background for remote sensing, GIS, digital photogrammetry and GPS in the new geoinformatics concept in the discipline-oriented and the methodology-oriented forest applications including introduction to LBS application.

- **Modeling of Forest Socioecology (3)**

Quantitative techniques used in socioecological Forestry. It provides insight into sustainable forest management(SFM) planning of forested lands. From model specification described in spatial information.

- **GIS Application of Forest (3)**

Recent advances in geographic information systems (GIS) to directly address specific analysis or management in forest resources. It includes fundamental scientific problems and decision support tool in GIS applications.

- **Human Impact in Wildlife Ecology (3)**

Presenting the available management of how endangered and threatened species relate to their habits. Details the role of predators in ecosystems and landscape ecology. It deals also with understanding between preservation and hunting which may be used to help manage "desirable" and "undesirable species.

- **Satellite Environmental Monitoring (3)**

This subject is to designed to meet observation techniques of various kinds of earth environment and to promote basic researches to understand the mechanism of the variations of earth environment based on earth observation information from space.

- **Restoration Ecology (3)**

Theories on the restoration and rehabilitation of the structure, function, and development of ecosystems destroyed by anthropogenic as well as natural disturbances are taught and the examples of restored and rehabilitated ecosystems are introduced for further discussion.

- **Tree Resource & Dendrology (3)**

To develop and maximize the potentials for using trees as resources, theories on the classification and identification of trees including the issues on distribution, ecological characteristics, and usages of them are taught. Emphasis is placed on specific usages of trees as medicines, foods, ornaments, and environmental resources for further discussion.

- **Landscape Ecology (3)**

Theories on the structure, function, and development of landscapes including diverse array of ecosystems are taught and practical examples in the preservation of natural ecosystems and conservation natural resources are introduced for further discussion in restoration and rehabilitation of degraded

ecosystems in Korea.

- **Forest and Environment (3)**

Theories on the relationship between forests and air pollutants are taught and measures for mitigating the damages caused by the air pollutants are introduced for further discussion. Emphasis is placed on the diverse aspects including the mechanisms of source-sink and dose-response relationships of air pollutants with forests.

- **Management of Natural Environment (3)**

Theories on the conservation, preservation, utilization, and restoration of natural environment including diverse array of practical application are taught. The ecology and practices in the preservation of natural ecosystems and conservation natural resources are introduced for further discussion in the management, restoration, and rehabilitation of degraded ecosystems and environment in Korea.

- **Management of Plant Resources (3)**

To develop and maximize the potentials for using plants as resources, theories on the conservation, protection, utilization, and preservation of them including botanical and ecological issues on the classification, identification, distribution, habits, and usages of them are taught. Emphasis is placed on specific usages of natural plants in Korea as medicines, foods, ornaments, and environmental resources for further discussion.

- **Special Topics in Environmental Pollution Management (3)**

In order to wisely manage pollutants contained in the trees and the other biotic organisms and the abiotic environment in the air, water, soil, etc., in the forest ecosystems, lectures are focused on the understanding of the dynamics of them and the measures how to control them wisely in view of sustainable management of forest ecosystems.

- **Growth and Yield (3)**

The focus of this course is on discussing the relationship between tree growth and yield. This course deals mainly with principles of growth and yield by species and locality. Based on statistical theory, also, the methodology of developing growth and yield models is lectured throughout actual research case studies. The application method of the models will be discussed for the rational forest management.

- **Forest Mensuration (3)**

This course deals with theory and technique of forest measurement required in

basic data survey for research. The measurement methodology of growth and yield for both individual tree and forest stand will be considered based on advanced theory and computer application. Also, the latest topics in the field of forest measurement will be discussed.

- **Advanced Biostatistics (3)**

This course investigates the advanced statistical theories and methodologies relevant to biological studies. Methodologies such as hypothesis testing, correlation analysis, regression analysis, analysis of variance, time-series analysis are covered, and will provide effective tools, theoretical backgrounds, and statistical programming skills for academic research.

- **Environmental and Resource Economics (3)**

This course provides a variety of critical perspectives on how current environmental issues. Students will learn how to view environmental problems under an economic perspective, with particular focus on efficient and general usage and management of forest resources, and to develop models to handle such issues.

- **Experimental Statistics (3)**

This course emphasizes on statistical application to research problems of forestry. The contents of lecture include basic concepts of statistical models, use of samples, measures of variation and central tendency. Statistical analysis techniques such as test of hypothesis, analysis of variance, regression and correlation are discussed with actual research data. Also, the technique of computer programs will be provided to enhance the ability of statistical analysis.

- **Planning for Forest Landscape (3)**

This course is designed to understand the social demand for forests and development activity, and propose a model for solving problems through providing a plan for constructing aesthetic landscape and recreational space. In this procedure, students have to research the possibilities of mountain forests in historical and ecological aspect. Based on these observations, they will approach to the spatial planning in harmony with mountain forest environment.

- **Special Topics in System Engineering in Forestry (3)**

This study deals with some big issues concerning forest road, tree harvesting, mountain erosion control. Especially, it focuses on relationship of forest road with tree harvesting and mechanization, forest labor and ergonomics, hydrological

and civil engineering against erosion in mountain forest area.

- **Design Theory for Forest Trails (3)**

This lecture is close related to special topics in forest system engineering and forest landscape planning. Students review forest management, tree harvesting, forest recreation, and then research how to plan and design the forest management trail and the forest recreational trail as forest road, logging trail, recreational trail, nature experience trail, etc.

- **Recreational and Tour Planning for Mountain Communities**

In order to cope with forest tourism demand in mountain region, Students will learn the possibilities of mountain forest in aspect of mountain community and ecology. Thereafter they study how to approach to the recreational planning and designing in harmony with mountain forest area.

- **Design of Forest Healing and Therapy (3)**

Forest therapy is a activity physically and spiritually promoting the human health through physiological, sensory, and mental response between human organs and various natural factors(landscape, sound, aroma, phytoncide, negative ions, light, climate, topology, etc) in forests. This course deals with healing mechanism and application methods of elements related to forest healing and therapy.

- **Environmentally Sound Site Planning (3)**

In accordance with increase of social demand for forest developments, the woodlands in the area of suburb are seriously opened up and it damages the forest landscape quality visually and emotionally. This subject deals with issues caused by such engineering works as forest road, golf ground, ski slope, quarry, etc., and harvesting and logging operations. It aims to find out some methods which can environmentally and soundly restore the damaged woodland sites.

- **Forest Genetics (3)**

To understand principal concepts of forest population genetics, molecular genetics, and ecological genetics and apply these genetic concepts for making decisions in tree improvement and species conservation & management strategies .

- **Forest Pathology (3)**

To obtain knowledge on basic concepts of forest pathology and identify major forest diseases in the world, especially Korea and US. And, to understand the impact of forest disease under climate change scenarios.

- **Forest Genetics and Pathology (3)**

This course is designed to understand the ecological roles of biological and environmental factors that cause the disease in forests and develop approaches for predicting, preventing, and managing tree pathogens. Methods to identify forest pathogens and examine host-pathogen interactions will be reviewed for applications to maintain forest health, sustainability, and resilience of diverse forest ecosystems.

- **Forest Molecular Biology (3)**

Concepts and methods of advanced forest molecular biology research will be discussed for potential application of population genetics, phylogenetics, and genomics/transcriptomics to maintain forest health and conservation.

- **Forest Health Management (3)**

Major topics covered by the course include forest pest (disease and insect) and fire, how these factors interact with each other and their environment within forest ecosystems, and how to manage healthy forests for sustaining resilient forest ecosystems.

- **Disturbance Ecology (3)**

Ecological disturbances are critical in understanding the dynamic nature of ecosystems and vegetation change. Disturbances can occur in a variety of spatial and temporal scales, with varying intensity and frequency. Such characteristics can play an important role in determining the structure and function of any particular ecosystems. In this course, students will learn the theoretical background and current research on disturbance ecology, with a chance to experience several quantitative and modeling approaches.

- **Spatial Analysis and Statistics (3)**

Ecological phenomenon is often dynamic and heterogeneous across time and space. Such diversity and heterogeneous nature of ecological phenomena has drawn significant interest in the field of ecology. This course will provide several important theories on spatial analysis and statistics, along with practical training on how to use actual statistical tools and programs to conduct the relevant analyses.

- **Ecological Modeling (3)**

Forest ecology consists of various components and relationships among them, and its functional characteristics are determined by the complex interactions between such components. Modeling approach is a useful tool to understand such complex systems, and to predict and/or project system behaviors, and to facilitate planning for management. This lecture will provide theoretical

background and practicum for various existing modeling platforms and modeling approaches in the field of forest ecology.

- **Ecological Management and Ecosystem Service Valuation (3)**

Ecosystem service indicates the totality of the various benefits ecosystem provides to humankind. For sustainable development and ecological conservation, it is critical to understand ecosystem service and properly evaluate its values to assist decision making. This lecture provides the fundamentals of the concept of ecosystem service, tools to evaluate and model ecosystem service, and real-world examples on how this approach is applied.

- **Special Topics in Urban Ecology (3)**

Urban ecology is a study of the complex system of human, flora and fauna, natural and artificial environments, their organizations, and the interactions between the components. Sustainable urban management can only be possible with the consideration of the unique characteristics of the urban ecosystem. This lecture provides the theoretical background of the nature of the urban ecosystem components, their dynamics and interactions, and provide the mainstream perspective to critically assess sustainable urban planning.

- **Special Topics in Climate Change (3)**

Climate change is one of the major change we face, now and in the future. It will influence not only the atmospheric condition of the Earth, but the entirety of the ecosystem and how humans live. Due to the complexity of the phenomenon, the outcomes of climate change can be unpredictable and complicated. This lecture provides the advanced scientific foundation of climate change, and how it will influence human livelihood and ecological integrity of the biosphere.



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## Dept. of Forest Products & Biotechnology

In master's course of forest products, the advanced programs are provided on the utilization of forest products concerned with environment-friendly green materials, bio-based chemicals, and energy ranging from total nature product acquired by the forest. Especially Department offer the contents which include the biotechnological conversion science and utilization of forest biomass for energy and bio-products, the wood science and utilization such as Wood-based building materials and timber engineering, and paper science & engineering, paper conservation science and environmental analysis in the field of paper science.

### Courses

#### Forest Products & Biotechnology Major Courses

##### • **Seminar in Wood Engineering (3)**

Presents and discusses theoretical and technological investigation of the wood-based material and engineering.

##### • **Seminar in Wood Chemistry (3)**

The purpose of this seminar is to understand a trend of all about wood chemistry. For example, spectroscopy, organic chemistry, tree biochemistry, wood extractives chemistry and wood polymer science. After studying this lecture, we hope that students will understand all about wood chemistry.

##### • **Seminar in Forest Products (3)**

Presents and discusses the theoretical and technological investigation of the forest science, and forest products science and engineering.

##### • **Application Statistics in Forest Products (3)**

The main topic of class is the statistical analysis for the scientific research. Collection, analysis, and interpretation of scientific data for the research and utilization of natural resources will be introduced and practised.

##### • **Experimental Design (3)**

Better understanding of fundamental notions of statistics and explanation of important principles of experimental design make good use in forest products research. Moreover, regression, correlation, and dispersion analysis are closely managed in order to work as a base to assist having better understanding of and analyzing the consequences of the computer program.

- **Research Ethics & Dissertation Study (3)**

Instruct specific areas including the theme selection, experimentation, framing of a dissertation and research ethics. It will cover the identification of the research problem, problem solving approaches and results, literature survey, and thesis formats. This course will also provide opportunity to become involved in graduate research, under guidance of a supervisor, on a problem of mutual interest to student and supervisor.

- **Advanced Wood Physics (3)**

Specific gravity and moisture content variation affecting the physical properties, and movement of water at the fiber and wood will be discussed. And wood in relation to heat, etc. will be also discussed.

- **Advanced Timber Design & Mechanics (3)**

Selected problems will be outlined in the field of design procedures for the glued laminated members, panel products and built-up members. Elastic theory for the stiffness and strength, and buckling resistance of composites will be discussed.

- **Advanced Wood Mechanics (3)**

This course deals with the wood as an engineering materials affecting design of wooden members. Emphases are on the stress-strain relations for non-isotropic materials, influence of density, defects, and glued laminated constructions.

- **Advanced Engineered Wood (3)**

Recent topics on engineered woods such as specialty plywood, particleboard, fiberboard, glued laminated wood, laminated veneer lumber, and newer developments such as laminated or oriented strand lumber, laminated veneer board, triboard, and wood-nonwood composite are reviewed in detail.

- **Microtechnique and Wood Identification (3)**

Basic techniques of sample preparation, result interpretation, skillful use of microscope, etc. for light and electron microscopies needed in wood anatomy and identification are treated in advance. And, wood identification procedures based on macroscopic, microscopic, and ultramicroscopic features of commercially important domestic and imported woods are discussed in detail. Laboratory work is essential.

- **Advanced Wood Adhesion and Finishing (3)**

In adhesion part, mechanism of wood adhesion, types and characteristics of

wood adhesives, factors of wood adhesion, testing methods and standards of bond performance, newer developments are treated in detail. In finishing part, characteristics and types of wood finishes, finishing and refinishing of wood finishes in solid woods and wood-based materials, effect of construction practices on finish durability, and prevention of failure or discoloration of finishes are treated extensively.

- **Advanced Wood Protection (3)**

The biological mechanism of wood deterioration by insects and microbes will be introduced and students will learn the intensified theories which are required for preservation of wood from biological deterioration.

- **Advanced Treatment Technology in Wood Protection (3)**

The diverse treatment technologies for wood protection from deterioration are introduced and students also learn the knowledge of the recent study.

- **Microbiology in Wood Deterioration (3)**

Students study the biodeterioration of wood caused by microbes and its characteristics, especially by exploring the wood deterioration research on most common wood deterioration microbes.

- **Insects in Wood Deterioration (3)**

Students study the biodeterioration of wood caused by insects and its characteristics, especially by intensified studies on insects and their characteristic damage according to environmental and regional variation.

- **Advanced Wood Deterioration in Wooden Cultural Properties (3)**

This subject manages advanced theories centered specifically on the causes of occurrence and detailed damage properties for wooden structures and landscape components etc. by wood decaying fungi and insects.

- **Advanced Conservation Science and Technology in Wooden Cultural Properties (3)**

This subject covers related theories and technologies in the area of conservation & restoration of wooden and paper cultural heritage. Key focus of conservation science is studying the biodegradation or deterioration mechanism of objects, effective inspection as well as maintenance technologies.

- **Repair and Maintenance Technology in Wooden Cultural Properties (3)**

This subject covers the conservation-restoration treatments for the continuance of wooden cultural heritage to exist in its best condition possible, regardless of

age and degradation.

- **Plant Quarantine (3)**

This subject gives the advanced theories in the area of biological pest control or chemical treatment, that are used to prevent the introduction of organisms such as insect pests which could generate from the increase of regional and national trade quantity.

- **Advanced Bioenergy Science and Technology (3)**

Based on understanding biochemical and biophysical characteristics of cellular materials, students study the processes to produce high-value bio-products.

- **Enzyme Engineering (3)**

The class introduces the expertise and the latest research trends in the theory and application of enzymes which are used in the biological conversion of biomass for the production of high value products.

- **Current Topics in Biomass Pretreatment (3)**

Cellulosic materials are particularly attractive as feedstocks for biofuel or biochemicals production because of their relatively low cost, great abundance, and supply sustainment. However, lignocellulosic biomass, such as the woody plant, contains polymers of cellulose, hemicellulose, and lignin bound together in a complex structure, which is recalcitrant for liberating each component. This subject covers for the pre-treatment technologies for separating each component of the lignocellulosic biomass, emphasizing concepts as well as understanding the mechanism of action and practicability.

- **Current Topics in Wooden Biomass Energy (3)**

This subject deals with the current topics in wooden biomass energy. Especially, researches on converting and processing of wood biomass into biofuels or other value-added products that are recently presented at professional journals are mainly discussed.

- **Biomass Resources (3)**

This subject covers the global forest resources supplying for wood and energy industry. Especially, evaluation of timber and fuel feedstock, supply prospects and their potential from world forest resources are major focuses.

- **Advanced New and Renewable Energy Science (3)**

This subject deals with the new and renewable energy that is needed for implementing the United Nations Framework Convention on Climate Change (UNFCCC) and reducing greenhouse gases. It will focus on all aspects of this particular renewable energy source—its availability, expanded support policy, economics, environmental effects, and practicality.

- **Biomass Fermentation Technology (3)**

Students will learn the fermentation characteristics and the process of carbohydrate obtained through the biomass component separation. The class will emphasize to learn the details of fermentation process including the relationship between the fermentation and pretreatment and saccharification process of biomass.

- **Topics in Natural Products Chemistry (3)**

The study of natural products has always been the starting point of the discipline of chemistry in every country of the globe, and, in view of the importance of these organic compounds in agriculture, medicine, and industry, every student of chemistry today feels the need to acquire further knowledge in this field. Specially, we will deal with wood's structures, properties, natural sources, and synthesis with emphasis on biological activities of important natural products such as terpenoids, alkaloids, flavonoids, steroids, lignans, and other phenolic compounds as well as various essential oils will be introduced.

- **Advanced Nuclear Magnetic Resonance Spectroscopy (3)**

NMR is a spectroscopic method that is even more important to the organic chemist than other spectroscopy. We can acquire many information about the number of magnetically distinct atoms of the type being studied. During the NMR study, we can acquire a structure about unknown compounds. It is very powerful method.

- **Topics in Nuclear Magnetic Resonance Spectroscopy (3)**

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- **Advanced Instrumental Analysis (3)**

Before attempting to deduce the structure of an unknown organic substance from an examination of its spectra, we can simplify the problem somewhat by examining the molecular formula of the substance. The purpose of this lecture is to describe how the molecular formula of a compound is determined and how structural information may be obtained from that formula.

- **Current Topics in Instrumental Analysis (3)**

Before attempting to deduce the structure of an unknown organic substance from an examination of its spectra, we can simplify the problem somewhat by examining the molecular formula of the substance. The purpose of this lecture is to describe how the molecular formula of a compound is determined and how structural information may be obtained from that formula. Many of methods are still in routine use today, but the use of mass spectrometry has become a common alternative. So it will be also covered more weightly

- **Advanced Biochemistry (3)**

Biochemistry is the investigation of the molecular basis of life. Also, Tree biochemistry is too. Structure, dynamics, and the function of biological molecules in cells and organisms will be focused in this class. Metabolisms, formation, and properties of cells, membranes, organelles, and whole living bodies will be also covered.

- **Metabolic Engineering (3)**

In this class, students will acquire knowledge that can be applied to study metabolites through cellular enzymes and their reactions associated with the primary metabolism and secondary metabolism of cells.

- **Advanced Cell Biology (3)**

This class studies the structure and the function of cells and discusses the mutual relation between these two aspects in cells.

- **Wood Materials (3)**

The purpose of this lecture is to understand the fundamental principles of cellulose technology and presents current techniques to modifying the basic chemistry of lignocellulosic materials.

- **Wood Extractives Chemistry (3)**

Among wood species, differences of chemical structures of three major cell wall components, cellulose, hemicellulose, and lignin, are few. However, a great

diversity in extractive composition is found throughout wood species. Although the extractives are low in concentration compared with those of the cell wall polymers, this fraction characterizes each wood species chemically. Most components of wood extractives are classified as secondary metabolites, and the distribution of specific compounds is restricted in certain wood species. This feature provides the basis of chemotaxonomy of woody plants. The purpose of this lecture is to understand how we can use a benefit of wood extractives that has many bio-activity.

- **Advanced Wood Extractives Chemistry (3)**

Among wood species, differences of chemical structures of three major cell wall components, cellulose, hemicellulose, and lignin, are few. However, a great diversity in extractive composition is found throughout wood species. Although the extractives are low in concentration compared with those of the cell wall polymers, this fraction characterizes each wood species chemically. Most components of wood extractives are classified as secondary metabolites, and the distribution of specific compounds is restricted in certain wood species. This feature provides the basis of chemotaxonomy of woody plants. The purpose of this lecture is to understand how we can use a benefit of wood extractives that has many bio-activity.

- **Advanced Papermaking Chemistry (3)**

This course introduces the practical aspects of water, treatment methods of fresh water, white water and effluents. The relevant operations include the physical, chemical and biological operations, the environmental analysis factors, and furthermore the process designs for zero-effluents.

- **Advanced Paper Physics & Converting (3)**

This course gives an understanding and application of the physical and mechanical properties of paper, and various converting processes and end-use requirements involved in the manufacture of commodity and specialty products. The main converting processes are coating, calendaring, super calendaring, printing, and the manufacture of corrugated board.

- **Advanced Paper Machine & Process Control (3)**

This course introduces the principle and structure of pulp and paper machinery. The fundamental subjects are focused on the technical understanding of recent machinery and types of unit operation machine.

- **Advanced Water Treatment in Paper Processes (3)**



Topic includes the introduction to physical, chemical and biological parameters of water and wastewater quality as well as principles of unit operations and processes for water and wastewater treatment. Discussion of zero-effluents design for papermaking process.

- **Advanced Fiber Recovery and Deinking (3)**

The course covers the fiber chemistry and recycling of waste paper. Lecture focuses on the properties of virgin and secondary fibers, re-pulping of waste paper, removal of deinked particles, bleaching of deinked pulps, and deinking process.

- **Advanced Paper Conservation (3)**

The course introduces various aging behaviors and principles of paper by acidification, thermal degradation, moist heat treatment, and structural mechanism of paper for understanding the conservation treatment and systematic approach of aging.

- **Advanced Pulping Science (3)**

Advanced Pulping Science provides the technological and chemical consideration of pulping of raw materials used in the paper industry. Includes advanced consideration of the pulping and bleaching processes, related chemistry, and discussions of related operations, e.g., chemical recovery.

- **Advanced Paper Environmental Analysis & Seminar (3)**

Advanced Paper Environmental Analysis & Seminar introduces the topics of physical, chemical and environmental parameters in paper making process and recycling of waste paper as well as water and waste water treatment. Includes discussions and presentations in advanced topics on paper environmental analysis.

- **Advanced Pulp Fiber Thin-filming Technology (3)**

Advanced course in materials and processes for nano conversion and solutionization using lignocellulosic materials and regenerated cellulose fibers. Study of the thin film fundamentals and operations with nano materials and additives.

- **Microbial Molecular Biology (3)**

This course gives better understanding of the elementary theories of molecular standard relating to life phenomenon, and specifically centering on fungi and bacterium. It investigates the multiplication, evolution, behavior, regulation, and

ecology of microorganisms from molecular level and the research technology of DNA.

- **Regulation of Gene Expression (3)**

The gene expression is the critical beginning process for cells. This class studies the function of local DNA region for gene expression, the regulatory system for gene expression, and the introducing mutations for practical studies.

- **Advanced Protein Engineering (3)**

Protein is the essential molecules for production of many bio-products. This class emphasizes the characteristics of protein and introduces the methods for improving the activity of protein and for producing the protein efficiently.

- **Advanced Microbiology (3)**

This class studies the physiology, the growth, and the application of microorganism with a case study. This case study will provide the bottom-line principles of microbiology in application.

- **New Approaches for Biotechnology (3)**

New cutting-edge technologies are introduced continuously in life science. This class introduces the principles of these new technologies and discusses their application on the study of students.

- **Advanced Biotechnology (3)**

Students will understand the biological characteristics of cells, genes, proteins, and metabolites in this class. They also study the process to produce biological products with added value through their learning and introducing engineering processes.

- **Theory of OMICS (3)**

New biological techniques provide the opportunity to observe the specific characteristic at the cell level. This class will introduce these new technologies with a case study.

- **Current Topics in Wood-based Bionanomaterials (3)**

Current topics and applications of various biomaterials mostly using wood-based nano cellulose are introduced. After that, the applied technology concepts/methods are discussed and analyzed. As a result, the understanding for the bio-nano materials and related new technologies will be promoted.

- **Advanced Wood-based Biomaterials (3)**

This course is designed to provide the use of sustainable wood-based biomaterials and development guides for various new materials.

- **Advanced Green Environmental Materials (3)**

Based on the information for the physical, chemical, and mechanical characteristics of various natural fibers and polymer materials required in developing eco-friendly materials, the thermal, viscoelastic, acoustical, and surface-chemical properties of green composites will be investigated using analytical equipment.

- **Wood-based Environmental Science (3)**

This course treats housing or building environments using various environmentally-friendly construction materials such as wood, wood-based materials, and wood-plastic composites, etc.

- **Advanced Wood Polymer Science (3)**

Wood is a natural composite material and a chemical complex of cellulose, lignin, hemicellulose, and extractives. And polymer is a large (sometimes very large) molecule built up by repetitive bonding together of many smaller molecules. Cellulose, for example, is a polymer built of repeating sugar units: lignin is a polymer formed by the enzymatic dehydrogenation of phenyl-propanes followed by radical coupling. The purpose of this lecture is to understand how a polymer of wood is determined.

- **Wood Polymer Science (3)**

This course considers macromolecular properties of wood.

- **Advanced Wood & Water Relationship (3)**

Specific gravity and moisture content variation affecting the physical properties, and movement of water at the fiber and wood will be discussed. And wood in relation to heat, etc. will be also discussed.

- **Wood Housing Science (3)**

Basic wood properties, wood as an industrial raw material, wood and engineered wood as green building materials, wood-frame house and human health, etc. are discussed in detail.

- **Advanced Paper Material Chemistry (3)**

This course focuses on the chemistry in papermaking processes, and the

principles of colloid and surface chemistry. The topics include the interaction of papermaking materials and chemical additives in the wet-end of a paper machine system, the retention of fine solids and dewatering mechanism, and the practical applications of wet-and dry-end strength additives, sizing agents, water soluble polymer, charge balance, sticky control and other microorganism control agents.

- **Advanced Paper Physics (3)**

This course gives the advanced theory and application in paper structures and properties. The topics are focused on the mechanical behaviour of single fibers, fiber-fiber bonding, paper structure, stress-strain curve of paper, viscoelasticity, paper elastic stiffness behaviour, effects of moisture content and temperature, fiber orientation, formation and optical properties.

- **Advanced Paper Modification (3)**

The course covers the internal and surface sizing, calendaring, coating for the purpose of functional ability of paper and additional special treatment through the paper modification of base paper. Lecture also includes the theoretical background and special applicable field in paper modification.

- **Advanced Paper Mill Modeling (3)**

The course covers the practical understanding of process control in the pulp and paper industry. The objectives of topic are the introduction of chemical engineering controls in papermaking process, process instrumentation, process dynamics, and the fundamental unit operation and mass and energy transfer concepts.

- **Advanced Analysis of Paper Heritage (3)**

Introduction to physical, chemical theories and properties of record & painting materials. Advanced science courses in cellulosic fibers, inorganic additives, deterioration behaviors and analysis methods, deacidification and special treatment for paper conservation.

- **Advanced Hazardous Paper Chemical Analysis (3)**

Introduction to solid and hazardous waste regulations. Analysis and design of solid and hazardous waste management systems, including generation, storage, transport, recycling, biological, physical, chemical and thermal treatment; energy recovery; land disposal; environmental protection systems and monitoring.

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