2017 Course Catalogue

POSTECH Graduate Program
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Department of Mathematics

1. Education Aim

Mathematics is the language for all sciences. It has thousands of years of history, but the modern mathematics has been developed very rapidly and profoundly. Not only basic sciences but also social sciences, liberal arts, engineering, politics and economics all employ mathematical principles and techniques. This kind of trend is all the more so in modern sciences and engineering, and mathematics has expanded and branched out to meet the needs.

In particular, much progress has been made recently in applied mathematics in conjunction with the development in engineering, computational mathematics, and computer science.

The curriculum in the Department of Mathematics prepares students to understand the basic and important theories in pure mathematics such as algebra, analysis, geometry and topology; applied mathematics such as nonlinear analysis, applied statistics, fluid mechanics; and computational mathematics such as numerical analysis, combinatorics, coding theory, and cryptography. Upon completing the curriculum, students will possess basic knowledge of mathematics, experience and confidence well enough to continue their graduate studies in mathematics or to join in any other areas of science and engineering.

2. Program Overview

Each student in the graduate program should design his/her graduate study according to the Guidebook published each year by the Department of Mathematics. Thus, please refer to the Guidebook for details.

[MS/Ph. D Integrated Program]

A. To graduate with Ph. D degree

This program is designed for students whose final goal is to earn a Doctor’s Degree in Mathematics. To be qualified as a candidate for Ph. D, a student must satisfy the following requirements:

(1) Pass Qualification Exam (QE).
(2) Your candidacy must be approved by the departmental committee.

Once qualified, a student shall start working on his/her Ph. D dissertation under the guidance of an academic advisor.

After the dissertation is completed, a student may request his/her dissertation to be reviewed if the student can submit evidence(s) to show that all or part of his/her thesis has been
pre-approved for publication or is published by a professional journal recognized by the University, and earned 60 credits or more (including 33 coursework credits). Then the student’s thesis will be reviewed in accordance to the University’s regulations on conferring of degrees. Once the student passes the review, he/she will go through several minor administrative processes for Doctor’s Degree Conferment.

B. To graduate with MS degree

If a student in MS/Ph. D Integrated degree program wants to graduate with a master’s degree, he/she must first submit a withdrawal application to the Department and the satisfy the following MS program requirements for the Master’s degree:

1. Earn at least 28 credits (including 18 coursework credits)
2. Submit a master’s thesis

Please note, however, at least 18 credits of the earned credits must come from the lecture courses and the rest can be earned through other regular courses and/or from independent studies toward preparation of the student’s thesis.

Besides the credit requirement mentioned above, a student must also satisfy the followings to graduate with a master’s degree: Choose an academic advisor by the announced due date, complete thesis under the guidance of the advisor, and submit the thesis for review. Once the student passes the review, he/she will go through several minor administrative processes for Master’s degree conferment.

[Course Classification]

The students, who are admitted to POSTECH from the academic year of 2005 and wants to obtain MS or Ph. D degree, must take at least one course from 3 different streams out of 6 streams specified below.

The graduate program offers courses on three different levels: namely 500-, 600- and 700- level courses The 500 level courses are the basic introductory graduate courses and the 600 level courses are mostly comprised of advanced courses. Lastly, the 700 level courses are seminar/independent studies in specific research areas. Thus, students are encouraged to choose 500 level courses according to their academic/career plans. When choosing 600 and 700 level courses, however, students are strongly advised to consult their academic advisors beforehand.

The Mathematics graduate program categorizes the 500- and 600- level courses into the following six streams. For your convenience, The course numbers have been attached based upon the POSTECH Guide.

Stream1 : Algebra, Number Theory, Algebraic Geometry and related courses
(501, 502, 503, 504, 505, 506, 507, 508, 509, 603, 604, 606, 608)

Stream2 : Real Analysis, Complex Analysis, Partial Differential Equations and related courses
(510, 514, 515, 517, 519, 545, 612, 616, 617, 619, 647)

Stream3 : Topology, Geometry and related courses
(520, 523, 524, 621, 622, 623, 624, 625)

Stream4 : Numerical Analysis and Applied Mathematics
(541, 542, 551, 640, 641, 643, 645, 647, 651, 652)
(530, 531, 533, 537)  
Stream6 : Cryptology, Coding Theory, Combinations and related subjects  
(560, 561, 562, 565, 567, 661, 662)  

[Colloquium]  

The students, admitted to POSTECH from the academic year of 2013 for Ph. D degree, are required to obtain at least three credits for seminar(colloquium) course.

Students will earn one colloquium credit by attending a minimum of 15 class hours in one semester.

A minimum of 3 colloquium credits are required for graduation. Register for MATH799 (Seminar) during a course registration period.
3. Course Description

MATH50 Algebra I ........................................................................................................ (3-0-3)
Prerequisite: MATH301
Recommended Prerequisite: MATH302
Structure of groups, Nilpotent group, Solvable group, Projective module and Injective module, Hom and duality, Tensor product, Fields, Galois Theory, Finite Fields, Separability, Cyclotomic Field

MATH502 Algebra II .................................................................................................... (3-0-3)
Prerequisite: MATH501
Recommended Prerequisite: MATH302
Structure of groups, Nilpotent group, Solvable group, Projective module and Injective module, Hom and duality, Tensor product, Fields, Galois Theory, Finite Fields, Separability, Cyclotomic Field

MATH503 Commutative Algebra .................................................................................. (3-0-3)
Recommended Prerequisite: MATH302
Rings and Ideals, Quotient ring, Module, Primary decomposition, Noetherian ring, Artinian ring, Discrete valuation ring, Dedekind domain, Completion, Dimension Theory

MATH504 Commutative Ring Theory ............................................................................ (3-0-3)
Recommended Prerequisite: MATH501, 503
Chain conditions, Prime ideals, Flatness, Completion and the Artin-Rees lemma, Valuation rings, Krull rings, Dimension Theory, Regular sequences, Cohen-Macaulay rings, Gorenstein rings, Regular rings, Derivations, Complete local rings

MATH505 Algebraic Number Theory ............................................................................ (3-0-3)
Prerequisite: MATH301
Recommended Prerequisite: MATH501
Arithmetic on number fields, Dirichlet unit Theorem, Ideal class group, Prime ideal decomposition, Hilbert Theory, Introductory class field Theory

MATH506 Analytic Number Theory ............................................................................. (3-0-3)
Recommended Prerequisite: MATH505
Arithmetic of modular forms, Elliptic curves, Zeta function, L-series, Distribution of prime numbers

MATH507 Additive Number Theory ............................................................................. (3-0-3)
The sum of four squares, Polygonal number theorem, Hilbert-Waring problem, The Hardy-Littlewood method, Elementary properties of primes, Vinogradov’s theorem, The linear sieve, Chen’s theorem
MATH508 Introduction to algebraic geometry ................................................................. (3-0-3)
Prerequisite : MATH501
We study algebraic varieties, the main objects in algebraic geometry, from scratch. In particular, the course covers affine, projective and quasi-projective varieties, coordinate rings, regular maps, functions fields, rational maps, bi-regular and bi-rational maps, singularities, blow-ups, divisors, canonical divisors, intersections, and so forth. Also, many examples of algebraic curves and surfaces are dealt with.

MATH509 Finite Group Theory .................................................................................... (3-0-3)
Recommended Prerequisite : MATH301
Basic properties of finite groups, Group actions and Sylow Theorem, Free groups, The structure theory, Classify the groups of special orders, p-groups, Solvable and nilpotent groups, Frattini subgroups, Fitting subgroups, Sylow basis for solvable groups

MATH510 Complex Analysis ....................................................................................... (3-0-3)
Recommended Prerequisite : MATH210
Analytic Function, Complex Integral, Singularity, Maximum Principle, Runge Theorem, Riemann Mapping Theorem, Analytic Continuation and Riemann Surface, Harmonic Function, Picard Theorem

MATH514 Real Analysis I .............................................................................................. (3-0-3)
Prerequisite : MATH311, 312
Recommended Prerequisite : MATH311
Lebesgue Measure and Integral, Differentiation, Classical Banach space, Maximal Function, Measure Theory, Representation Theorem, Basic Theory of Functional Analysis

MATH515 Real Analysis II (3-0-3)
Prerequisite : MATH514
Recommended Prerequisite : MATH311
Lebesgue Measure and Integral, Differentiation, Classical Banach space, Maximal Function, Measure Theory, Representation Theorem, Basic Theory of Functional Analysis

MATH517 Partial Differential Equations ..................................................................... (3-0-3)
Recommended Prerequisite : MATH413

MATH519 Functional Analysis ..................................................................................... (3-0-3)
Recommended Prerequisite : MATH311
Topological Vector space, Banach space, Hahn–Banach Theorem, Operator Theory, Fredholm Theory, Hilbert space, Distribution, Fourier Transform, Banach Algebra

MATH520 Differentiable Manifolds and Lie Groups .................................................. (3-0-3)
Recommended Prerequisite : MATH421
Differentiable Manifold & submanifold, Tangent Bundle, Vector Field, Frobenius Theorem, Tensor Theory, Differential form, Lie derivatives, Lie group & Lie algebra, Exponential Maps, Integration on manifolds
MATH523 Introduction to Differential Topology  ................................................................. (3–0–3)
  Prerequisite: MATH421
  Immersion, Submersion, Transversality, Topological invariants

MATH524 Introduction to Algebraic Topology ................................................................. (3–0–3)
  Recommended Prerequisite: MATH421
  Simplicial complexes, Euler number, Homology Theory, CW complex, Lefschetz Fixed Point Theorem, Kunneth Formula, Cohomology Ring, Poincare duality, Intersection & Linking number

MATH530 Mathematical Statistics ..................................................................................... (3–0–3)
  Recommended Prerequisite: MATH430
  Decision problem, Neyman-Pearson Lemma, Likelihood ratio test, Uniformly most powerful test, Unbiased test, Sequential test, Non-parametric test, Contingency table, Baysian method

MATH531 Probability Theory ............................................................................................ (3–0–3)
  Recommended Prerequisite: MATH311, 431
  Probability measure theory, Stochastic process, Brownian motion, Markov property, Weak convergence, Infinitely decomposable distribution, Martingale, Stochastic integral equation, Stochastic differential equation, Probability approximation

MATH533 Regression Analysis .......................................................................................... (3–1–3)
  Recommended Prerequisite: MATH333, 430
  Gauss–Markov theorem, Least squares method, Data analysis, Analysis of variance, Robust inference

MATH537 Stochastic Calculus & Financial Mathematics ................................................... (3–0–3)
  Prerequisite: MATH230, 311

MATH541 Methods of Applied Mathematics I .............................................................. (3–0–3)
  Recommended Prerequisite: MATH412
  Method of image in PDE, Asymptotic expansion, Regular and Singular Regular & Singular perturbations, Surface layers, WKB Method, Green’s functions

MATH542 Methods of Applied Mathematics II .............................................................. (3–0–3)
  Recommended Prerequisite: MATH413
  Integral Equations, Volterra Equation, Fredholm Equation, Hilbert-Schmidt Theory, Wiener-Hopf method, PDE, (Distribution)

MATH545 Calculus of Variations ....................................................................................... (3–0–3)
  Recommended Prerequisite: MATH311
  Variational principle in mathematics, Euler equation, Hamilton-Jacobi equation, Quasi-Convex function, Existence Theorem, Differentiability.
MATH551 Advanced Numerical Analysis ................................................................. (3-1-3)

Prerequisite: Programming Experience
Recommended Prerequisite: MATH451

Interpolation by polynomials and trigonometric functions, Numerical integration and differentiation, System of linear equations, Data fitting

MATH560 Applied Geometry for Computer Graphics and Vision ................................ (3-0-3)

Recommended Prerequisite: MATH120, 261

Differential geometry of curves and surfaces, Computational algebraic geometry and topology of manifolds needed for computer vision and geometric design, Morphology for pattern recognition and wavelet and fractal geometry for image data compression

MATH561 Combinatorics I .................................................................................... (3-0-3)

Prerequisite: Basic Knowledge in Groups, Matrices and Topology
Voltage graph, Group actions on graphs, Cayley graph, Embedding of graphs, Map Colorings, Genus of groups, Graph and matrices, Algorithm

MATH562 Combinatorics II .................................................................................. (3-0-3)

Prerequisite: Basic Knowledge in Groups, Matrices and Topology Independent of MATH561
Combinatorial Enumerations, Polya Theory, Interconnection network, Block design, Finite geometry, Algorithm

MATH565 Coding Theory .................................................................................... (3-0-3)

Linear Codes, Nonlinear codes, Hadamard matrices, The Golay codes, Finite fields, Dual codes and their weight distribution, Codes and designs, Perfect codes, Cyclic codes, BCH codes, MDS codes, Reed-Muller codes, Bounds on the size of a code

MATH567 Algebraic Cryptology .......................................................................... (3-0-3)

Prerequisite: Knowledge of an introductory abstract algebra is required. (Knowledge of several areas of mathematics including number theory, groups, rings, fields and probability would help but not necessary.)
Recommended Prerequisite: MATH302
Public key crypto-algorithm, Cryptanalysis, Finite field Study public key cryptosystem based on a various number theoretical theories. We will discuss such as elliptic curve crypto system and RSA systems

MATH570/CSED508 Discrete and Computational Geometry ............................... (3-0-3)

Discrete geometry is intimately connected to computational geometry. This course will cover basic concepts of discrete geometry, including convexity, incidence problems, convex polytopes, arrangements of geometric objects, lower envelopes, crossing numbers. In addition, we will study how to design optimal algorithms for geometric problems, by exploiting these combinatorial and geometric properties.

MATH603 Algebraic Geometry ............................................................................. (3-0-3)

Complex variety, Hilbert’s nullstellensatz, Riemann surfaces and algebraic curves, Residues, Quadric Line Complex
MATH604 Elliptic Curves .................................................. (3-0-3)
   Recommended Prerequisite: MATH505
   Algebraic varieties, Algebraic curves, Geometry on elliptic curves, Elliptic curves on local fields, Elliptic curves on global fields.

MATH606 Automorphic Forms ........................................... (3-0-3)
   Modular Form, Siegel modular form, Jacobi form, Quadratic form, L-function

MATH608 Homological Algebra ......................................... (3-0-3)
   Recommended Prerequisite: MATH301
   We study the basic concepts in homological algebra such as Hom, Tensor, Ext, Tor and show how these can be applied to solve purely algebraic problems.

MATH612 Several Complex Variables .................................. (3-0-3)
   Recommended Prerequisite: MATH510
   Bergman Kernel & Integral Formula, Plurisubharmonic function, Pseudoconvexity, Domain of Holomorphy, problem, Levi Problem, Hardy Space

MATH616 Fourier Analysis ............................................... (3-0-3)
   Recommended Prerequisite: MATH311
   Basic Properties of Fourier Series, Uniform Convergence, Convergence & Divergence at a point, Hardy-Littlewood Maximal function, Fourier Transform on Lebesgue space

MATH617 Harmonic Analysis ............................................ (3-0-3)
   Prerequisite: MATH514
   After a brief review of the theories of Fourier transforms, Schwartz space and oscillatory integrals, we will cover a selection of modern topics in harmonic analysis including restriction theorems, Bochner–Riesz operators, the Kakeya maximal operators, the spherical maximal theorem, convolution operators and their applications to partial differential equations and the theory of Besicovitch sets.

MATH619 Theory of Banach spaces .................................... (3-0-3)
   Basic sequences, Classical Banach spaces, Devoretsky-Rogers Theorem, Grodendick inequality, Choquet Integral Representation Theorem

MATH621 Differential Geometry ........................................ (3-0-3)
   Recommended Prerequisite: MATH520
   Theory of connections, Manifolds, Riemann tensor, Sectional Ricci curvature, Scalar curvature, Jacobi fields, Geometric invariants, Gauss-Bonnet Theorem, Gauge transformation, Curvature & Topology

MATH622 Complex Manifolds ............................................ (3-0-3)
   Prerequisite: 1. Commutative Algebra (Atiyah & McDonald’s book) 2. Basic Algebraic Geometry (Fulton’s Algebraic Curves, Hartshorne’s Algebraic Geometry - Chap 1) 3. Homological Algebra
(Hu’s Introduction to homological algebra).
Recommended Prerequisite: MATH520
Sheaves, Cohomology, Infinitesimal Deformations, Geometry on Hermitian & Kaehler manifold

**MATH623 Differential Topology**

Recommended Prerequisite: MATH520
Manifold Embedding, Sard Theorem, Transversality, Vector Bundle Theory, Euler number, Hopf Degree, Morse Theory, Cobordism Theory

**MATH624 Algebraic Topology**

Recommended Prerequisite: MATH524
Universal coefficient Theorem, Poincare duality, Jordan-Brouwer Separation Theorem

**MATH625 Lie Groups and their Representation**

Recommended Prerequisite: MATH520
Exponential Maps, Clifford algebra & Spinor group, Semi-simple Lie algebra, Representation Ring, Lie algebra representation, Peter-Weyl Theorem, Dynkin Diagram

**MATH641 Eigenvalue and Boundary Value Problems**

Best uniform approximation, Condition numbers, Krylov method, Eigenvalue problems, Several Time Scale

**MATH645 Mathematical Fluid Dynamics**

Recommended Prerequisite: MATH413
Navier-Stokes Equations, Weak-Strong Solution, Vanishing viscosity limit, Euler Equation, Results of Kato & Ponce & Yudovich, Vortex Dynamics, Measure-valued Solutions, Singular Solutions of 3-D Euler Equations, Concentration-Cancellations

**MATH647 Nonlinear Partial Differential Equations**

Recommended Prerequisite: MATH517
Schauder Theory, Fixed Point Theory, Harnack Inequality & Local Regularity or Fluid Equation, Existence & Uniqueness of the Solutions of Equations from Mathematical Physics

**MATH651 Advanced Numerical Analysis**

Prerequisite: Programming Experience
Recommended Prerequisite: MATH 551
Finding zeros and minimum points, Eigenvalue problems, Ordinary differential equations, Iterative methods for large system of linear equations

**MATH652 Numerical Analysis of PDE**

Recommended Prerequisite: MATH413, 651
Finite difference methods, Finite element methods, Parabolic problems, Hyperbolic problems, Elliptic problems, Error analysis in Sobolev spaces, Singularity
MATH661 Algebraic Graph Theory

Prerequisite: Undergraduate Linear Algebra and Abstract Algebra
Recommended Prerequisite: MATH 464

The aim is to learn algebraic methods utilizing the well-developed matrix theory and group theory in the study of graph theory and its applications. It is also to learn algebraic aspect of discrete mathematics and give a mathematical foundation for related areas of combinatorics, such as, distance-regular graphs, association schemes and t-designs. Graphs and these combinatorial objects will be studied through an investigation of their structures, existence and constructions.

MATH662 Topological Graph Theory

Recommended Prerequisite: MATH301, 421

Group presentations and Tietz transformations, Cayley graph, Graph coverings and related group theory, Maps on surfaces, Branched coverings of surfaces, Hurwitz numbers, Map colorings, Graph embedding invariants, Knots and spacial graphs

MATH699 Master Thesis Research

Recent research papers are studied independently under the guidance of a thesis supervisor. By giving a talk about them, each student improves his/her own research ability.

MATH709–789 Topics I, II, III

MATH709 Topics in Algebra
MATH711 Topics in Number Theory Algebra
MATH719 Topics in Analysis
MATH729 Topics in Geometry
MATH739 Topics in Statistics
MATH749 Topics in Applied Mathematics
MATH759 Topics in Computational Mathematics
MATH761 Topics in Combinatorics
MATH762 Topics in Graph Theory
MATH768 Topics in Coding Theory
MATH779 Topics in Numerical Analysis
MATH789 Topics in Topology
MATH798 Applied Mathematics Seminar ......................................................... (1-0-1)

The understanding of the applications of the theories of mathematics to sciences and engineering is improved through the lectures of invited speakers.

MATH799 Seminar ......................................................................................... (1-0-1)

The understanding of various major areas in mathematics is improved through the lectures of invited speakers.

MATH899 Doctoral Dissertation Research ....................................................... (1-9)

Recent research papers are studied independently under the guidance of a thesis supervisor. By giving a talk about them, each student improves his/her own research ability.
1. Education Aim

The Physics department of POSTECH was founded in 1986 whose goal is a research-oriented university. The goal of the Physics department is the department with global competitiveness. The department runs the graduate courses in order to make creative research experts with

A. Excellent Research Capabilities
B. Fluent Communication Skill and Teaching Ability
C. Strict Ethical Integrity

2. Program Overview

Physics is the most basic of all natural sciences and its application ranges broadly from the neighboring sciences to engineering. Physics has not only made significant contributions to the progress of modern technology but has also profoundly altered our views on the origin of the universe. In its methodology, physics depends on two inseparable and complimentary components: theoretical principles and experimental observations. Its predictive power plays its complimentary role by verifying the existing theory and also motivates further theoretical progress with new experimental discoveries.

The department of physics accepts the special responsibility of providing the best education and research opportunities to prepare individual students to be creative physicists. The faculty pursues excellence and commitment, both in teaching and in research, at the frontiers of physics in a highly competitive academic setting. Students are strongly encouraged to specialize not only in the traditional branches of physics but also in the new, interdisciplinary areas.

The graduate program offers Ms-Ph. D Integrative and Ph. D. Much of graduate student’s effort will be directed toward dissertation research that should involve original and creative approaches that are of significance to physics.

[Master’s Program]

A. The minimum number of credits required for a master’s degree is 28, at least 24 of which must be coursework credits.
B. Required Courses:
   - At least one of the following: Electrodynamics I & II
   - At least one of the following: Quantum Mechanics I, II & III
   - Colloquium (1 credit)
   - Master’s Thesis Research (variable credit: may be taken more than once)
[Ph. D Program]

A. The minimum number of credits required for a Ph. D degree is 32, at least 12 of which must be coursework credits. Credits earned during a master’s program are excluded.

B. Required Courses
- Analytic Mechanics (Substitute course: Advanced Mechanics)
- Statistical Mechanics (Substitute course: Advanced Statistical Mechanics)
- Electrodynamics I
- Quantum Mechanics I
- At least one from the following: Electrodynamics II & Quantum Mechanics II (It is possible to substitute Quantum Mechanics III for Quantum Mechanics I or Quantum Mechanics II)
- Colloquium (2 credits)
- Doctoral Dissertation Research (variable credits: may be taken more than once)

[Ms-Ph. D Integrated Program]

A. The minimum number of credits required for a Ph. D degree is 60, at least 33 of which must be coursework credits.

B. Required Courses
- Analytical Mechanics (Substitute course: Advanced mechanics)
- Statistical Mechanics (Substitute course: Advanced Statistical Mechanics)
- Electrodynamics I
- Quantum Mechanics I
- At least one from the following: Electrodynamics II & Quantum Mechanics II (It is possible to substitute Quantum Mechanics III for Quantum Mechanics I or Quantum Mechanics II)
- Colloquium (2 credits)
- Doctoral Dissertation Research (variable credits: may be taken more than once)

* Additional Information

A. All graduate courses, except for Master’s Thesis Research and Doctoral Dissertation Research, are graded on a letter grade basis. (However, Colloquium courses may be graded on an S/U basis.)

B. If a graduate student takes 400-level undergraduate courses, up to 6 credits may count toward his/her graduate program. If a graduate student takes a course from another graduate program and wishes to have the credit acknowledged by his/her own department, the student must choose to be evaluated on a letter grade basis.

C. Doctoral degree program students who earned their master’s degree from another university are exempted from one Colloquium course, and up to twenty four credits from the previous graduate study may be recognized upon approval by the Graduate Committee. If a student took one Colloquium course in the master’s program at POSTECH, he/she must take one more Colloquium course in the doctoral program.

D. If a student took two Colloquium courses in the master’s program, he/she is not required to take additional Colloquium course in doctoral program. Up to three Colloquium courses (total of three credits) may count toward graduation credits in a master’s and doctoral program combined or in an MS/Ph. D integrated program.
3. Course Description

**PHYS501 Analytical Mechanics**

Prerequisite: PHYS203

Topics include the Lagrangian and Hamiltonian formalism and its modern applications to nonlinear dynamics. The Lagrangian-Hamiltonian mechanics, the dynamics of the rigid body, the mechanics in the non-inertial coordinate systems and the theory of the special relativity are treated.

**PHYS502 Advanced Mechanics**

Prerequisite: PHYS501

Topics include the canonical transformation, Hamilton-Jacobi theory, the mechanics of the continuous media. Various modern applications of the classical mechanics including the nonlinear dynamics are discussed.

**PHYS503, 504 Electrodynamics I, II**

Prerequisite: PHYS206, PHYS209

Treated is an advanced level classical electromagnetism such as the statics of electromagnetism, Maxwell equations, special relativity, electromagnetic waves, motions of charged particles, and electromagnetic radiation.

**PHYS505, 506 Quantum Mechanics I, II**

Prerequisite: PHYS209, PHYS301

An intermediate level quantum mechanics. The course will cover the basic principles of quantum mechanics, problems of various potentials, symmetry and conservation laws, scattering theory, perturbation theory, atoms and molecules, radiation, identical particle systems, and introductory relativistic quantum mechanics.

**PHYS512 Statistical Mechanics**

Prerequisite: PHYS301, PHYS304

This course deals with equilibrium and nonequilibrium statistical mechanics at advanced level. Topics to be covered are the theory of ensemble, the basics of the thermodynamics, Fermi and Bose systems, applications to the interacting systems, random walk problem, critical phenomena and the concept of the re-normalization group.

**PHYS513 Advanced Statistical Mechanics**

Recommended Prerequisite: PHYS512

This course deals with equilibrium and nonequilibrium statistical mechanics with an emphasis on the latter. Linear response theory, temporal correlation functions, Boltzmann equation, transport phenomena, and the fluctuation-dissipation theorems are covered.

**PHYS517 Computational Physics Lab.**

Topics include Shell programming, system calls in Unix and VAX/VMS environment, programming using C and MATLAB. Small computing projects selected from electromagnetism, quantum mechanics, statistical physics and mathematical physics are required to be completed.
PHYS521, 522 Solid State Physics I, II ................................................................. (3-0-3)
Recommended Prerequisite: PHYS301, PHYS302, PHYS304, PHYS401
This course discusses at advanced level experimental and theoretical problems in solid state physics. Topics include electromagnetic, optical, thermal and transport properties of solids, energy band theory and Fermi surface, magnetism, and superconductivity.

PHYS551 Advanced Physics Laboratory .............................................................. (0-6-3)
Carried out are experiments to provide students with experience in experimental methods in selected topics of modern physics. Topics may vary according to the interests of the students.

PHYS601 Quantum Mechanics III ................................................................. (3-0-3)
Recommended Prerequisite: PHYS505, PHYS506
An advanced level quantum mechanics course. Topics include the Klein-Gordon equation, the Dirac equation, second quantization, the Feynman diagram and its applications, and introductory quantum field theory.

PHYS606 Elementary Particle Physics .............................................................. (3-0-3)
Classification of elementary particles and their interactions are covered. Gauge symmetry, standard model and theories beyond the standard model are introduced.

PHYS608, 609 Plasma Physics I, II ................................................................. (3-0-3)
Various phenomena of charged particles in the electromagnetic field will be discussed. Topics include Coulomb collision and transport phenomena, motions of charged particles in magnetic fields, MHD theory, plasma confinement, various instabilities, and the plasma kinetic theory.

PHYS610 Many Body Theory ................................................................. (3-0-3)
The theory on interacting particle systems will be covered. Topics include quantum field theoretic methods, Coulomb gas, imperfect Bose gas, Fermi liquid, magnetism, superconductivity, and nuclear matter.

PHYS611 Quantum Field Theory ................................................................. (3-0-3)
Recommended Prerequisite: PHYS505, PHYS506, PHYS601
This course covers quantum electrodynamics (QED), quantum chromodynamics (QCD), re-normalization group theory, path integrals, and current topics in theoretical high energy physics.

PHYS612 Computational Physics ................................................................. (2-2-3)
The course deals with various computational techniques in supercomputers currently used in many areas of physics including numerical analysis, the Monte Carlo method, molecular dynamics, and lattice gauge theory. Students are required to complete term projects on a topic of their choice.

PHYS613 Theory of Relativity ................................................................. (3-0-3)
The course covers the general relativity. After reviewing the special relativity, necessary tools in the differential geometry such as differential forms, curvature tensors are introduced. Einstein’s field equation is derived. The black hole physics and the modern cosmology are discussed.
PHYS615, 616 Particle Accelerator Physics I, II ......................................................... (3-0-3)
This course is about general theory of beam optics. Particle accelerators such as cyclotron, synchrotron, linear accelerator, storage ring are discussed. Particle beam sources such as ions, electron, and positron are dealt with.

PHYS650 Surface Physics ................................................................................................................... (3-0-3)
Surface properties of the condensed matter systems are covered. Topics include the problems in the theories and experiments in the structure reconstruction, surface band structure, magnetic and thermal properties and the critical phenomena. Interface, thin film and clustering are discussed.

PHYS651 Magnetism .......................................................................................................................... (3-0-3)
The theory of magnetism in conductor, semiconductor and insulator is covered. The foundational principles and the applications of the magnetic phenomena are discussed.

PHYS652 Vacuum Physics & Technology ......................................................................................... (3-0-3)
Emphasizing the underlying physics, this course provides all the information required by new users of vacuum systems. Its coverage is wide-ranging - from the behavior of gases at low pressures, through methods of vacuum production and measurement, to system design and testing.

PHYS653 Superconductivity .............................................................................................................. (3-0-3)
Topics include the basic concepts in the superconductivity such as the BCS theory, Josephson phenomena, Type I, II superconductivity, Ginzburg-Landau theory, magnetic properties of the superconductivity, fluctuation effect, description using the field theory and the High temperature superconductivity.

PHYS662/IBIO633 Biological Statistical Physics .............................................................................. (3-0-3)
The statistical physics approach to biological phenomena is discussed. Topics to be covered are basics on important constituents of the biological systems such as water, electrolytic liquids, biological membranes and the ion channels. The statistical and stochastic approaches to the dynamical phenomena in the biological systems such as protein folding and neuro-transmission, body flow and models of biological evolution are included.

PHYS663 Phase Transition and Critical Phenomena ....................................................................... (3-0-3)
Recommended Prerequisite: PHYS512
This course is intended to understand the principles underlying the critical phenomena and the phase transitions in the condensed matter systems. Topics include the models describing the critical phenomena in the dielectric and magnetic materials, critical exponents, universality and the scaling theory, re-normalization group and the computational simulation of the critical phenomena.

PHYS665/IBIO634 Nonlinear Dynamics and Chaos Theory ............................................................ (3-0-3)
This course is intended to understand the nonlinear methodology to treat the origin of chaos and synchronization based on the dynamical phenomena in the complex systems. The objects of interest are network pattern formation of the coupled oscillator, stochastic resonance and the neural network.
PHYS666/IBIO631 Physics of Soft Condensed Matter .................................................. (3–0–3)
This course introduces conformation and dynamics of polymers, membranes and liquid crystals. Topics include ideal chain and semi-flexible chain theory, bio-polymers, fluctuations and the interactions of the interface, self-assembled interfaces and bio-membranes.

PHYS667/IBIO612 Quantitative Theoretical Biology .................................................. (3–0–3)
Quantitative Theoretical Biology is a basic course geared to the quantitative analysis and modeling necessary for the theoretical understanding of biology. This course especially focuses on bio-statistics, non-linear mechanics, bio-informatics, thermodynamics, bio-dynamics, data analysis and data mining.

PHYS670 Plasma Diagnostic ......................................................................................... (3–0–3)
This course covers the principles of various diagnostic methods and their experimental applications for the measurement of plasma parameters. Topics include electric probe methods, optical diagnosis, microwave diagnosis, diagnostic methods using particle beams. Some experimental demonstrations of plasma diagnostics are carried out.

PHYS671 Low Temperature Plasma Physics ............................................................. (3–0–3)
This course deals with the basic principles and phenomena of the low temperature physics related to the plasma processing applicable to the semiconductor manufacturing and the surface treatment processes. Topics include the motions, collisions and diffusions of the charged particles in an electric field, the glow discharge using RF and microwave, diagnosis of the glow discharge and plasma application processes.

PHYS680 Introduction to Synchrotron Radiation Applications .................................. (3–0–3)
This course covers the principles of the generation of the synchrotron radiation and applicational research using the synchrotron radiation and experimental techniques.

PHYS681 Accelerator Technology ............................................................................... (3–0–3)
This course deals with the lattice design of the particle beam accelerators and the technology related to the critical subsystems. Topics covered are beam dynamics, lattice design, ultrahigh vacuum technology, high frequency wave technology, pulse modulation technology, electric magnet and the power source technology, beam diagnostics and system controls.

PHYS690 Advanced Optics ......................................................................................... (3–0–3)
This course covers the various topics in the modern optics. Topics include spectroscopy, fiber optics, nonlinear optics, Fourier optics and other applications.

PHYS691 Laser Physics ............................................................................................... (3–0–3)
This course deals with the principles of the laser, its theory and types. Topics include stimulated emission, rate equation, Q-switching, mode locking, the types of gain medium and laser applications to various fields.
PHYS692 Quantum Optics

This course deals with the representation of the light states and their measurements, the interactions of the light and matter based on the quantization of the electromagnetic fields. Photon number states, coherent states, photon detections, coherence, interactions with two-state atom and nonclassical states of the light are discussed.

PHYS699 Master Thesis Research

Graduate students working toward the Master’s degree are required to carry out master’s thesis research under the supervision of their advisor.

PHYS701, 702, 703 Special Topics in Condensed Matter I, II, III

Advanced courses on the topics of condensed matter physics. Topics will include semiconductors, surface physics, low temperature physics, polymers, magnetism, and superconductivity. The topics and prerequisites will depend on the instructor.

PHYS705, 706 Special Topics in Modern Physics I, II

Advanced courses on the topics of modern physics besides condensed matter and statistical physics. The topics include particle, nuclear, atomic, and molecular physics and quantum optics. The topics and prerequisites will depend on the instructor.

PHYS707 Special Topics in Statistical Physics

Advanced courses on the topics of statistical physics. The topics include nonequilibrium phenomena, phase transition, and critical phenomena. The topics and prerequisites will depend on the instructor.

PHYS709 Special Topics in Mathematical Physics

Prerequisite: PHYS209, PHYS408
This course covers mathematical topics which are necessary for theoretical physics research. The material covered will depend on the instructor.

PHYS710 Special Topics in Optics

This course covers various advanced topics in the classical and the modern optics.

PHYS712 Special Topics in Biological Physics

This course is intended to cover various advanced topics in biological physics.

PHYS715 Special Topics in Particle Accelerators

This course is about advanced theory on accelerator beam optics. Topics include physics of low emittance electron (or positron) storage ring, principle of insertion devices such as wigglers and undulators, nonlinear dynamics of circular accelerators. Physics of beam instabilities, advanced theory of linear accelerator and physics of intense beams are discussed.

PHYS718 Special Topics in Plasma Physics

This course covers various advanced topics in the plasma physics.
PHYS720/IBIO632 Special Topics in Brain Science

This course provides the overall basic concepts in the brain structure and its functions. Topics include vision, memory, emotion, biological rhythm, motion control, neural coding, linguistic functions, nondestructive brain function measurements. The course could include seminars of the invited speakers.

PHYS801 Colloquium

Students are encouraged to attend the colloquium lectures on current topics presented by departmental or invited speakers.

PHYS811, 812, 813 Special Topics in Advanced Physics I, II, III

Advanced courses on contemporary topics which are not specified above but are necessary for graduate study. The topics and prerequisites will depend on the instructor.

PHYS890 Extramural Research Internship

PHYS899 Doctoral Dissertation Research

Graduate students working toward the Ph. D. degree are required to carry out Ph. D. dissertation research under the supervision of their thesis advisor.
Department of Chemistry

1. Program Overview

Students are to follow academic regulations and requirements of the POSTECH graduate program. The following presents the required courses of each individual division and the ones common to all divisions.

- Physical Chemistry: Take two courses from Quantum Chemistry (CHEM510), Molecular Spectroscopy (CHEM513), Statistical Thermodynamics (CHEM613), and Chemical Dynamics (CHEM614).
- Analytical Chemistry: Advanced Analytical Chemistry (CHEM541).
- Polymer Chemistry: No courses are required.
- Biochemistry: Advanced Chemical Biology (CHEM561).

[Required to all students]

- Master Thesis Research (CHEM699), Doctoral Dissertation Research (CHEM899): these courses can be taken repeatedly.
- Colloquium (CHEM809): The following requirements are applied to the graduate students starting from year 2012.
  - For those in the master program: Should take each course three times or more
  - For those in the M.S-Ph.D integrated program: Should take each course six times or more
  - For those in the Ph.D program: Should take each course three times or more

[M.S. program]

For a student to be qualified for submitting his/her thesis, in addition to taking credits required to complete a graduate curriculum, a proposal for thesis research should be submitted to and approved by the thesis committee members one semester before filing the thesis. The thesis should be completed according to the university regulations and approved by the committee. In the case the student needs to switch his/her research advisor, upon the new advisor’s approval, the submission of the research proposal can be delayed into the graduating semester, but no later than one month prior to the thesis approval by the committee.

[Ph.D. program]

For a student to be qualified for submitting his/her dissertation, he/she must complete the major and minor courses required for qualifying examination with a grade of A- or higher. In addition, a student must obtain approval for dissertation proposal from dissertation committee members.

The dissertation should be completed according to the university regulations and approved by the dissertation committee members.
[M.S.-Ph.D. integrated program]

Students in this program do not submit a Master’s thesis. A student must complete major and minor courses required for qualifying examination with a grade of A- or higher. In addition, he/she must obtain approval for dissertation proposal from dissertation committee members.

The dissertation should be completed according to the university regulations and approved by the dissertation committee members.
2. Course Description

CHEM500 Current Trends in Chemistry ................................................................. (3-0-3)
This course explores the latest trends and the future of various disciplines in rapidly developing chemical sciences and technologies of today.

CHEM510 Quantum Chemistry ........................................................................ (3-0-3)
Fundamentals of quantum mechanics and its application to atoms and molecules. Topics include Schrödinger equation, matrix mechanics, uncertainty principle, molecular rotation and vibration, angular momentum, electronic structure of atoms and molecules, wave packets, and perturbation theory.

CHEM511 Experimental Physical Chemistry .................................................... (3-0-3)
The principal focus of this course is to provide the fundamentals of experimental techniques widely used in experimental physical chemistry laboratory. Topics include vacuum techniques, lasers and optics, mass spectrometry, time and frequency measurements, Fourier transformation and other signal processing techniques, and basic electronics.

CHEM513 Molecular Spectroscopy .................................................................... (3-0-3)
Development of molecular quantum mechanics and its application to the spectroscopy of atoms and molecules. Topics include interaction of the electric field with matter, group theory, rotational and vibrational spectroscopy of molecules, electronic spectroscopy of atoms and molecules, and photoelectron spectroscopy.

CHEM521 Advanced Organic Chemistry ........................................................... (3-0-3)
Primary topics of this course include detailed discussions of physical organic chemistry (structure and properties) and understanding of many types of fundamentally important and practically useful reactions in terms of their mechanisms.

CHEM522 Organic Reaction Chemistry ............................................................. (3-0-3)
Many organic reactions including reactions with carbanions, organometallic reactions, oxidation-reduction reactions, and cyclo-additions will be described in this course.

CHEM531 Advanced Inorganic Chemistry I ......................................................... (3-0-3)
The subjects of this course span from fundamental concepts about atomic and molecular structures to bioinorganic and supramolecular structures. Especially, symmetry and group theory, ligand field theory, crystal field theory, and molecular orbital theory are introduced to understand the relationship between the structures of inorganic complexes and their optical, electrical and magnetic properties.

CHEM532 Advanced Inorganic Chemistry II ....................................................... (3-0-3)
This course focuses on transition metal based organometallic compounds. The concept of ligands and the rules of their coordinations to transition metals are introduced, which further provides concrete understandings about their optical, electrical, magnetic properties. The synthesis, chemical
reactivity, characterization methods are also covered. In the last part, currently rising hot topics in materials chemistry are introduced.

**CHEM535 Physical Methods in Inorganic Chemistry**

This course is to provide characterization methods that provide specific chemical bondings and geometrical structures of inorganic compounds and organometallic complexes. The topics include powder and single crystal X-ray diffraction, nuclear magnetic resonance, electron spin resonance, vibrational spectroscopy, and various surface characterization methods.

**CHEM541 Advanced Analytical Chemistry**

This course provides a thorough background on chemical equilibria and related materials that are particularly important to analytical chemistry. These include: treatment of errors, chemical equilibria, classical methods of analysis, electrochemistry, spectrometry, kinetics, and separations.

**CHEM542 Analytical Spectroscopy**

This course provides a thorough treatment of the instrumental principles, terminology, methodology, and instrumentation to analytical spectrochemical methods. It also discusses specific spectrochemical analysis techniques in terms of their implementation and characteristics, where appropriate, representative examples of practical applications of the techniques are given.

**CHEM543 Electrochemistry**

This course covers fundamentals and applications of electrochemistry. Classes for the first weeks cover thermodynamics and kinetics related to electrode/electrolyte interfaces, basic techniques to solve electrochemical problems, and various experimental techniques. These are followed by discussions of applications including various electrochemical devices and analytical techniques.

**CHEM544 Chemical Separation**

This course covers principle, instrumentation, and applications of various separation techniques: extraction, filtration, chromatography, electrophoresis, field-flow fractionation, and multidimensional separation methods.

**CHEM551 Synthesis and Characterization of Macromolecules**

An introductory course on polymer chemistry mainly dealing with various polymerization reactions and molecular characterization methods of polymers.

**CHEM552 Morphology and Properties of Macromolecules**

An introductory course to give general scopes on the morphology and properties of macromolecules and their relationships. In addition, their analytical methods are introduced.

**CHEM561 Advanced Chemical Biology**

This course is to provide students advanced principles and concepts in biochemistry, molecular biology, and chemical biology, focusing on the structure and function of biomolecules, and the experimental approaches to study them. Topics include: chemistry of nucleic acids, structure and function of proteins, molecular machines involved in biochemical reactions, metabolism and biochemical control mechanism.
CHEM571 Environmental Chemistry ................................................................. (3-0-3)

The study of the sources, reactions, transport, effects, and fates of chemical species in water, soil, and air environments and the effects of technology thereon.

CHEM600 Critical Review on Chemical Research ............................................. (3-0-3)

This course aims to have students get critical view on research in various disciplines of current chemical sciences and technologies.

CHEM612 Advanced Quantum Chemistry ....................................................... (3-0-3)

Theoretical study of semi-empirical, density functional, and ab initio calculations, molecular mechanics and dynamics, Monte Carlo simulations, integral equation methods, path integral methods, free energy perturbation approach, scattering and collision, wave packets, etc.

CHEM613 Statistical Thermodynamics ........................................................... (3-0-3)

The course introduces elementary statistical mechanics with application to simple physical and chemical systems at the level of "Statistical Mechanics" by McQuarrie.

CHEM614 Chemical Dynamics ........................................................................... (3-0-3)

Principal focus of this course is the microscopic treatment of chemical reaction dynamics. The lecture focuses on both theory and modern experimental techniques. Topics include the chemical kinetics, transition state theory, microscopic description of unimolecular reactions, and statistical approach to chemical reaction dynamics.

CHEM616 Surface Chemistry ............................................................................. (3-0-3)

Introduction to the behavior of atoms and molecules adsorbed on solid surfaces. Topics include the structure of surfaces and adsorbate layers, bonding of molecules to surfaces, adsorbate phase transitions, and surface reactions.

CHEM617 Computational Chemistry ............................................................... (3-0-3)

Computational application to geometric and electronic structure analysis, spectral analysis, nano-material/ device design, drug design, and protein folding.

CHEM618 Special Topics in Physical Chemistry ............................................... (3-0-3)

Advanced course dealing with a subject not ordinarily covered by regularly scheduled courses.

CHEM619 Nanochemistry .................................................................................. (3-0-3)

Nanochemistry deals with syntheses of various nanomaterials and nanostructures and the characterizations thereof. This class intends to address syntheses and applications of recently developed nano-sized structures that include organics, semiconductors and metals. Students in this class shall understand recent nanoscience and nanotechnology, and thus develop capabilities leading principal researches at future careers in academia and industries.
CHEM621 Organometallic Chemistry  
Historical background for organometallics, physical and chemical properties of organometallic compounds, and reaction mechanisms for organometallic transformations are the major topics of this lecture.

CHEM622 Medicinal Chemistry  
This course covers fundamental features of modern medicinal chemistry topics in the areas of theoretical aspects of drug action, structure-activity relationships, design and synthesis of drug molecules in major therapeutic categories, and drug delivery technology.

CHEM623 Physical Organic Chemistry  
Bonding theories and structures for understanding physical and chemical properties of organic compounds and mechanisms for organic transformations are the major topics of this lecture.

CHEM624 Organic Synthesis Chemistry  
This course deals with design and synthesis of organic compounds such as natural products, various application of organic reactions, and synthetic application of stereochemistry.

CHEM625 Natural Products and Bioorganic Chemistry  
The objective of this course is to provide the organic aspects of biomolecules such as nucleic acids and proteins/enzymes and bioactive molecules such as natural products. The isolation, structure determination, activities, and reaction mechanisms of these bio-related molecules are studied with molecular details.

CHEM626 Enzyme Chemistry  
This course covers physical and chemical properties of soluble proteins and membrane proteins, interactions in protein-ligand complexes, enzyme catalysis, and design and chemical synthesis of enzyme inhibitors.

CHEM627 Spectroscopic Determination of Molecular Structure  
This practical course give students the detailed information about how to utilize the spectroscopic data for the structural determination of unknown organic compounds.

CHEM629 Special Topics in Organic Chemistry  
Notable trend and special topics for organic chemistry are discussed.

CHEM631 Bioinorganic Chemistry  
This course focuses on the understanding about the role of inorganic metal ions in biological systems. The involvements of inorganic metal ions which cause specific biochemical reactions, for example, oxygen delivery, enzyme activity, electron and ion transfers through membranes, etc. are the main topics. The mechanisms of uptake, delivery, storage, and transfer of inorganic metal ions in biological systems are also introduced.
CHEM632 Supramolecular Chemistry

Synthesis and properties of supramolecules composed of organic, inorganic molecules as well as biomolecules are introduced in this course. The concepts of self-assembly and specific molecular recognition which are critical chemical routes for the formation of supramolecular structures are covered combined with the potential applications of supramolecules towards energy storage, efficient catalysis, bottom-up generation of nanoscale electronic devices, etc.

CHEM633 Materials Chemistry

This course introduces the role of chemistry in the preparation of magnetic materials, nonlinear optical materials, liquid crystals, molecular scale nanoelectronic components. The formation of thin film of such functional materials on various solid substrates and related surface chemistry, such as self-assembly, Langmuir-Blodget film coating, layer-by-layer deposition process are also introduced.

CHEM634 Solid State Chemistry

Synthesis and characterizations of solid state materials are the main topic of this course. This course also covers fundamental theories and backgrounds of the chemical bond formation during the solid state reactions as well as appropriate characterization tools, such as X-ray diffractometer, X-ray photoelectron spectroscopy, transmission electron microscope, scanning electron microscope.

CHEM636 Nano-Surface Chemistry

Investigation about chemical reactions of specific functional molecules on various solid state surfaces such as metal, semiconductor, polymer, or well-defined self-assembled organic monolayer is the main subject of this course. The basic principles of scanning probe microscopy, ellipsometry, surface plasmon resonance which enable such explorations at molecular levels are also introduced.

CHEM639 Special Topics in Inorganic Chemistry

Special topics in modern inorganic chemistry, materials chemistry, surface chemistry, solid state chemistry are introduced.

CHEM642 Chemical Instrumentation

This course covers the fundamentals for chemical measurements. Subjects including basic analog and digital electronics are covered first, which is then followed by discussions on computer interfacing and chemical instrumentation. The lab covers basic electronics and computer interfacing experiments.

CHEM649 Special Topics in Analytical Chemistry

A select subset of current topics in analytical chemical sciences and technologies are reviewed and discussed.

CHEM651 Macromolecular Physical Chemistry

An advanced physical chemistry course dealing with the relationship between molecular characteristics and physical properties of polymeric materials in bulk and solutions.
CHEM652 Biopolymer Chemistry

The introductory part will provide basic concept, synthetic strategies for biopolymers. In the subsequent lectures bioconjugation of polymers and their acquired properties along with their potential application in biotechnology will be dealt in details. The major focus of this course will be on development of imaging agents, drug delivery carriers, gene delivery vectors and polymer scaffold for tissue engineering.

CHEM659 Special Topics in Macromolecular Chemistry

This course reviews most recent trends in the macromolecular sciences and additionally introduces most attractive subjects of matters as well as hottest issues to be solved in the macromolecular science.

CHEM669 Special Topics in Biochemistry

Selected topics from bio-organic, biophysical, or biological chemistry will be discussed. The contents of this course will vary.

CHEM699 Master Thesis Research

Graduate students working toward the Master’s degree are required to carry out master’s thesis research under the supervision of their advisor.

CHEM711 Theoretical Background for Computer Simulations of Biological Systems

This course covers the background of theoretical methods that are used in computational research in chemistry and other related fields for studying biological molecules and other macromolecules. In the first stage, statistical mechanical techniques such as Monte Carlo and molecular dynamics are discussed, and later other methods are covered with an emphasis on realistic applications. Sampling issues in biological simulations and the related generalized ensemble approach for solving the issue are also discussed. Representative topics include: molecular dynamics, integration algorithms, periodic boundary conditions, Monte Carlo, detailed balance, force field model, vibrating molecules and constraints, Markov process, constant pressure Monte Carlo, integration errors, long range forces, Ewald summations.

CHEM712 Computational Methods in Condensed Matter System

This course will provide the theory and application of computational method for the condensed matter system.

CHEM714 Dynamics of Elementary Gas Reactions

Quantitative principles and experimental methods of studying detailed gas-phase reaction dynamics. Topics include scattering cross sections, intermolecular potentials, reactive scattering, and the application of lasers and molecular beam techniques to the study of reaction mechanisms.

CHEM715 Atomic and Molecular Theory of Surfaces

Current topics in surface science: surface characterization, adsorption and heterogeneous catalysis.
CHEM716 Multiple Quantum NMR Spectroscopy ................................................................. (3-0-3)
The course introduces the theory behind modern nuclear magnetic resonance (NMR) spectroscopy. Topics include multiple quantum coherence and product operator formalism with application to a wide range of multidimensional pulse sequences.

CHEM717 Femtosecond Chemistry ................................................................................. (3-0-3)
Theory and experiment on the time domain spectroscopy. Topics include femtosecond lasers and measurement techniques, time correlation function formalism, linear and nonlinear polarization, linear response, response function theory, wave packets, dephasing and relaxation, chemical reaction dynamics in condensed phases.

CHEM718 Computer Aided Molecular Design .............................................................. (3-0-3)
Practice of computational chemistry. Research of special molecular systems using various theoretical methods such as semi-empirical, density functional, and ab initio calculations, molecular mechanics and dynamics, Monte Carlo simulations, integral equation methods, path integral methods, free energy perturbation method, chemical expert systems, chemical data base, and bioinformatics.

CHEM719 Dynamics of Mass Spectrometry ............................................................... (3-0-3)
Principal focus of this course is the ion motions involved in mass analyzers. The lecture focuses on theory, SIMION simulation, and application of mass analyzer. Topics include time-of-flight, quadrupole mass analyzer, octopole ion guide, quadrupole defl, magnetic sector, ion trap, Fourier transform ion cyclotron resonance, and orbitrap.

CHEM721 Biological Molecular Chemistry ............................................................... (3-0-3)
This special topics course entails the literature discussion on the various research topics related to the design, synthesis and their biological utilities of various physiologically important molecules. A recent emphasis was on a group of enzymes and their inhibitors in connection with their relevance as drug development targets.

CHEM722 Applied Bioorganic Chemistry ................................................................. (3-0-3)
This special topics course entails the literature discussion on the research topics of bioorganic chemistry such as molecular recognition, library construction, and their utilities involving small molecules, peptides, carbohydrates, lipids, and nucleic acids in connection to their medicinal chemistry applications.

CHEM723 Asymmetric Organic Synthesis ................................................................. (3-0-3)
Focussed on chiral molecular recognition and catalysis, metal complex catalysts, major contents involve the synthesis of chiral molecules, chiral molecular recognition, and synthesis and applications of functional molecules.

CHEM724 Enzymes in Organic Synthesis ................................................................. (3-0-3)
The applications of enzymes in organic chemistry are studies with their structures, activity, selectivity, and reaction mechanisms. Particularly, their catalytic applications in stereoselective synthesis constitute the main part of this course.
CHEM725 Molecular Recognition Chemistry ....................................................... (3-0-3)
Focussed contents involve the molecular recognition phenomena in modeled and real molecular systems.

CHEM726 Organometallics in Organic Synthesis ....................................................... (3-0-3)
New research results described in recent papers are used as the main lecture source. Basic organic transformations and multistep organic synthesis involving organometallic reagents are discussed.

CHEM735 Model Studies in Metalloenzymes ....................................................... (3-0-3)
This course introduces about the chemical reactivity of metalloenzymes in organic and inorganic syntheses. Recent reports and review articles covering this topic are utilized to establish solid backgrounds of metalloenzymes and further to design new and better molecular model systems.

CHEM736 Homogeneous Catalysis ....................................................... (3-0-3)
Catalytic reactions of organic compounds using organometallic compounds are introduced. The theoretical and experimental backgrounds for the developments of active organometallic complexes to specific catalysis as well as mechanism studies of various catalytic reactions in solution phase are mainly covered.

CHEM741 Applied Electrochemistry ....................................................... (3-0-3)
This course covers applied electrochemistry and related aspects relevant to graduate research. These include various experimental techniques important to student’s thesis research and interpretations thereof.

CHEM742 Analytical Vibrational Spectroscopy ....................................................... (3-0-3)
Principle, instrumentation, and analytical applications of various vibrational spectroscopic methods: infrared absorption spectroscopy, Raman scattering spectroscopy, etc.

CHEM743 Bioanalytical Chemistry ....................................................... (3-0-3)
Principle, instrumentation, and applications of various, contemporary bioanalytical methods: biosensors, bioseparations, bio-mass spectrometries, nanobiotechnologies, and miniaturization techniques.

CHEM754 Physical Properties of Macromolecular Solutions ....................................................... (3-0-3)
An advanced course learning thermodynamics of polymer solution related with the static and dynamic properties of single polymer chains and their ensembles.

CHEM755 Speciality Macromolecules ....................................................... (3-0-3)
Specialty polymers are introduced in the aspect of novelities in applications, and their pros and cons in the polymerization, structure, properties, and applications are discussed. In addition, for some selected specialty polymers there are discussed potential solutions to solve their disadvantageous characteristics.
CHEM761 Nucleic Acid Chemistry........................................................................................................ (3-0-3)

The goal of this course is to help students understand the basic concepts on the structure and function of nucleic acids, and based on this knowledge, to discuss recent progresses on the novel structure and function, and the development of nucleic acids as diagnostic and therapeutic molecules.

CHEM801 Literature Seminar A/B........................................................................................................... (1-0-1)

In this course students present seminar talks on their own reviews of literature on current topics in chemistry. Students majoring physical chemistry, analytical chemistry, and polymer chemistry take Literature Seminar A, and students majoring organic chemistry, inorganic chemistry, and biochemistry take Literature Seminar B.

CHEM809 Colloquium.......................................................................................................................... (1-0-1)

Students are encouraged to attend the colloquium lectures on current topics presented by departmental or invited speakers.

CHEM899 Doctoral Dissertation Research.............................................................................................. (1~9)

Graduate students working toward the Ph.D. degree are required to carry out Ph.D. dissertation research under the supervision of their advisor.
Department of Life Sciences

1. Program Overview

Analytic methods flourished in the field of life science in the latter half of the 90s. As many new areas of biology were created and developed into independent disciplines, many life phenomena have been studied at the molecular level. Recently, major universities are undertaking initiatives to reintegrate those segmented research areas. This is not only because integrative approaches are more practical for understanding life phenomena, but also because the universities are trying to restructure the education of life science for ready application of their research results to industry, anticipating that business founded on life phenomena will be at the heart of the industrial restructuring in the knowledge-based society of the 21st century. Based on Postech’s philosophy of research-oriented education, the Department of Life Sciences intends to provide a globally competitive graduate program by expanding the infrastructure for future industry and facilitating active exchanges in interdisciplinary education and research.

To become a successful scientist in modern biology, one needs to know how to incorporate the technology and experimental strategies used in different disciplines. To produce human resources who can contribute the nation and humankind in the realms of academia and industry, the Department has adopted a “track” concept in its educational system. The Department of Life Sciences has four tracks: Structural and Molecular Biology, Molecular and Medicine, Cellular and Developmental Biology and Plant Sciences. All graduate students are provided with recommended courses and professional guidance from their advisors in the track. Within each track synergistic effects are being maximized centered on research by encouraging active exchange between professors, researchers and students. An inter-organic educational system is built in among the tracks so that students can have easy access to other areas. The curriculum offered in each track provides the students within the track. However, the students in a certain track are not bound to the curriculum offered by the specific track, but are in fact encouraged to take courses offered in other tracks or in other departments as well depending on their academic or research interests.

2. Course Planning

Each track emphasizes different course work. Students should consult with their advisor before taking the classes. Molecular and Medicine emphasizes Cell Biology, Molecular Biology, Medicinal Chemistry, Immunology and Virology. The Cellular and Developmental Biology track requires courses in Molecular Biology, Genetics, Developmental Biology, Neurobiology and Physiology. The Structural and Molecular Biology track emphasizes lectures on Enzymology, Protein Biochemistry, Protein Engineering, Biophysics, and Protein Crystallography. Finally, the Plant Sciences track requires Molecular Biology, Biochemistry, Genetics, Plant Molecular Biology, Plant Cell Biology, and Plant Physiology. In addition, students are trained to promote research capability by critical reading and understanding of research papers and by attending seminars, presentation sessions, and journal clubs.
3. Course Description

LIFE501 Virology ................................................................. (3-0-3)
This course explores the biological and molecular properties of viruses, structures of viral genes, the relationships of viral genes with genetic phenomena, cells infected with viruses, and the immune system.

LIFE502 Advanced Biochemistry ..................................................... (3-0-3)
This course explores the structures and regulation of receptors and ionic channels, and the molecular regulatory mechanisms of factors in signal pathways that emanate from them. In addition, the principles of enzyme chemical structures, functions, and application and related metabolic pathways and their significance as well as contemporary research techniques are addressed. In particular, emphasis is placed on enzyme kinetics, reaction mechanisms, and active sites, labeling and determination techniques, structural relationships among active inhibitors and active sites, and the modification of enzymes using genetic engineering and gene expression.

LIFE503 Advanced Immunology ....................................................... (3-0-3)
This course explores the principles of techniques for conducting research on immunity and application for the resolution of major biological problems. In particular, emphasis is placed on the reactions of antigens and antibodies, immuno assay, structures and reactions of immunoglobulins, genes governing the immune system, processes through which antibodies are formed, principles of cell-mediated immunity, complements, tolerance, and transplantation, and techniques for producing and applying monoclonal antibodies.

LIFE504 Pharmacology ............................................................ (3-0-3)
This course explores pharmaceutical reactions and the principles and research techniques for their clinical application. In particular, emphasis is placed on the relationships among pharmaceutics and receptors on a molecular level, pharmacokinetics, the molecular structures and functions of various receptors, and the regulation of cell functions through receptors.

LIFE505 Neurobiology .............................................................. (3-0-3)
This course explores the basic principles of the organization and reactions of the nervous systems of various life forms. In particular, emphasis is placed on neurocytology, the structure of the nervous system, the development of nerves, and the biochemical mechanisms of action potential and transmission and of sensory transduction.

LIFE506 Plant Physiology ............................................................ (3-0-3)
This course explores photosynthesis, metabolism, growth, reactions to the environment, plant-microbe interrelations, genesis, control and regulation, and hormonal reactions.

LIFE507 Advanced Cell Physiology ................................................ (3-0-3)
This graduate course comprehensively explore various mechanisms for the movement of large molecules such as the movement of ions through cell membranes, signal transduction mechanisms through which stimuli outside cells are transmitted within, and proteins in the cytoplasm.
LIFE508 Advanced Developmental Biology
This course explores the mechanisms through which the fertilized egg develops into an entity composed of various cells, tissues, and organs.

LIFE509 Advanced Cell Biology
This course explores the structures of cells in relation to their functions, analysis of observations using optical and electron microscopes, and techniques for verifying the distribution of target proteins in cells using marked antibodies.

LIFE510 Plant Molecular Biology
This course explores in plant molecular biology and plant molecular genetics. In particular, emphasis is placed on biochemistry and molecular biology of recent plant sciences.

LIFE511 Cellular Signaling
This course comprehensively explore the basic principles of regulating hormones, neuro-transmitters, growth factors, and cells’ reactions to changes in the external environment, components of receptors, switches, amplification systems, and molecular networks on a molecular level, various forms of signal transduction, as well as the growth, development, differentiation, and death of cells.

LIFE512 Metabolic Controls
This course comprehensively explore major metabolism related to body energy and biosynthesis and their molecular regulatory phenomena through the latest research. In particular, emphasis is placed on signal pathways from changes external to cells to the active regulation of metabolic enzymes, regulatory mechanisms through phosphorylation, and a molecular understanding of diseases including diabetes that are caused by abnormalities in such mechanisms.

LIFE513 Environmental Toxicology
This course explores the metabolic pathways and effects of xenobiotics on the human body, with an emphasis on the mechanisms through which chemicals due to environmental pollution poison the body and on countermeasures from the point of view of industrial control.

LIFE514 Molecular Imaging
The goals of this course are to provide a broad overview of the principles and applications of optical technologies that are being widely used or newly emerging in various scientific fields. It also introduces students cutting-edge imaging and research tools to allow unpresendent biological research performed with cells in living subjects and to develop new ways to diagnose diseases. Accordingly, the course is open to under and graduate students with diverse backgrounds, such as material science, and mechanical engineering and physics, as well as biological sciences, who wish to learn one of fastest-developing techniques for biological research and medical intervention.

LIFE515 Biology of Aging
The focus of this course is on current understanding of aging process at an organismic level. Emphasis is placed on genetic control mechanisms that regulate aging and age-related diseases. Moreover, students will discuss key molecular signaling pathways that regulate aging processes, which are conserved across phyla.
LIFE516 Plant Molecular Cell Biology ................................................................. (3-0-3)

In this subject, students will learn the organization of the eukaryotic cell, physiological roles of organelles, operating principles of eukaryotic cells, and the theory/hypothesis on the cellular evolution. Furthermore, students will learn the mechanism of protein translation, protein targeting to the ER, chloroplasts and mitochondria, protein trafficking between endomembrane compartments, and proteins and lipid molecules involved in the protein trafficking. This class will consist of lectures, presentation and group discussion.

LIFE517 Advanced Molecular Genetics ............................................................ (3-0-3)

This course is designed to help students learn recent exiting advances in the molecular genetics. The topics include functional genetics, model organisms, molecular genomics. In addition, students will discuss breakthrough findings in the molecular genetics field.

LIFE570 Translational Research in Plant Science ............................................. (3-0-3)

Knowledge obtained from Plant science can be applied to improve the quality and quantity of food, energy, and to protect environment, and thus is becoming more and more important for our everyday life and world economy in 21st century. This course explores the current translational researches which attempt to connect the knowledge from basic plant science to application field such as agriculture, industry, and environment. The course will consist of lectures from professors and student presentations. Occasionally invited speakers will give a lecture to the students in the class.

LIFE601 Advanced Molecular Biology I ............................................................ (3-0-3)

This course explores in depth DNA replication in lower cells, genetic recombination, DNA repair, structures and functions of genes, transposable elements, and gene expression regulation through the latest research and literature.

LIFE602 Advanced Molecular Biology II ......................................................... (3-0-3)

Continuation of MOLS 601, this course explores the structures and replication of chromatin in advanced cells, gene expression regulation, somatic recombination, and oncogenes.

LIFE603 Advanced Genetics .............................................................................. (3-0-3)

In this course, students explore the latest research on genetics by reading and discussing academic papers. The topics is selected under the faculty member’s supervision and the class is conducted in a seminar format.

LIFE604 Viral Molecular Genetics ................................................................. (3-0-3)

With a view that viruses are particles with chemical, physical, and genetic properties, this course explores viruses’ structures, replication, mutation, and relationships with host cells.

LIFE605 Plant Signal Transduction ................................................................. (3-0-3)

This course explores the mechanisms through which plants recognize and react to external conditions such as light, temperature, moisture, and pollutants and internal conditions such as hormones and developmental processes.
LIFE606 Advanced Plant Cell Biology

This course explores in depth unique structures and functions of plant cells and examine the latest accomplishments, trends, and developments in research in this field.

Recommended prerequisite: MOLS506 Plant Physiology

LIFE607 Plant Functional Genomics

This course explores techniques for conducting research on plant genomes. In particular, emphasis is placed on rapidly developing areas of study including gene isolation, mutation induction, genome mapping, proteomics, and bioinformatics through an examination of the latest literature.

Prerequisite: MOLS510 Plant Molecular Biology

LIFE608 Plant Developmental Biology

This course explores plant development in depth through the latest literature. In particular, emphasis is placed on the entire development process of plants from the germination of seeds, development of leaves and roots, transition from vegetative reproduction to reproductive growth, and flower development to seed development.

Prerequisite: MOLS510 Plant Molecular Biology

LIFE609 Protein Engineering

This course explores the principles and practical applications related to protein modification based on genetic engineering in order to understand the structures and functions of proteins. In particular, emphasis is placed on both basic theory and applicative principles including the prediction of protein structures and functions based on genetic information, gene expression through various types of cells, directed mutagenesis, analysis of the effects of mutation, protein folding and stability, designing proteins and drugs, and industrial applications using protein engineering.

LIFE610 Advanced Enzymology

This course explores the structural properties of enzymes, analysis of active sites, enzyme kinetics, analysis of enzymic reaction intermediates and products, analysis of idiosyncratic enzymic reactions, and the stability and structural folding of enzymes in order to understand the structures and reaction mechanisms of enzymes and to apply them industrially. Based on traditional enzymology, the approach here will emphasize recently developed genetic engineering and mechanical analysis methods.

LIFE611 Biomacromolecular Structures

This course addresses a structural understanding of the functions of proteins a structural understanding of protein-DNA, protein-sugar, protein-steroid, and protein-protein interactions; a structural understanding of enzyme protein reaction mechanisms and protein structures as means to functional genomics to arrive at an advanced understanding of the functions of proteins, which dictate a majority of biological phenomena.

LIFE612 Enzyme Mechanisms

This course explores the reactions of enzymes and substrates and enzyme reaction mechanisms on an atomic level. In particular, emphasis is placed on chemical methods, methods for studying
enzyme mechanisms using enzyme proteins’ tertiary structures, electrons’ pathways of movement during chemical reactions, and the roles and chemistry of co-enzymes.

LIFE613 Molecular Embryology .................................................................(3-0-3)
Through lectures and discussions on the latest academic papers this course explores molecular and genetic mechanisms related to the development of the embryo in higher animals. Particular emphasis is placed on differentiation, induction, and pattern formation.

LIFE614 Neuroendocrinology .................................................................(3-0-3)
This course explores the functions of the brain-nervous system, the secretion and reaction mechanisms of neuro-transmitters, and the roles and uses of related molecules from biochemical and cellular biological point of views. In addition, the latest trends and methods in research in these fields is discussed.

LIFE615 Cell Membrane Physiology ......................................................(3-0-3)
This course explores not only properties unique to cell membranes but also the structures, functions, and regulatory mechanisms of receptors, ionic channels, and transmitters that exist on cell membranes. Discussions on physiological and biochemical research methods and approaches to these components of cell membranes and the application of biochemical and molecular biological techniques to the latest research will help students in conducting their own research.

LIFE616 Biocommunications .................................................................(3-0-3)
This course explores the molecular principles and diversity of cell-molecule interactions in multicellular life forms. Particular emphasis is placed on receptor ligands, which are the key molecular mechanisms that form the basis of intermolecular recognition for the regulation of cellular functions and signal transduction, the functional modules and motifs of signal proteins, and unique molecular interaction through lectures and presentations. In order to enhance students’ mathematical and bioinformational understanding of communication in biosystems consisting of such components, experts will give tutorial lectures.

LIFE617 Tissue Biochemistry .................................................................(3-0-3)
This course explores molecules that compose life forms in terms of their functions in tissues and organs. In particular, the regulation of and the molecular mechanisms of diseases in nervous, circulatory, digestive, excretory, and reproductive organs is examined based on the latest research. A part of the course consists of lectures by guest speakers clinical practitioners and pharmaceutical developers and researchers who will speak about the reality and future of the treatment of diseases and the development of pharmaceutics.

LIFE618 Proteomics & Molecular Networks ..........................................(3-0-3)
This course explores in detail the latest research on proteome, which is the functional object of genomes. Particular emphasis is placed on the structures and properties protein machines, which consist of protein multi-complexes including proteasomes, spliceosomes, focal adhesion complexes, and post-synaptic density complexes. In addition, hi-tech techniques for analyzing and determining molecular networks through protein molecule interactions is addressed.
LIFE619 Bioinformatics

This course addresses ways of searching for and analyzing DNA and protein information, as well as providing insight into biological literature and the latest trends in and the future of bioinformatics.

LIFE620 Advanced Biostatistics

This course explores advanced statistic processing techniques and analyses needed for the analysis and understanding of biodata.

LIFE621 Protein Biochemistry

This course comprehensively explores the principles and applications of techniques for analyzing proteins in order to understand the molecular structures, functions, and properties of proteins. In particular, emphasis is placed on protein biosynthesis, modification after gene translation, protein interaction, protein phospholipid mechanisms, proteolytic process, properties of membrane proteins, affinity labeling methods, and regulatory mechanisms of protein reactions from a biochemical point of view.

LIFE622A-Z Advanced Topics in Life Science A-Z

This course explores the latest trends in and the future of various disciplines in the rapidly developing life sciences of today.

LIFE623 Ionic Channels

This course explores excitable cells, with an emphasis on the physical and molecular properties of ionic channels that exist on the cell membranes of neurons.

LIFE624 Advanced Bioengineering

This course presents the promising biotech industry in the spotlight, its prospects and research directions. In addition, this course introduces basic and newly developed technology for the biotech industry.

LIFE690 Graduate Seminar I

In this course, students present their research results.

LIFE699 Masters Thesis Research

In this course, students conduct research under the supervision of their respective academic advisors.

LIFE701 Methods in Plant Molecular Genetics

In this course, students explore various techniques in plant molecular genetics through lectures, discussions, and experiments.

LIFE702A-D Methods and Logic in Molecular Biology A-D

This course explores techniques for characterizing genes, structures of genetic materials, and stable inheritance and expression for application to further research.
LIFE703 Regulation of Gene Expression ................................................................. (3–0–3)

This course explores DNA replication, chromosome stability, gene applicability, and regulation both before and after replication and before and after transcription.

LIFE704 Practical Methods in Enzymology ............................................................ (0–6–3)

In this course, students conduct experiments to isolate, refine, and characterize enzymes by using high-performance liquid and affinity chromatography as well as experiments to apply anti-bodies and molecular biological techniques to the study of enzymes.

LIFE705 Muscle Physiology .................................................................................... (3–0–3)

This course explores the fundamental properties of muscles, with an emphasis on the stimuli needed for anatomical functions, contraction, and relaxation, the movement of ions, changes in the electric potential of cell membranes, and the mechanical properties of muscles.

LIFE706 Receptor Biochemistry ............................................................................. (3–0–3)

This course explores current trends in research on receptors, the isolation and verification of receptors, the isolation and verification of receptor DNAs, and the relationships among structures and functions.

LIFE707 Developmental Genetics ......................................................................... (3–0–3)

In this course, students explore in depth genetic regulatory mechanisms that intervene in the ontogeny of certain animals by presenting and discussing the latest research.

LIFE708 Molecular Endocrinology ........................................................................ (2–2–3)

This course explores the latest research on the secretion and reaction mechanisms of hormones and reexamine and understand hypotheses whose experimental evidence is undergoing review through lectures and discussions. Particular emphasis is placed on the process through which hormones are secreted, reactions in target organs and their mechanisms, and the regulatory mechanisms for the secretion and concentration of hormones on a molecular level.

LIFE709 Cell Membrane and Lipid Biochemistry .................................................. (3–0–3)

This course explores the chemical properties and biological functions of lipids that compose cell membranes and lipid metabolites. Particular emphasis is placed on lipid mediators’ functions, membrane traffic, molecular understanding of endocytosis and exocytosis, metabolism of cholesterol and neutral fats, and principles of diseases due to abnormalities so as to promote a comprehensive understanding of lipid reactions on a molecular level.

LIFE710 Laboratory Techniques in Plant Physiology ............................................. (0–6–3)

This course explores and apply techniques used to study the growth, development, and water metabolism of plants, as well as ion transport in plants, in order to enable students to resolve basic problems in plant physiology.

LIFE711 Techniques in Plant Biochemistry ............................................................ (1–4–3)

This course explores nitrogen metabolism and aspects unique to plants during respiration, basis methods for conducting experiments on plant hormones, photosynthesis, and photo-morphogenesis, and the latest techniques and their results.
LIFE712 Plant-Environment Interaction ................................................................. (3-0-3)
Through studies of academic papers this course explores in depth the latest research on the physiological, biochemical, and molecular biological regulation of the processes through which plants recognize and react to various environmental factors (light, temperature, moisture, gravity).

LIFE713 Advanced Plant Pathology ..................................................................... (3-0-3)
This course comprehensively explores the characterization and pathology of plant germs including viruses, bacteria, and fungi, these germs’ interactions with plants, and the physiology and biochemistry of infected plants. The latest research on molecular biology will also be examined.

LIFE714 Methods in Cell Biology ....................................................................... (3-0-3)
In this course, students explores the cell biological experiment techniques needed to understand the structures and functions of advanced cells through lectures, presentations, and discussions.

LIFE715 Protein Crystallography ....................................................................... (3-0-3)
This course explores the theory and application of protein X-ray crystallography. Particular emphasis is placed on crystal symmetry, diffraction theory, multiple isomorphous replacement, and molecular replacement.

LIFE716 Methods in Immunology ...................................................................... (3-0-3)
This course explores the evolution of the immune system, concomitant immunity, new concepts of and strategies for vaccines, immune tolerance, and autoimmune diseases.

LIFE717 Methods in Virology ............................................................................ (3-0-3)
In this course, students explores the techniques and methods needed to conduct research on viruses and viral diseases through lectures and discussions on academic papers.

LIFE718 Techniques in Molecular Immunology ................................................. (1-4-3)
In this course, students explores immunological techniques used in the study of various life forms on the molecular level through lectures and experiments.

LIFE719 Molecular Biophysics ......................................................................... (3-0-3)
This course explores various problems in physics, biochemistry, and biology on the molecular level and from physical and chemical point of views. Particular emphasis is placed on the relationships among the structures of bio-polymers and molecules and on physical techniques used to characterize proteins and nucleic acids.

LIFE720 Chemical Carcinogenesis and Teratogenesis ..................................... (3-0-3)
This course explores the mechanisms through which chemicals cause disabilities in babies and cancer. In addition, students will examine the latest research on biochemistry, cellular biology, and molecular biology.
In this course, students will measure ion movement by using materials that combine with ions to become fluorescent or by fixing the electric potential or current of cell membranes. They will also learn to use patch clamps by which they will measure ion movement by removing parts of cell membranes, and measure the secretion of hormones or neurotransmitter by using various pharmaceutics.

LIFE722 Mammalian Genetics

This course explores the genetic diseases of mice and human beings through analysis of past and recent literature, with an emphasis on research techniques and the genetic and molecular biological mechanisms of such diseases.

LIFE723 Metabolic Regulation

This course explores, on a molecular level, the regulatory phenomena of enzymes in allosteric regulation, reversible phosphorylation, and degradation that are important to metabolic regulation. In addition, the latest research techniques and experiments is included.

LIFE802A–Z Graduate Seminar

LIFE806A–Z/IBIO801A–Z Special Topics in Systems Biology A–Z

This course explores the latest trends in and the future of various disciplines in the rapidly developing systems biology of today.

LIFE890 Graduate Seminar II

In this doctoral seminar, students will present their research.

LIFE899 Doctoral Dissertation Research

In this course, students in the doctoral program will conduct research under the supervision of their respective academic advisors.
Department of Materials Science and Engineering

1. Education Aim

Through an understanding of the importance of thermodynamics and kinetics – and thus the properties and the synthesis of materials – the department aims to afford students with basic pivotal knowledge in materials science and engineering. Such knowledge spurs developments of highly creative ideas and their practical realizations based on theoretical competence and experimental skill.

2. Program Overview

The Graduate School of the Department of Materials Science and Engineering (MSE) at Pohang University of Science and Technology (POSTECH) offers Masters and Doctor of Philosophy degree programs.

MSE will continue to focus research on materials deemed critical in the 21st century. Specific research areas, utilizing metals, ceramics, polymers, and electronic materials, include the following:
3. Advanced Structural Materials.
4. Clean & Green Ferrous Technologies.
5. Biomaterials.

[Course Requirement]

[Master’s Program]
- The minimum number of credits required for a master’s degree is 28, of which at least 24 must be course credits and 4 research credits.
- Take AMSE699 (Master Thesis Research) to fulfill the research credit requirement.
- Course Credits
  - Major Electives:
    - AMSE500, 600 and 700 level courses
    - Graduate courses from other departments
    - Two 400 level courses from MSE or other departments (undergraduate courses)
  - Total number of credits earned by taking graduate courses of other departments with the S/U (Satisfactory/Unsatisfactory) grade option and by taking 400 level courses may not exceed 6 credits.

[Doctoral Program]
- The minimum number of credits required for a doctoral degree is 32, of which at least 18 must be course credits and 14 research credits.
(Credits from courses taken to fulfill the requirements for a master’s degree will be excluded.)
- Take AMSE899 (Doctoral Dissertation Research) or 4 semesters of AMSE701 (Seminars in Materials Science) to fulfill the research credit requirement.
- Course Credits
  - Major Electives:
    - AMSE500, 600 and 700 level courses
    - Graduate courses from other departments
    - Two 400 level courses from MSE or other departments (undergraduate courses)
  - Total number of credits earned by taking graduate courses from other departments with the S/U (Satisfactory/Unsatisfactory) grade option and by taking 400 level courses may not exceed 6 credits.
  - AMSE encourages its students to take at least 6 credits from other departments or disciplines to enrich their knowledge and broaden their perspectives.
  - Students are required to pass the Q.E and the proposal defense by the time designated by AMSE.

**[MS/PhD Integrated Program]**
- The minimum number of credits required for the MS/PhD Integrated Program is 60, of which at least 42 must be course credits and 18 research credits.
- The courses students may take to meet the course and research requirements are the same as for the doctoral degree.
- Students are required to pass the Q.E and the proposal defense by the time designated by AMSE.
- If a student in a master’s program wishes to transfer to the integrated program, he/she must meet the requirements and follow the procedures specified in the Statutes of the university.
- If a student in the integrated program who has completed all the requirements for a master’s degree wishes to withdraw from the integrated program, he/she may be conferred a master’s degree.

**[Credits required for graduation]**

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3. Course Description

AMSE501 Advanced Thermodynamics of Materials……………………………………………(3-0-3)

This course reviews the fundamental principles of thermodynamics and instructs the students their applications to real materials processing problems. The concepts of basic thermodynamic law, equilibrium, solutions, statistical thermodynamics, defects, surfaces and electrochemistry will be used to illustrate the role of thermodynamics in materials science.

AMSE502 Phase Transformation…………………………………………………………………(3-0-3)

Provides an opportunity to check the basic rule of thermodynamics in phase transformations, study surface/interface and diffusion kinetics. Deepens understanding of general kinetics, nucleation kinetics, growth kinetics, non-classical nucleation theory (spinodal decomposition). Introduces latest research results in CVD thermodynamics, abnormal grain growth, multicomponent diffusion, surface/interface reaction.

AMSE503 Interface Science………………………………………………………………………(3-0-3)

This course describes theoretical principles and properties of various interfacial systems. The topics include thermodynamics of surfaces and interfaces, adsorption and interfacial segregation of various solutes, wettability and interfacial electrochemical properties, theory of colloid stability and powder dispersion, and applications of various modern spectroscopic methods to the understanding of electronic states and surface structure.

AMSE505 Polymer Engineering………………………………………………………………(3-0-3)

Polymer materials are produced and applied in huge amounts in Korea on the basis of petrochemistry. This course pursues for a wide range of understanding on commercial polymers by introducing the students industrial manufacturing processes, physical and chemical properties of the polymers so that the students become more capable of selecting the optimal polymer material for specific applications in mind.

AMSE506 Non-crystalline Inorganic Materials…………………………………………………(3-0-3)

Discussion of molecular structure, basic physical and chemical properties, chemical durability, annealing and tempering, mechanical strength, optical and thermal properties of glasses. Design of composition for desired engineered properties. Provide an atomistic understanding of the role of composition on the structure and properties of glasses.

AMSE507 Instruments for Materials Characterization………………………………………..(3-0-3)

This course aims to deliver underlying physical backgrounds and fundamental working principles of scientific instruments for materials characterization. Instead of merely introducing diverse instruments, this lecture mainly focuses on basic theory of microscopy and spectroscopy techniques which were developed for different information. Upon completion of this course, the students will be familiar with basic principles of sophisticate scientific instruments and the acquired knowledge can be easily extended to other similar instruments.
AMSE508 Research Method in Materials Science and Engineering

The course discusses research itself. Those students, who are beginning their own research, will face herds of frustrating questions, such as: 'what topic and problem to research?', 'what are data?', 'how to plan data collection?', 'how to write a draft?', and after all, 'what is the significance of one's research?', etc. All these are fuzzy problems to the beginners, even experienced. The class will handle those topics on the path of research, such as value of research, research problem making, reading scientific articles, writing and disseminating results, etc. The class aims at helping those students to be more comfortable with research.

AMSE509 Atomic Simulation

Provides an ability to utilize atomistic simulation (molecular dynamics, Monte Carlo) methods in materials researches. Basic theory and computation/simulation techniques will be introduced and practiced with relevant computer softwares.

AMSE521 Organic Electronics for Information and Energy Technologies

Printed plastic electronics and displays are currently one of the most researched topics within the flat panel display and solid-state lighting device community. The field of flexible or flat panel displays is truly unique in the sense that it is interdisciplinary to the display community, combining basic principles from nearly all engineering and science disciplines. In addition, solid-state lighting devices becomes more and more important because of energy and environmental issues. Energy conversion devices such as organic photovoltaic cells also attracted many interests in the organic electronics fields. In this course, the organic materials and devices for information displays and energy conversion devices will be covered. Basically, organic light-emitting diodes, organic photovoltaic cells, and organic light-film transistor based on organic materials will be studied in this course. Finally the applications of the component devices to flexible displays will be covered.

AMSE522 Inorganic Materials for Optoelectronics and Applications

The course teaches the physical foundations underlying the operation of modern optoelectronics device. Quantum mechanical foundation are emphasized. In addition, the course covers areas such as semiconductor statistics, doping, hetero-structures, transport, p-n junction theory, and tunneling. The course will give students a solid foundation for optoelectronic devices such as light-emitting diodes, laser diodes and solar cells.

AMSE601 Dislocations and Strengthening Mechanisms

The advanced concepts and application aspects of dislocations will be introduced first. The continuum theory of dislocations will be studied first in view of the internal stress fields, forces, and energies. The Green’s function method is introduced to solve the stress fields of general curved dislocations. The crystallography of dislocations including the Peierls-Nabarro dislocation and partial dislocations will also be studied in this course followed by the single crystal plasticity. The various strengthening mechanisms are then studied especially in relation to the interaction between the barriers and dislocations. Finally, the recently developed internal variable theory of inelastic deformation will be introduced at the end of course.
AMSE604 Solid State Reactions and Sintering ................................................................. (3-0-3)
This course covers the fundamentals of solid state reaction kinetics involved in crystalline and non-crystalline solid including metallic and ionic systems. Crystal defects and transport theories are discussed in depth as a basis of solid state reactions. A wide range of solid state reaction kinetics are addressed in quantitative manners. They include homogeneous reaction, inter-diffusion, solid-gas reactions, solid-solid reactions, fuel cells, galvanic cells, and sintering practice.

AMSE605 Solid State Physics ............................................................................................... (3-0-3)
This course will present an introductory treatment of solid state physics. Topics to be discussed include: free electron model, nearly-free electron model, electromagnetic theory, band theory, defects, thermal and optical properties of materials, dielectrics and ferroelectrics, magnetism, and optoelectronic and spintronic devices.

AMSE606 Statistical Mechanics of Materials ................................................................. (3-0-3)
This course emphasizes fundamental theoretical principles of statistical mechanics and their applications to the understanding of various types of functional materials. The topics include ensembles and ergodicity, principles of classical and quantum statistics, molecular partition functions, linear response theory, time-correlation function formalism, molecular spectroscopy and dielectric relaxation, cooperative magnetic transitions and various solid solutions.

AMSE608 Electron Diffraction and Microscopy ............................................................ (3-0-3)
Introductory course which deals with electron waves, the structure of electron microscope, theories of electron diffraction, theories of diffraction contrast and phase contrast, and their applications to imaging of crystal structure, defects and phase transformation in current crystalline materials.

AMSE609 Advanced Electron Microscopy ................................................................. (3-0-3)
This course aims to provide physical background and to deepen the understanding of the image formation theories in transmission electron microscopy (TEM). The lecture covers: 1) the diffraction contrast imaging routinely used in conventional TEM and its application to defect analyses, 2) the phase contrast imaging of high resolution TEM (HRTEM) and its quantitative interpretation based on image simulation techniques and 3) scanning TEM (STEM) Z-contrast image theory and the simulation of HAADF images. The last part of lecture is devoted to the basic theory and recent progress in electron spectroscopy techniques with particular emphasis on spectroscopic imaging techniques with characteristic X-ray and electrons with energy loss.

AMSE611 Experiments for Transmission Electron Microscopy .................................. (1-4-3)
Laboratory experiment course for the prerequisite course of AMSE608. The basic operation of transmission electron microscope, the practice for electron diffraction and imaging of crystalline defects are performed. High resolution imaging and analysis are also practiced with an aid of analytical microscopy EDS, STEM, EELS in current materials.

AMSE612 X-Ray Diffraction and Imaging ................................................................. (3-0-3)
In-situ microscopic observation is getting important in nano-technology or biotechnology. Conventional microscopes have limitations on surface observation (optical microscope, scanning
electron microscope, atomic microscope, etc) or in environments (mostly vacuum). The only in-situ microscopic method to overcome such limitations is X-ray imaging. In this lecture the basic principles of X-ray imaging are introduced together with cases of recent researches. Practical methodologies of X-ray imaging are taught as well. This lecture is for the graduate students oriented in materials science, nano-technology or biotechnology.

**AMSE613 Applied Quantum Mechanics**

This course emphasizes fundamental understanding and prediction of electronic structure and materials properties on the basis of ab initio quantum mechanical computations. After briefly introducing the Hartree-Fock self-consistent field (HF-SCF) approach, I will systematically explain core quantum principles and methods of the density functional theory (DFT). Participating students will learn the basic ideas and modern computational schemes of the DFT based on ab initio pseudo-potentials, in addition to gaining scientific insight into actual computations of complex electronic structures and materials properties without adopting any unjustified assumption.

**AMSE621 Alloy Design**

Examines the application of science and engineering principles to the design, selection, and performance of engineering alloys (steel, Al, Mg, Ti, Ni alloys, etc). Studies alloy classes, design, effect of alloying elements, relation to processing variables, and structure-property relationships.

**AMSE624 Deformation Processing of Structural Materials**

Based on fundamental theories of stress states and deformation, this course introduces various deformation processes of structural materials. Examples of actual deformation phenomena and analyses of defects occurring during deformation processing will be explained by deformation theories.

**AMSE625 Theory of Elasticity and Plasticity**

This course intends to provide graduate level students the basic principles of Elasticity and Plasticity together with the ability to solve the stress fields of various engineering solids under a general loading. The basic concepts of continuum mechanics will be reviewed first. Then the theory and application aspects of Elasticity problems will be studied including the Thermo- as well as the Visco-elasticity. The fundamental aspects of continuum plasticity will also be studied in relation to metal forming processes. Finally, the recently developed internal variable theory of inelastic deformation will be introduced.

**AMSE626 Fracture Phenomena and Mechanisms**

Fundamental fracture mechanics including linear-elastic fracture mechanics, elastic-plastic fracture mechanics, and micro-fracture mechanics will be introduced. Using these fracture mechanics theories, examples of fracture phenomena occurring in structural materials will be explained by analyzing fracture mechanisms and by defining fracture models, and then methods for preventing fracture phenomena will be suggested.

**AMSE627 Fatigue Mechanisms**

Theories and mechanisms for fatigue of materials will be studied, and various mechanical, micro-structural and environmental factors influencing the fatigue will be discussed in detail.
Several important topics are the cyclic stress- or strain-controlled fatigue, crack growth retardation by crack closure, fatigue life prediction and design concept. Recent issues will also be discussed in the student’s seminar.

AMSE628 High Temperature Deformation Behavior of Materials .......................................................... (3-0-3)
High temperature deformation behavior of materials will be studied based on the detailed knowledge of slip, climb, creep and grain boundary sliding. Several important topics are the processing maps, high temperature deformation mechanisms, superplasticity of meso-scale or nano-scale micro-structures and super-plastic forming and diffusion bonding. Recent issues will also be discussed in the student’s seminar.

AMSE633 Corrosion Science ...................................................................................................................... (3-0-3)
Principle of corrosion and corrosion prevention on the basis of electrochemistry is introduced, and corrosion phenomena occurring in various environmental conditions will be discussed with respect to corrosion reaction mechanisms. For corrosion prevention, various methods of alloy design, surface coating, cathodic protection and corrosion inhibitor are presented in terms of engineering principle.

AMSE634 High Temp Oxidation & coating ................................................................................................ (3-0-3)
Principles of high temperature oxidation, sulfidation and hot corrosion are introduced, and high temperature corrosion phenomena occurring in various industries are discussed with respect to reaction mechanisms. For high temperature corrosion protection, various types of diffusion coating, overlay coating and thermal barrier coating are presented with respect to coating methods based on engineering principle.

AMSE642 Conducting Ceramics .............................................................................................................. (3-0-3)
The electrical conductivity of oxides, including the electronic and ionic conducting ceramics, is discussed in terms of transport theory and defect chemistry. Further discussion will also include the correlation between the electrical conductivity and temperature, oxygen partial pressure, composition, and microstructure. The application to solid oxide fuel cell will also be discussed.

AMSE644 Magnetic Properties of Materials .............................................................................................. (3-0-3)
The subject covers the introduction of magnetism, and various magnetic phenomena for practical use: such as anisotropies, nano-size magnetism, and magnetic interactions. Base on these knowledges, modern magnetic materials will be discussed.

AMSE645 Optical Properties of Materials ............................................................................................... (3-0-3)
This course will present an intermediate treatment of the optical properties of semiconductors and insulators. Topics to be discussed include: basic electromagnetic theory, electronic band theory, absorption and dispersion, radiative transitions, stimulated emission, non-linear optical properties, and so on.

AMSE648 Structure of Thin Films ............................................................................................................. (3-0-3)
In the first part of thin film processes, we study on vacuum, plasma, physical vapor deposition, and chemical vapor deposition. In the second part of thin film structures, we study on surface and
interfaces, growth mechanism, transition, preferred orientation, and defects of thin films, mostly using synchrotron x-rays. Very recent research results are introduced on thin films structures.

AMSE649 Photonics Glasses................................................................. (3-0-3)

Discussion of basic principles, optical characteristics and future trend of photonic glasses for lasers, fiber-optics and display technologies. Tailoring of their optical properties through nano-structuring of glasses will also be discussed.

AMSE650 Piezoelectric/Ferroelectric Materials......................................... (3-0-3)

This course introduces various interesting modern topics in ferroelectric systems. These include crystal structure, statistical thermodynamic and Landau’s phenomenological descriptions of ferroelectric phase transitions, lattice dynamics and Raman scattering, domain structure, relaxor ferro-electricity, and magneto-ferroelectric couplings.

AMSE655 Solid-state Electrochemistry and Fuel Cells.................................. (3-0-3)

Recent energy and environmental problems require the development of energy-efficient and environment-friendly devices where solid-state electrochemistry is becoming increasingly important. This course introduces solid-state electrochemistry and reviews status, materials, fabrication of solid-state electrochemical devices. Batteries, fuel cells, sensors and electro-chromic devices, topics for which solid state electrochemistry makes a major contribution. Materials and fabrication methods for solid electrolytes and electrodes will be discussed that include fuel cell as an example of electrochemical devices.

AMSE661 Advanced Polymer Synthesis...................................................(3-0-3)

This course deals, on the basis of fundamental organic chemistry, with fundamental polymerization reactions and their in-depth mechanisms affecting the structure and chain length of the polymers to be prepared. The reactions comprise chain-growth ones of radical, anionic, cationic, and metallocenic mechanisms and step-growth ones.

AMSE662 Advanced Polymer Physics....................................................... (3-0-3)

This advanced level covers the various theories and experimental results in the fields of single chain conformation, dilute and semi-dilute polymer solution, mixture, block copolymer, crystalline and glassy states. Concepts of statistical thermodynamics and scaling laws in polymer solution and melts are also introduced.

AMSE664 Molecular Design of Functional Polymers...................................(3-0-3)

Functional polymers responding to various factors such as light, electrical fields, thermal treatments are introduced. Emphases are on polymerization methods including traditional approaches such as anionic, radical condensation, mechanism for the development of special functions, and relationships between structure and function.

AMSE667 Instrument Techniques in Polymer Science................................ (3-0-3)

The basic properties of x-rays and neutrons, the principles of their scattering from matter and experimental techniques are introduced. Wide-angle diffraction, small- angle scattering and reflectivity measurements are discussed for molecular packing structure of crystalline polymers,
degree of crystallinity and orientation, polymer solution, block copolymer nano-structure, surface and interface profiles.

**AMSE669 Nano-Biomaterials**

The convergence of recent advances in nano-biotechnology and medicine has created the new research domain of nano-medicine. This course will provide students with an in-depth understanding of nano-biomaterials for nano-medicine in terms of life science, chemistry, physics, and materials science.

**AMSE681 Properties of Semiconducting Materials**

The goal of this course is to bring together the fundamental physics of the semiconductor material and the semiconductor device physics. In this course, optical and electrical properties of semiconductor films are studied.

**AMSE682 Surface Analysis and Nano-scale Characterizations**

This course will present an intermediate treatment of the surface and interface analysis of solid materials and nano-scale characterizations of nano-materials and nano-structures. Topics to be discussed are basic theories and experimental techniques for characterizations of surfaces and interfaces.

**AMSE683 Light Emitting Diodes**

The goal of this course is to bring together the fundamental physics of light emitting diodes (LED) including electrical properties and optical properties. In this course, the recent trend of LED research and development is studied.

**AMSE686 Electrical Properties of Low Dimensional Materials**

This course specifically aims to provide experimentalists with a phenomenological introduction to electron transport in low-dimensional materials, defined rather broadly. The lecture overviews the basic principles of electron transport particularly through confined potentials, and their typical manifestations in experimental observations. The goal of the course is also to develop the skill of critical reading of the experimental literature. This includes how to read an experimental paper, how to read forward and backward in the literature (including web-searched materials) without getting overwhelmed, and how to present and discuss your ideas effectively in a group setting. (Hence the class-takers are required to give a presentation on a given subject in a group setting.)

**AMSE699 Masters Thesis Research**

As a partial fulfillment of a master degree, an independent research for a master thesis is conducted under the guidance of a designated thesis advisor.

**AMSE701 Seminars in Materials Science**

Contemporary topics in general materials researches are discussed in the departmental seminar settings given by invited speakers.

**AMSE721 Special Topics in Materials Science A/Z**

Selected topics in advanced materials science are lectured in this special course.
AMSE731 Special Topics in Metallurgical Engineering (3-0-3)
Selected topics in advanced metallurgical engineering are lectured in this special course.

AMSE741 Special Topics in Ceramics (3-0-3)
Selected topics in advanced ceramic materials are lectured in this special course.

AMSE742 Special Topics in Electronic Materials (3-0-3)
Selected topics in advanced electronic materials are lectured in this special course.

AMSE899 Doctoral Dissertation Research (1~9)
As a partial fulfillment of a doctorial degree, an independent research for a master thesis is conducted under the guidance of a designated thesis advisor.
1. Program Overview

Mechanical engineering plays a vital role in different industrial applications such as system design, energy-related technology and development of new materials and manufacturing techniques. Department of Mechanical Engineering, POSTECH is making efforts to meet the societal demands to advance various multidisciplinary industries such as intelligent robotics, bio-systems, airplanes, automobiles, shipbuilding and electronic devices.

We are currently involved in the following four major categories of graduate research and education to cope with evolving research objectives and international trends.

1. Mechanics & Materials
2. Dynamics / Control / Measurement
3. Thermal / Fluid Engineering
4. Design, Manufacturing

12 specific areas for concentrating education and research activities are described below.

Micromechanics & Nanotechnology
MEMS (Micro Electro Mechanical Systems) is a new technology developed in the field of mechanical engineering and it enables the constructions of sensors, actuators, and other structures of dimensions in micron scale, based on fabrication process technologies developed for micro-electronic (or semiconductor) industry. It also covers general mechanical engineering phenomena such as heat transfer, fluidics, control, dynamics, etc, in micro/nano scales.

Manufacturing and Materials Processing
Manufacturing and materials processing is one of important mechanical engineering disciplines closely related to industrial problems of manufacturing high quality products of various forms and materials with high productivity. The manufacturing technologies of current interest include machining (cutting) process and various forming processes of advanced materials such as metals, plastics, powder materials and composites.

Robotics and Control
The research in robotics and control aims to develop robots possessing similar intelligence and capabilities as human beings and utilize them for simple repetitive tasks or hazardous and difficult tasks such as underwater exploration, minimally-invasive surgery and artificial limbs.

Composite Materials and Smart Structures
Composite materials and smart structures explains the mechanics, experimental analysis and processing of composite materials and smart structures. Research is focused on processing and mechanical characterization of metal matrix composites, fatigue and fracture of polymer composites, mechanical behavior of composites under multi-axial loads and optimal stacking sequence design of laminated plates. Theories of adaptive control of structures and experimental
analysis of vibration control are investigated in the smart structures area. They include variable geometry truss structures and smart structures using piezoelectric materials, shape memory alloys and optical fibers.

**Flow Modeling & Computation**

Research program of the Flow Computation and Modeling (FCM) provide new ideas, models and computational tools for accurate engineering design analysis and control of basic and complex flows. A significant emphasis is placed on physical modeling and analysis of engineering systems. There are efforts on turbulence structure and rational modeling, flow control and drag reduction, materials processing in injection molding processes, vortical flows in rotating machinery and aerodynamics, and flow and heat transfer in steel making processes.

**Flow Control & Environmental Thermo-fluid**

Research activities of flow control and environmental thermo-fluid include analytical and experimental flow control techniques for reduction of drag resistance, noise, use of energy, and their application such as aerodynamics of vehicles, flow in the vicinity of structures, hydrodynamics, thermo-flow in steel manufacturing processes and shipbuilding/marine engineering. In addition pollutant production in air and sea water, mechanisms of pollutant dispersion, and techniques of capturing and removing pollutants are being investigated.

**Biomechanical Engineering**

Bio-engineering is an interdisciplinary engineering discipline which performs research on human biology and physiology to improve human health and well-being by combining medical science and modern mechanical engineering. The field has developed rapidly in the past 30 year, with a wide range of engineering involvements such as artificial limbs and simulation of natural environments through mechanical design.

**CAD/CAE**

In this relatively new field major efforts are focused on development and application of computer based methodologies for analysis and design of machine elements, structures, and in particular, manufacturing processes. CAD/CAE plays an essential role in modern engineering research activities with extensively related work performed in diverse fields of mechanical engineering.

**Mechanics of Materials**

Deformation and fracture of engineering materials are investigated from the perspective of micro/macro mechanical analysis of solid structures. The constitutive behavior and fracture of metals, porous materials and composite materials are modeled by combined experimental and analytical approaches. Fatigue and fracture mechanics theories are utilized to predict crack initiation and growth in engineering materials. Methods for stress and vibration are developed and applied to engineering problems.

**Combustion and Propulsion Engineering**

Both fundamental and application oriented research is performed in the areas of turbulent flow, fuel spray, premixed and diffusion combustion and radiative heat transfer for design and analysis of various combustion devices including spark ignition and diesel engines, gas turbines, burners
and furnaces. Major research efforts are concentrated on development and validation of three dimensional computational fluid dynamic software with relevant physical models.

Heat Transfer & Energy Engineering

The research activities of heat transfer and energy engineering are categorized into two-phase heat transfer, enhanced heat transfer, and safety analysis of nuclear systems from thermal hydraulic view points by experimentation and modeling analysis. Research on wind and solar energy conversion technology is also active, as part of efforts toward alternative energy engineering.

Aerodynamics & Aerospace Engineering

In this field, education and research on disciplines related to the design, analysis and manufacture of aerospace vehicles are pursued as an integral whole. It includes aerodynamics, gas dynamics, propulsion engineering, lightweight smart structure and mechanics of composite materials.

[Remarks on Graduation Requirements with degrees in Mechanical Engineering]

1. All graduate students are required to take Graduate Seminar(MECH803, MECH804)
   - Master’s Program students must take Graduate Seminar for two semester.
   - Ph.D. Program students must take Graduate Seminar for three semester.
   - Integrative Program students must take Graduate Seminar for five semester.

2. Registering for courses MECH806(Technical Writing), MECH807(Scientific Writing)
   - Graduation requirement : Requires MECH806 or MECH807
   - Completion of one of the two courses is required for graduation but not included in credit needed to graduate.
   - One of the two courses must be completed by all students in graduate courses.
   - If you completed MECH806 or MECH807 during a master’s course, you do not need to register for this course.

3. Information about taking the MECH702D, 702E(Graduate Research Seminar A, B)

<table>
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<td>For whom</td>
<td>Ph.D. Program students who are in the 1st or 2nd semester/ Integrative Program students who are in the 1st or up to 4th semester</td>
<td>Ph.D. Program students who completed the 3th semester, Integrative Program students who completed the 5th semester</td>
</tr>
<tr>
<td>Topic</td>
<td>To analyse research trends and give a presentation after organizing them</td>
<td>To present your own research areas and plans</td>
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</table>

- This course is mandatory for the new students starting from 2014 Fall semester.
- This course is mandatory for Master’s Program students.
4. Graduate course credits may include the following:
   - Up to 6 credits of 400-level undergraduate courses offered by the Department of ME and other Departments
   - For courses with S/U credits from other departments, up to 9 credits are allowed for Master’s and Ph.D. students, and up to 18 credits for Integrative Program students.

2. Course Table

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<td>MECH701</td>
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<td>MECH702</td>
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<td>MECH704</td>
<td>Special Topics in Applied Mechanics A/Z</td>
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<td>MECH771</td>
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<tr>
<td>MECH807</td>
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</table>
3. Course Description

MECH501 Analytic Methods in Engineering ................................................................. (3-0-3)
This course focuses to enhance students ability for dealing analytically with various physical phenomena in mechanical engineering. The focus is placed on solution methods and physical interpretation of the results.

MECH505 Numerical methods for mechanical engineering ....................................... (3-0-3)
Engineers sometimes solve problems using analytical mathematics. While these solutions are useful, they are not always available and the engineer more often solves problems using computers. Software packages are available for many classes of mechanical engineering problems but if the user does not know what they are doing, it is very easy to produce nonsensical results. It is therefore important to know how codes for solving problems, how they can go wrong and what one can do about it. This course is intended to provide that kind of background for problem types that occur commonly and specifically in mechanical engineering practice.

MECH507 Software practice for Mech. Engineers .................................................... (1-2-2)
Education on the fundamentals of and practice with the 5 representative software programs needed in Mechanical Engineering.
1) MATLAB : general math tool
2) DAFUL : dynamics, motion
3) COMSOL : Flow, Heat Transfer
4) ABAQUS : FEM-based CAD/CAE
5) OpenFOAM : CFD

MECH510 Analytic Dynamics ...................................................................................... (3-0-3)
Prerequisites: Dynamics or permission of the professor
The content of this course includes kinematics and dynamics of particles and rigid bodies: Newton mechanics; Lagrange equation; Hamilton’s principle; Euler’s equation; transformation theory in dynamics; applications such as motion under a central force, orbital motion, gyroscope, stability, and collision.

MECH511 Advanced Mechanical Vibrations ............................................................... (3-0-3)
Prerequisites: Mechanical vibrations or permission of the professor
Students will learn about how vibrational problems are solved by matrix iteration with the help of fundamental concepts of mechanical vibrations. The latter part of the course deals with non-proportional damping as well as proportional damping.
MECH515 Continuum Mechanics

Prerequisite: Solid Mechanics I, II

The kinematics of deformation, concepts of stress, mass conservation, balance laws of linear and angular momentums and energy. Also, studies constitutive equations for the theory of plasticity in strain space formulation. Various constitutive equations are studied such as an ideal fluid, linear viscous fluid, linear elastic solid.

MECH518 Computational Kinematics and Dynamics

Prerequisite: Dynamics

The aim of this module is to enable students to analyse the kinematics of simple linkages and the dynamics of complex structures through the use of computers. Students are also introduced to constraint problems, revolute/translational joints, and analysis on the position and the acceleration of linkages.

MECH522 Time Series and System Analysis

Application of time series analysis to industrial and physical systems, identification, stability criterion, forecasting control and characterization are investigated. Dynamic Data System (DDS) is employed in the process, and its theory and applying method are instructed. Also computer modeling strategy using DDS is introduced.

MECH525 Advanced Automatic Control

Prerequisite: System Control

The concept of eigenvalues and various canonical forms will be introduced. Modeling of dynamic systems, methods to characterize the system, transform between I/O relations to state variables, response characteristics, controllability and observe-ability, stability theories and LQ problems are covered in this course.

MECH526 Transducer Theory and Its Applications

Prerequisites: Physics II, Solid mechanics, Dynamics, Fluid mechanics, Thermodynamics, Mechanical Vibrations, System Control

This course introduces various kinds of energy conversion which is applied to transducers such as sensors and actuators. We will study the physical and dynamic characteristics of energy conversion. First, approach methods are introduced for modeling energy conversion, and then we will study the methodologies for modeling transducers to analyze their dynamic behavior. With a term project, all students would have chances to understand transducer theory more easily. Students will model and design a proper transducer and analyze the results.

MECH531 Acoustics

Prerequisites: Solid mechanics, Fluid mechanics, Thermodynamics, Mechanical Vibrations

This module gives students more insight into the nature of acoustic phenomena. The content is: characteristics of waves: derivation of acoustic equation: transmission, reflection, refraction, attenuation, and absorption of acoustic waves: pipes, cavities, wave-guides, resonators, ducts, and filters generation and detection of acoustic waves: acoustic transducers.
MECH532 Tissue Engineering for Mechanical Engineers .......................................................... (3-0-3)

Tissue engineering is the use of a combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to improve or replace biological functions. This course teaches fundamentals that span several academic areas related to tissue engineering to students who have a mechanical engineering background, and introduces various approaches to research. Topics include basic cell-biology, chemistry, bio-materials, anatomy, computer-aided design/computer-aided machining(CAD/ CAM), and manufacturing technology. Various mathematical and mechanical tools for simulating cell behavior are introduced. In addition, basic experimental laboratory instruction covers cell culture and scaffold fabrication.

MECH533 Applied Optics ............................................................................................................. (3-0-3)

This course is designed to teach non-optical engineers the fundamentals of optics, optical instruments, lasers, etc. Various applied topics, including optical methods for non-contact analysis, engineering measurement and materials processing, are also introduced.

MECH534 Bio-Imaging Technology .......................................................................................... (3-0-3)

The course is designed to provide basic principle of optical microscopy and its various techniques such as phase contrast microscopy and polarization microscopy, and to introduce state-of-the-art optical imaging technologies and their applications.

MECH535 Introduction to BioMEMS ....................................................................................... (3-0-3)

Expanding potential research areas through learning applied biology, which is important in the application field of MEMS.

This course covers the platforms of micro technology for BioMEMS and the principals and production method of each platform, as well as their application to biotechnology. We select contemporary high-interest fields, and plan to add new subjects every year, including lectures on DNA detection, Cell Analysis, Pathogen detection, etc.

MECH540 Elasticity .................................................................................................................... (3-0-3)

Fundamental concepts in linear elasticity such as kinematics of deformation, equilibrium equations, constitutive equations, and energy principles are reviewed in-depth. Formulation of boundary value problems and methods of solution are studied. Important boundary value problems in plane deformation and three dimensional problems are considered in this course.

MECH541 Mechanics of Composite Materials ....................................................................... (3-0-3)

Students will develop a deeper understanding of mechanical properties of composite materials such as long fiber, short fiber, and particle types in the context of both macroscopic and microscopic behaviour. Introduction to stress concentration in composite materials: stress-strain constitutive relations of anisotropic materials: and theory of orthotropic materials: analysis on laminated composite plates, will be covered.

MECH544 Fracture Mechanics ................................................................................................. (3-0-3)

Prerequisites: Elasticity or permission of the professor

The fundamental concepts of linear elastic fracture mechanics and elastic-plastic fracture mechanics are reviewed, and the method of application of theses concepts to engineering problems
are considered. Analytical methods are applied for analysis of the crack tip stress field. Practical approaches for evaluating structural integrity of mechanical components are also introduced. A brief review is also given on essential features in creep fracture and dynamic fracture.

**MECH550 Advanced Thermodynamics**

Prerequisite: Thermodynamics Advanced

Thermodynamics deals in classical/statistical theories on material states and properties, analysis techniques for various devices and systems utilizing the state change (pipe flow, nozzle, turbine/engine, pump/compressor, power plant, refrigerator), new techniques of improving efficiency and thermodynamic optimization skills.

**MECH560 Advanced Heat Transfer**

Prerequisite: Heat Transfer or permission of the professor

This course provides the skills necessary for applying conduction, convection, and radiation principles to complex practical problems, such as those in heat exchangers. The course covers various analytical skills and numerical methods of heat transfer.

**MECH562 Energy Conversion and Power Plant Technology**

Starting from economic analysis on current energy resources, methods of generating electricity from the energy resources are studied. Characteristics of various systems in a power plant are introduced, and techniques of efficient energy use and conservation are studied.

**MECH570 Advanced Fluid Dynamics**

Prerequisite: Fluid Mechanics

The course deals with the following fundamental topics for advanced fluid dynamicist: the Navier-Stokes equations; momentum theory; vortex theory; inviscid potential flow; viscous flow; dimensional analysis; boundary layer theory and approximate solutions; theory and experimental formulae of turbulent flow.

**MECH571 Aerodynamics**

Prerequisites: Fluid Mechanics

The course is aimed at delivering understanding of the following fundamental aerodynamic topics: two-dimensional inviscid potential flow, Juokowski’s airfoil theory, thin airfoil theory, vortex flow, viscous vortex flow, vortex line, vortex distribution, induced velocity, finite wing theory, lifting line/surface theory, singularity points and their distributions.

**MECH574 Capillary and Wetting Phenomena**

Prerequisites: Thermodynamics, Fluid Mechanics

Capillarity and wetting phenomena have become increasingly important as the size of engineering systems and processes continue to shrink, as for example in microelectronics, labs-on-a-chip, and polymer processing. This course will focus on phenomena derived from the presence of a surface or interface between two or more phases, particularly those involving surface tension, van der Waals forces, electrical double layers, and so on. Several of these surface phenomena will be described qualitatively and quantitatively.
MECH575 Electrokinetics

There exist electrical double layers at the interface between a liquid and solid (or other fluid). Electrokinetics is the study of physico-chemical-hydrodynamic processes derived from the presence of electrical double layers. Electrokinetics is important to understand the interactions of micro- and nano-sized particles, and is the most important tool to control liquids and particles in the micro-and nano-scale. In this course, the following topics will be covered: electrical double layer, electro-osmotic flow, electrophoresis, induced charge electro-osmosis, electro-wetting, and di-electro-phoresis.

MECH578 Gas Dynamics

The course is designed to introduce the following fundamental topics of compressible flow: isentropic flow, one-dimensional extraordinary wave, acoustic wave, shock wave, Prandtl-Meyer wave, interference and reflection of shock waves, perturbation theory, slender body theory, similarity principle for high-speed flow, transonic flow, characteristic curve, viscosity of flows, and heat transfer effect.

MECH579 Introduction to Microfluidics

The aim of this lecture is to provide a fundamental theory on the electrical and hydrodynamic force acting on fluid and particles and their subsequent motion in the micro-scale. Students will learn about the important issues of micro-fluidics, transport phenomena, electrokinetics, and di-electro-phoresis. Some general knowledge on micro-fluidic applications and their state-of-the-art will also be provided.

MECH582 Optimum Design

This coursework introduces various theories of optimization in finite dimension for designing mechanical components and structures with and without constraints in terms of size, degree of deformation and yield criteria. It also deals with mathematical modeling and computer algorithms for optimum design.

MECH583 Introduction to Finite Element Method

Finite element method plays an important role as a numerical analysis tool in analyzing various engineering problems. Through this course, students learn the fundamental principles of the finite element method to deal with structural analysis, elastic deformation, heat transfer, flow analysis, etc. and get accustomed to finite element analysis systems such as ABAQUS.

MECH588 Theory of Mechanical Design

This course introduces the theory of mechanical design. The main topics are axiomatic design and TRIZ (theory of inventive problem solving). Axiomatic design is a newly proposed design theory which provides a systematic and rational method for design. Axiomatic design provides a framework for describing design objects that is consistent for all types of design problems at all levels of detail. Thus, the designer can understand the relationship between the intended functions of an object and the means by which they are achieved. The best design can be chosen among the proposed designs through logical judgment provided by axiomatic design. Axiomatic design can be applied to all the areas of design including systems, software, manufacturing systems, materials & materials-processing techniques and products. Practical examples from industry will be also given.
to aid the understanding of axiomatic design. TRIZ provides solution methods through a technical contradiction table. TRIZ can be applied to mathematics and medical science as well as engineering.

**MECH598 Bio Dynamics** ................................................................. (3-0-3)

Bio-dynamics deals with living bodies in the viewpoint of mechanical principles. Especially, basic theories of biological and physiological phenomena of human and their engineering applications are handled. This course will cover related theories and analysis, and introduces up-to-date research trends. It also covers interdisciplinary associations with other areas of medical science, life-science, chemistry, mechanical engineering and chemical engineering.

**MECH621 Advanced Microelectromechanical Systems** ......................................................... (3-0-3)

Recommended Prerequisite: Introduction to Microelectromechanical Systems

Advanced discussion of micro-machining processes used to construct MEMS. Coverage of many lithographic, deposition, and etching processes, as well as their combination in process integration. Materials issues such as chemical resistances corrosion, mechanical properties, and residual / intrinsic stress. Studies of state-of-the-art MEMS research area applications in various engineering fields. Basic science issues in micro domain including micro fluid science, mechanical behavior of micro-structures, surface tension, etc.

**MECH624 Biofluid Mechanics** ................................................................. (3-0-3)

Fluid flow phenomena in animals such as circulatory flow in the cardio-vascular system are handled. Rheological behaviors of blood and blood cells are analyzed based on fluid dynamic principles. In addition, the causes and early diagnosis of circulatory diseases in the heart and circulatory system are studied.

**MECH631 Scaling Laws and Biomimetics** ................................................................. (3-0-3)

Scaling laws and dimensional analysis are first discussed. The application examples of scaling laws and dimensional analysis will be simply discussed. Biological systems, including materials, structures, sensors, actuators and so on, are introduced. Bio-mimetic applications based on the fundamental mechanisms of biological systems will be extensively covered.

**MECH635 Biological Materials: Structure and Mechanical Properties** ................................................. (3-0-3)

Prerequisites: Solid Mechanics I, II or permission of the professor

Multi-scale structural, mechanical properties, and their relationships for various biological materials such as bioceramics, bio-polymers, and bio-composite materials will be studied in class through lecture, presentation, and discussion. In addition, this course will enhance the student’s ability to understand modeling thermo-mechanical behavior of biological materials and to use numerical simulation with finite element method (FEM).

**MECH639 Advanced Robotics I** ................................................................. (3-0-3)

Advanced topics on kinematics, dynamics and control of robot are covered in this course. Homogeneous transformation, recursive dynamics formulation and various position/force controllers are introduced.
MECH646 Nanobiotechnology

This course is designed to explore the conversion and material transport of fine energy, related devices and behaviors through the mechanical, material, physical, chemical, and biological analysis of fine bio-materials and reactions. This course further discusses cases of Bio-MEMS devices and Micro/Nano Electro Mechanical Systems development for the high throughput analysis and treatment of fine bio-materials and related scientific and technological issues.

MECH650 Microscale Heat Transfer

This course is to provide students with a microscopic understanding of heat transfer phenomena, introducing the transport phenomena of electrons, phonons, and photons. Analytical techniques are introduced for micro-scale heat transfer problems in which the assumption of local thermodynamic equilibrium is no more valid.

MECH655 Alternative Energy

This course introduces various technologies for utilizing renewable energy resources, such as solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, and biomass energy, to overcome the energy and environmental crisis. The covered topics include determination of total amount of the alternative energy available on the earth, physical and engineering characteristics of alternative energy, and design schemes for engineering systems that utilizes alternative energy. Furthermore, as specific applications, the course covers technical/economical analysis of heat pumps, energy storage systems and solar energy collection systems.

MECH661 Venture Business Based on Technology

According to the social demand for graduate level engineering education, this class provide students with basic concept and procedure for start-up by planning business plan with market study based on their own research results.
- Introduction to Entrepreneurship
- Market vs Technology
- Marketing and product strategy
- Team-building
- Writing business plan
- Early stage financing (Venture Capital)
- Financing
- Valuation
- Exit Strategy (IPO & M&A)

MECH674 Viscous Fluid Flow

Advanced course for postgraduate students majoring in fluid mechanics and heat transfer, which presents fundamental dynamic principles of viscous fluid flow.
MECH678 Flow Visualization

Flow visualization plays an essential role in the diagnosis and analysis of thermo-fluid flows. The course introduces the fundamentals of measurement theories and advanced fluid visualization techniques such as PIV (particle image velocimeter) velocity field measurement techniques and temperature field measurement techniques.

MECH679 Fundamentals of Wind Energy Engineering

The aim of this course is to introduce students to the fundamentals of design, construction, and maintenance of fan-driven generators systematically and to enable them to analyse and design a wind energy conversion system.

MECH686 Computational Fluid Mechanics

The course is designed to introduce the governing equations for fluid flow and numerical methods for discretizing the equations. The specific topics include: numerical solution procedures for incompressible flow, compressible flow, and boundary layer flow, theories on stability and convergence of numerical solutions, and their application to various fluid engineering problems.

MECH692 Experimental Methods for Thermo-Fluid Dynamics

Prerequisites: Thermodynamics, Fluid Mechanics or permission of the professor

Students will learn fundamentals of measurement theories and various kinds of experimental techniques for measuring flow velocity, temperature, pressure, and heat flux that are crucial in heat and fluid engineering fields. In addition, several measurement techniques are practiced through a range of laboratories including data acquisition and data processing, wind tunnel experiment, hot-wire anemometer, laser Doppler anemometer, flow visualization, uncertainty analysis, and temperature and heat flux measurements.

MECH699 Master Thesis Research

Credits can vary

MECH701 Special Topics in Systems and Design A/Z

MECH702 Special Topics in Mechanical Engineering A/Z

Credits can vary

MECH704 Special Topics in Applied Mechanics A/Z

MECH707 Special Topics in Thermo Fluids A/Z

MECH716 Energy Methods

This course introduces the principle of virtual work, Hamilton’s principle and various variational principles along with basic theory of the finite element method to deal with deformation of solid bodies with the help of energy concepts. Students are expected to learn how to make use of variational principles via the if application to bending, torsion and buckling of beams and plates. Variational principles for fluid flow and heat transfer will also be discussed.
MECH727 Advanced Topics in Robotics

In depth knowledge in the movement planning and control techniques of industrial robots are studied as well as path/trajectory planning, high level motion programming, advanced control techniques and other applications in AI.

MECH736 Optimal Control

Prerequisite: System Control

Variational principles, Linear Quadratic (Gaussian) problem and solutions will be covered for continuous time and discrete time spaces. Problem formulation and solutions for the Kalman filtering problem for both spaces, LQG/LTR, and the Disturbance Observer will be introduced.

MECH739 Advanced Robotics II

Advanced topics on robotics will be covered using papers on recent research topics. Multi-body dynamics, grasping, dynamic analysis of humanoid robots extra are possible topics in this course.

MECH741 Theory of Plates and Shells

Prerequisite: Elasticity

General bending theory of elastic plates and shells, and approximation theories are examined. Students will have the opportunity to analyse plate and shell problems using numerical schemes such as finite difference and the finite element method.

MECH743 Elastic Waves in Solids

Prerequisite: Elasticity, Analytical Methods in Engineering or Equivalent

Review the theories of wave propagation in elastic solids. The field equations and solution methods for wave problems in elastic solids will be studied. Major physical phenomena in wave propagation will be discussed. Wave propagation in unbounded medium, interaction of waves with boundaries in half-space, and problems associated with wave guides will be dealt with.

MECH745 Elasticity of Composite Materials

This course introduces elasticity of anisotropic materials and laminated composite plates. Elastic equilibrium equations of anisotropic materials, theory of laminated composite plates made of ortho-tropic materials, mechanics of laminated composite plates, and torsion of anisotropic materials are also main topics.

MECH747 Theory of Viscoelasticity

Viscoelasticity deals with the time dependent deformation phenomena of solids or fluids having both elastic and viscous behaviors. This course introduces linear and nonlinear theories, Boltzmann’s superposition principle, time-dependent superposition theory, boundary value problems, initial value problems, wave propagation and deals with various linear and nonlinear constitutive theories along with experimental methods.

MECH748 Plasticity

Studies the basic concepts of plasticity. Also, extensive studies on plastic yield and the constitutive equations for perfectly-plastic, elastic-perfectly plastic, and plastic solids including plastic theories for torsion and bending will be presented.
MECH760 Convection Heat Transfer ................................................................................................. (3-0-3)

Prerequisite: Heat Transfer

Heat and mass transfer in the laminar and turbulent boundary layer is analyzed based on the conservation principles of momentum, energy and mass. The effect of surface conditions on heat transfer coefficient is examined based on theoretical analysis and empirical correlations. This course also covers natural convection.

MECH761 Radiation Heat Transfer ..................................................................................................... (3-0-3)

Recommended Prerequisite: Heat Transfer or permission of the professor

Basic laws of radiation heat transfer and radiation properties of solid surfaces and media are examined. In particular, the course covers radiation heat transfer in an absorbing, scattering, and emitting medium and multi-mode heat transfer in which conduction, convection, and radiation mechanisms are combined. Based on the knowledge in radiation heat transfer, solar energy utilization and high-temperature heat.

MECH762 Hydrodynamic Stability ..................................................................................................... (3-0-3)

The course is aimed to introduce concepts of hydrodynamic stability of fluid flows observed in nature and engineering problems, and theoretical and analytical methods for studying the stability of fluid flow.

MECH769 Turbomachinery .................................................................................................................. (3-0-3)

Prerequisite: Fluid Mechanics

Students will be presented with basic theories for operation and design of turbo- machineries that have rotating blades such as turbines, compressors, pumps, and fans. Problems of energy exchange between rotating blades and fluid flow in the axial or radial direction, cavitation, stall, and surge are examined. Plus, we will investigate vapour and gas turbine theory, basic cycles, thermodynamics, and aero-dynamics in the context of irreversible process theory.

MECH771 Waves in Fluids ..................................................................................................................... (3-0-3)

Prerequisites: Fluid Mechanics or permission of the professor

The general aspects of waves in fluid will be reviewed, and the linear theory of wave motion will be examined for acoustic waves, water waves and internal waves. The nonlinear aspects of wave propagation will also be considered, and an introduction to mathematical methods will be made on the propagation, stability, diffusion and decay of fluid waves.

MECH774 Turbulence .......................................................................................................................... (3-0-3)

Prerequisites: Advanced Fluid Mechanics or permission of the professor

The course is designed to deliver understanding of physics of turbulent flow and related fundamental theories. The following topics will be discussed: analytical and numerical models for turbulent flows, derivation of governing equations for turbulent flows, theoretical, analysis of homogeneous turbulence, dimensional analysis, Kolmogorov theory, physical structures of inhomogeneous turbulent flows, turbulent boundary layer flows, turbulent jets and wakes, and application of turbulent flows to various engineering problems.
MECH775 Two Phase Flow

Prerequisite: Fluid Mechanics, Heat Transfer

This module gives students more insight into the nature of two phase flow. Pressure drop, heat transfer, phase transition phenomena including condensation and boiling are discussed. We will investigate designs and anomalous phenomena in the operation of vapour generators, condensers, and nuclear reactors. Instability of two-phase flow and flow differential phase generators are also introduced.

MECH783 Advanced Finite Element Method

Prerequisites: Introduction to Finite Element Method or permission of the professor

An overview of analytical methods described in ‘Introduction to Finite Element Method’ and their applications to heat transfer/elasticity/plasticity/fluid flow problems. How to approximate solutions to time-variant or nonlinear problems due to material and geometry.

MECH803 Mechanical Engineering Seminar I

MECH804 Mechanical Engineering Seminar II

MECH806 Technical Writing

MECH807 IT Scientific Writing

MECH899 Doctoral Dissertation Research (Credits can vary)
Department of Industrial and Management Engineering

1. Program Overview

The roles of industrial engineering have changed significantly for the past decade due to rapid advances of technology, globalization, shortening of product life cycles, and convergence of product and service businesses. Industrial and management engineering is a body of knowledge which enables organizations to optimally operate and continuously improve for better productivity and effectiveness. The IME department is dedicated to help students equipped with the knowledge, skills, and techniques of industrial and management engineering to make valuable contributions to global economy, welfare, and sustainability.

The IME department offers courses and conducts research in the following seven main areas: Operations Research and Supply Chain Management, Product Life-cycle Engineering, Ergonomics and Human Computer Interaction, Strategic Technology Management, Data Mining and Business Intelligence, Financial Engineering, and Service Science, Management and Engineering.

- Operations Research and Supply Chain Management
  Operations Research and Supply Chain Management pursues advancement in system analysis, development of optimization technologies, and application of them to real world private and public sectors. Research focus includes supply chain management, production planning, scheduling, logistics, quality engineering, systems analysis, systems design, forecasting, resource allocation. Related methodologies are mathematical programming, heuristics, simulation, markov chain, queueing theory, reliability, time series analysis, and regression.

- Product Life-cycle Engineering
  Due to environmental concern, how the product is designed, used, and recycled becomes a key factor determining value of the product. PLE is researching state-of-the-art methodologies for sustainable product life-cycle engineering covering product and product-service design and development, manufacturing, use and recycling, and information acquisition and exchange infrastructure via ubiquitous technology. Major topics are:
  1) Product life-cycle analysis and management,
  2) Green product and product-service development (Eco-design),
  3) Sustainable manufacturing,
  4) Ubiquitous system engineering (USE) and product life-cycle information infrastructure (UPLII).

- Ergonomics and Human Computer Interaction
  Ergonomics/HCI covers development of user-centered designs considering physical, physiological, cognitive, and affective aspects of human for better usability and customer values. Topics of the area include biomechanics, HCI, usability engineering, universal design, affective design, product design & development. Recent research focuses especially on mobile phone user interface design & evaluation, physical UI for consumer electronic products, user experience, and universal design for housing facilities.
- Strategic Technology Management

Technology is a vital tool for firms to get competitive advantage. The area is sorted into two sub-areas: Information Management Strategy (IMS) and Technology Management Strategy (TMS).

1) IMS is a strategy regarding how to use IT strategically as the IT plays a vital role in modern business management. Subjects include SIS (Strategic Information System), BPM/ERP/RE (Business Process Management /Enterprise Resource Planning/Real time Enterprise), and IS systems (MIS, IPS, DSS, EIS, ERP) as well as applied areas such as SCM, CRM, EC/MC, and KM.

2) TMS deals with future technology, technology foresight, technology strategy, technology architecture and patent strategy for technology innovation. Sources, types, and patterns of technology innovation are classified along with strategies of timing of entry, effective organization and collaboration. Case studies in TMS cover the successful technology innovation cases in Korea and worldwide.

- Data Mining and Business Intelligence

This area includes the development of new theories, algorithms, and applications for extracting meaningful knowledge from engineering and business data. This area is challenging when the data is large-scale, high dimensional and heterogeneous. The meaningful knowledge can be expressed by predicted target values, classification, clustering, ranking, and association rules. Statistical and mathematical methods as well as artificial intelligence and expert systems are dealt with. Major application areas include quality prediction of products, fraud detection, churn analyze is, market segmentation, financial volatility predictions, and so on.

- Financial Engineering

Financial Engineering is a science that designs, develops, and complements innovative financial instruments and procedures, and provides creative solutions for various financial problems. Its main subject is the analysis of spot markets (e.g. stock and bond markets) and financial derivative markets by exploiting computational and mathematical tools. Financial engineers also study financial investment and risk management for individual and institutional investors. In particular, in the field of risk management financial engineers strive to understand the risks of financial assets and to develop a methodology of hedging the risks by quantitatively pricing them. Financial engineering is a convergence study that has blended a variety of disciplines, such as finance, industrial engineering, applied mathematics.

- Service Science, Management and Engineering

Services science seeks to use expertise in industrial engineering and its related fields such as technology, management, mathematics and social science to improve the performance of service business. Our main research emphasis is placed on the engineering approach to new service development, service operation and management, service improvement and innovation, and customer value management. Special attention will be given to knowledge-intensive service industries with high impact, including healthcare service, information and communication service, financial service, and logistics service.
[Remarks on Graduation requirements with degrees in IME]
- All graduate students are required to take Graduate Seminar (IMEN801, IMEN802). However, foreign students are not required to do so.
  a. Master’s Program students must take Graduate Seminar for two semesters.
  b. Ph.D Program students must take Graduate Seminar for three semesters.
  c. M.S-Ph.D Integrated Program students must take Graduate Seminar for five semesters.
- Each student in MSIE or Combined Program must take Special Topics in Advanced Industrial engineering (IMEN 800).
- Up to 6 Credits for each student in MSIE or Combined Program and 3 credits for each PhD student taken among 400 level courses are approved as course credits.
- Up to 3 credits for each student in MSIE or PhD Program and 6 credits for each student in Combined Program taken as S/U courses are approved as course credits. However, IME seminar courses and IMEN 800 are not applicable to this requirement.

<table>
<thead>
<tr>
<th>Programs</th>
<th>Course Credit</th>
<th>Research Credit</th>
<th>Overall Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S</td>
<td>24 Credits</td>
<td>4 Credits</td>
<td>28 Credits</td>
</tr>
<tr>
<td>Ph.D</td>
<td>18 Credits</td>
<td>14 Credits</td>
<td>32 Credits</td>
</tr>
<tr>
<td>Integrative</td>
<td>42 Credits</td>
<td>18 Credits</td>
<td>60 Credits</td>
</tr>
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</table>

- Each student in MSIE program must take a minimum of 15 credits of graduate courses in IME department to satisfy graduation requirement.

2. Course Description

**IMEN523 Manufacturing Systems Engineering** ................................................................. (3-0-3)

Fundamental concepts on manufacturing processes and management along with information system are to be established. This course deals with many related principles for building automated and collaborated manufacturing systems as well.

**IMEN524 CAD/CAM** ............................................................................................................. (2-2-3)

This course offers the fundamental principles for computer aided design and an production and in depth study of the subjects on CAD/CAM integration such as programs for NC machining and movement planning of robotics.

**IMEN527 Process Control** ................................................................................................. (2-2-3)

Control techniques related to automation of manufacturing processes are studied along with the pneumatic system, pneumatic-pneumatic control, electric-pneumatic control, PLC control, and application techniques of microprocessors into the workplace.

**IMEN528 Manufacturing Information Technology** ............................................................ (2-2-3)

Prerequisite: Manufacturing Engineering

Information modeling language & methodology for e/u-manufacturing infrastructure is covered, including: 1) Domain knowledge for digital manufacturing and CAX, 2) Modeling methodologies/tools for manufacturing information, 3) Implementation & validation of the developed information model,
and 4) Application for e/u-Manufacturing infrastructure. For hands-on-experience, labs and a term project are required.

IMEN529 Manufacturing Management and Strategy .................................................. (3–0–3)
What differentiates winners from losers in today’s markets is that the winners are better able to consistently provide competitive products and services with regard to quality, time, and agility. Students will learn different manufacturing management and strategies necessary of today’s companies to survive.

IMEN542 Design and Analysis of Experiments ......................................................... (3–0–3)
Prerequisite: Probability and Statistics
Various experimental designs and their analysis methods are covered such as one-factor design, multi-factors design, randomized block design, latin square design, fractional factorial designs and Taguchi design.

IMEN551 Occupation Safety Engineering .......................................................... (3–0–3)
Prerequisite: Probability and Statistics
This course deals with the minimization of accidents in the work place, effective handling of accidents, safety management of the causes, and the methodology of the engineering-oriented analysis. Statistical analysis, configuration of computerized models and quantization of the analysis for accident causes are included.

IMEN553 Human Performance .............................................................................. (2–2–3)
Prerequisite: Ergonomics and Human Factors Engineering
This course is to present psychological and psychophysical aspects of the human factors engineering. Theories and measurements methods of human performance are covered along with their application areas. In addition, hypothetical human factors experiments are conducted for validating the theories and for practicing the measurement methods taught in the class.

IMEN555 Cognitive Psychology ............................................................................ (3–0–3)
Prerequisite: Ergonomics and Human Factors Engineering
The discipline of cognitive psychology studies the human’s cognitive process within complex and various systems, the human capability, and corresponding principles of work design. This course grasps the psychological principles especially in the aspect of engineers and derivates the engineering design and the evaluation principles to allow the application to the real world.

IMEN561 Network Flows ...................................................................................... (3–0–3)
Prerequisite: Mathematical Programming
This course studies efficient methods for solving the network problems which is a special case of linear programming. Theoretical parts for developing algorithms and methodology for solving using computers and its problems are also included.

IMEN572 Service Quality Engineering ................................................................ (3–0–3)
Prerequisite: Quality Engineering or Equivalent
Service Quality Engineering deals with various theories associated with quality engineering for
measurement, evaluation, and improvement of service quality, and engineering techniques usable in
design & development, operation, and delivery of new service. It focuses on the high-valued service
industries, which are knowledge-based rather than labor-intensive.

**IMEN573 Decision Analysis**
Prerequisite: Probability and Statistics
Various related principles required for decision making process with uncertainty are introduced. Using such principles, alternative analysis, sampling economics, risk analysis and methodology of
group decision are studied.

**IMEN577 Dynamic System**
Prerequisite: Applied Linear Algebra
Fundamental principles of dynamic systems required to model and analyze the dynamic
phenomena occurring in industrial and other social science area are lectured. The main focus is
on theory of linear systems including modeling of a system and latent variable analysis.

**IMEN580 Decision Support System**
Prerequisites: Management Information System, Introduction to Database
The three elements supporting the decision making process which is the ultimate goal of the
information system are database, model-base, and the user dialogue. This course deals with the
effective design and management of the three elements.

**IMEN584 Expert Systems**
Development of the intelligent systems with expert knowledge requires the application of the
machine learning theories into the engineering structures. For such development, the structural
elements of expert systems, inference, search and other theoretical backgrounds are learned. The
actual methods to build such systems are studied as well.

**IMEN585 Financial Engineering**
The objective of this course is to introduce the recent topics in financial engineering, focusing on
the basic theory of fixed income securities. For this, we explore the basic theory of fixed income
securities (bonds), interest rate derivative pricing models and their applications, financial risk
management and their applications, and recent topics in financial engineering such as financial risk
management.

**IMEN586 Advanced Computer Applications in Industrial Engineering**
Prerequisite: Computer Applications in Industrial Engineering
The objective is the software development and applications in industrial engineering areas and
the required knowledge on the basic principles and structure of (micro)-computers, and
programming language such as C, APL and ADA are studied.

**IMEN587 Science and Technology Policy Research**
A nation’s competitiveness rests on creation of knowledge in and application of new scientific and
technology, and the science and technology keep growing critical in this modern society. Students
examine a variety of research areas in scientific and technology and study real-life cases to
enhance research competencies in science and technology policy.
IMEN595 Product Development Strategy .............................................................................................................. (3-0-3)
To learn about management and strategy issues related to product development and value positioning in marketing. To experience with company leaders decisions and their outcomes through case studies.

IMEN597 Datalogical Management ....................................................................................................................... (3-0-3)
Through in-depth case studies and practical articles, innovative ideas and practices of the globalized Korean companies are studied. Key innovations through IT-applications and the state-of-the-art management techniques, such as PI, ERP, SCM, CRM, and SRM, are the major subjects.

IMEN611 Technology Planning ............................................................................................................................. (3-0-3)
This course covers advanced topics on technology strategy planning for sustaining & disruptive innovation. Topics to be covered include innovation theory, customer needs Analysis, strategy planning, technology planning, patent analysis, patent strategy.

IMEN623 Manufacturing Systems and Automation ............................................................................................... (2-2-3)
This course deals with the automation of manufacturing process and the related subjects. Continuous production system, discrete production system, numerical control method of automated production system, information processing system using MAP-I, and GT applied manufacturing system and other methods are overviewed.

IMEN625 Manufacturing Component Technology ............................................................................................... (2-2-3)
Prerequisite: Manufacturing Process Design
1. Understanding of underlying theories on CA(Computer Aided: CAD, CAM, CNC, CAI) technologies constituting the e-manufacturing: 1) Geometric Modeling, 2) Tool Path Generation, 3) CNC control system 4) Virtual machining, 5) OMM & closed-loop machining 2. Implementation capability (pseudo code for major algorithms) 3. Hands on experience with Labs (Turning Center, Machining Center)

IMEN627 Robot Engineering ............................................................................................................................... (2-2-3)
Structure of industrial robots, principles of movements, controllers and control algorithms are studied. Also, validity analysis for automated manufacturing and method of work design, equipment oriented interpretation of robotic structures, robotic programming language, configuration and application of Gripper, case study of robot applications, and performance evaluation of robot are included.

IMEN628 Engineering Metrology .......................................................................................................................... (2-2-3)
The techniques and methods of measurements and analysis in engineering work places are introduced. The precision and computer aided measurement techniques are covered as well.

IMEN641 Ergonomics Laboratory ......................................................................................................................... (1-3-3)
Prerequisite: Ergonomics and Human Factors Engineering
The operation procedures and analysis techniques of equipment and software used in ergonomics research are introduced and the theoretical models of ergonomics are evaluated by experiment.
IMEN642 Human Factors Research Methodology ....................................................... (3-0-3)

Prerequisite: Ergonomics and Human Factors Engineering

This course studies efficient methods for the design of human factors experiments such as factorial design, rational factorial design, central composite design, response surface methodology. Analytical techniques such as regression, ANOVA, non-parametric statistics are covered.

IMEN643 Biomechanics ........................................................................................................ (2-2-3)

Prerequisites: Statics, Ergonomics and Human Factors Engineering

The mechanical characteristics of the human body are introduced and the bio-mechanical methodologies and their applications to designing products, tools, work-places, and equipment are studied.

IMEN645 Work Physiology ................................................................................................ (2-2-3)

Prerequisite: Ergonomics and Human Factors Engineering

The physiological characteristics of the human body are introduced and the measurement and analysis techniques of physiological responses for workload assessment and product design evaluation are studied.

IMEN647 Bioengineering ..................................................................................................... (3-1-3)

Prerequisite: Biomechanics, Work Physiology

Mechanical and electrical interpretation of body parts and the corresponding configuration of measuring systems are studied along with computerized techniques of collecting data and analysis.

IMEN653 Human-Computer Interface ............................................................................... (3-0-3)

Prerequisite: Ergonomics and Human Factors Engineering

Systematic studies of the factors considered in designing computer systems such as applied psychology and ergonomics are covered to design efficient and easy-to-use systems. The research results on the interaction between computer and the user found in the area of cognitive psychology, human performance, computer engineering, and ergonomics are studied.

IMEN654 Product Design and Development .................................................................... (3-0-3)

The basic concept of product design and its process are to be understood and techniques required for product design are studied. Different approaches to conceptual design and the case study of their applications are covered along with the steps of reflecting the user’s request and ergonomic factors during product designing stage with their analytical methods. Parallel to theoretical learning, a project of inventing and producing the innovative products are carried out throughout the course.

IMEN661 Advanced Linear Programming ...................................................................... (3-0-3)

Prerequisite: Introduction to Operations Research

This course deals with advanced topics on linear programming and the subjects includes simplex and revised simplex method, dual simplex method, sensitivity analysis, the concept of decomposition, transportation problems and their solutions.
IMEN662 Discrete Optimization

Prerequisite: Introduction to Operations Research

This course deals with discrete optimization problems such as bin-packing, set covering, knapsack, assignment problem, TSP, vehicle routing problem and facility location, and their solution techniques such as exact methods, heuristic and meta heuristic. Computation complexity and real world’s application problems are also discussed.

IMEN666 Applied Stochastic Processes

Prerequisite: Probability Modeling and Analysis

This course covers the basics of probabilistic models including conditional expectation, Poisson processes, renewal processes, discrete time Markov chains, continuous time Markov chains, and Brownian motions. Some applications are also dealt with in the area of queueing systems, inventory problems, equipment replacement problems, reliability modeling and financial modeling.

IMEN671 Advanced Topics in Quality Engineering

Prerequisite: Advanced Topics in Quality Engineering or equivalent

Design and operation of quality assurance and control, with a focus on manufacturing systems context, including quality function deployment, Taguchi methods, response surface methods with multiple responses, six-sigma quality program, and emerging issues in modern quality engineering.

IMEN676 Advanced Production and Inventory Control

Prerequisite: Production Planning and Control at Undergraduate Level

Various issues and techniques are covered related to the optimal decision making for the operational management areas. The main topics covered are: Operations strategy, Global issues in operations planning, Supply Chain Design and Planning, Demand Planning, Master Planning, Distribution and Inventory Control, and Operations control.

IMEN677 Time Series Analysis

Prerequisite: Probability and Statistics

Box-Jenkins models including ARMA, ARIMA and seasonal ARMA processes, multi-variate time series, state space models are studied for system analysis and prediction based on the time-series data. Applications to economic and financial time series will be dealt with.

IMEN680 Advanced Management Information System

The course covers “bandwagon” topics in MIS. While IMEN780 covers the monumental and/or the popular advanced topics in MIS, this course provides browsing over some “fastly popping areas” in MIS at the discretion of instructor.

IMEN681 Engineering System Design and Analysis

New techniques of solving engineering problems are learned. The subjects includes functional, logic and object-oriented approach.

IMEN682 Software Engineering

Traditional techniques of software engineering are studied and the new methodologies for developing software such as object-oriented methods are covered.
IMEN683 Advanced Artificial Intelligence ................................................................. (3-0-3)
This course studies the concept of artificial intelligence and the applications its methods. Concept of learning, pattern recognition, knowledge based system, expert system, logic, information system and their applications are covered.

IMEN685 Object-Oriented Technology ..................................................................... (3-0-3)
This course is to provide the students with theoretical understanding of object-oriented technology and working knowledge about Object-Oriented programming languages and Object-Oriented databases as well as introduction to Object-Oriented system analysis & design and Object-Oriented middle wares. In particular, concepts and theories of object-oriented technology such as encapsulation, inheritance, polymorphism and abstract data type will be extensively covered.

IMEN690 Simulation Technique and Output Analysis .................................................. (2-2-3)
This course covers the knowledge acquirement on simulation language, methods of random extractions, extraction of probability parameters from probability distributions, variance reduction technique, system evaluation using simulation, validity evaluation of simulation models.

IMEN695 Information Modeling ................................................................................ (3-0-3)
Introduction to data modeling; meta-data modeling; meta-data transformation; business process modeling; semantics; applications of models to eBusiness and e-Manufacturing.

IMEN699 Master Thesis Research ............................................................................ (1-9)

IMEN721 Geometric Modeling I ................................................................................. (3-0-3)
Prerequisite: Numerical Control
Methods to generate numerical controlling data to design and process the 3-dimensional images are dealt with and their applications in manufacturing engineering are studied in depth.

IMEN722 Geometric Modeling II ............................................................................... (3-0-3)
Prerequisite: Geometric Modeling I
The studies on automation and intellectualization of the design and processing of 3-dimensional images are carried out. Subjects include solid representation, geometric reasoning, parameter design, and CAD database.

IMEN723 Manufacturing Intelligence ........................................................................ (3-0-3)
This course deals with the methodology to reduce people’s intervention and embody the small-quantity assigned production by modeling the knowledge and experience of human beings. To achieve such purpose, Knowledge Engineering and Software Engineering for production, robotic vision and functions are studied.

IMEN725 Advanced Topics in Numerical Control ...................................................... (3-0-3)
Prerequisite: Numerical Control
The new technologies and theories in NC area are considered in the aspect of development (machine body, controller and software), NC application (importing and applying technology), and systems (connection to CIM).
IMEN727 Advanced Topics in Robotics

Prerequisite: Robot Engineering

In depth knowledge in the movement planning and control techniques of industrial robots are studied as well as path/trajectory planning, high level motion programming, advanced control techniques and other applications in AI.

IMEN731 Computer Aided Process Planning : CAPP

This course covers the automation of process planning achieved by computers. The design and manufacturing representations of parts with CAD and GT coding are studied and process planning techniques regards to different moldings are considered in depth.

IMEN735 Tool Engineering

Prerequisite: Numerical Control

The basic principles if jig and fixture design and the designing techniques with CAD are studied. Approaches for efficient manufacturing process design are also covered.

IMEN737 Metal Cutting Theory and Practice

Prerequisite: Numerical Control

The theories on analysis and application of for machine processing and their application methods are covered. Tool wear, cutting mechanics, heat surface integration, material’s properties and the economical efficiency of cuttings are also studied.

IMEN738 Industrial Case Study

The purpose of this course is to apply the various techniques of industrial engineering into real-world problems and to develop the problem solving capability by formulating the problem finding the solutions, discussing and analyzing.

IMEN753 Advanced Topics in Ergonomics and Human Factors

Prerequisites: Ergonomics, Human Performance in Man-Machine Systems

The goal is to identify human’s capacity and limit functions to be considered during the designing of man-machine systems. The influences received by a person when working under various mechanical and physical environments are considered.

IMEN763 Nonlinear Programming

Prerequisite: Mathematical Programming

The research on the solution for non-linear objective functions with/without constraints are done. Also, Kuhn-Tucker condition, convergence theory, line search, steepest descent, Newton’s conjugate gradient, quasi-Newton solution, primal, penalty, Lagrangian algorithms are studied.

IMEN764 Dynamic Programming

Prerequisite: Introduction to Operations Research

This course deals with the formulation of multi-step decision-making problems, their solutions and their applications on the shortest path problem, equipment replacements, scheduling, optimized control, and inventory control.
IMEN766 Queueing Theory

Prerequisite: Applied Stochastic Processes

The goal of this course is to analyze the system where waiting is present. The subject dealt with in this course includes the basic waiting models such as M/M/1, and M/G/1, concept of work, Markov queues, models with priority, GI/G/1 model and the approximation methods.

IMEN772 Linear Statistical Model

Prerequisite: Probability and Statistics

General theories and applications on the linear statistical models mostly focused on regression models are studied. Statistical inferences, simple and multiple regressions, polynomial regression, analysis of variance, multi-equation model, and the introduction to non-linear least squares are included.

IMEN773 Reliability Engineering

Prerequisite: Applied Stochastic Processes

The subject studied in this course includes the reliability and utilization analysis of a part or a system, fault tree analysis, effective methods of computing the network reliability. This course also covers life distribution’s characteristics and applications to maintenances and replacements.

IMEN780 Advanced Topics in Management Information System

The course covers the important current research topics along with the milestone topics in MIS. In-depth knowledges on the MIS topics such as SIS, BPR/ERP, KM, EC, MC, UC and SCM/CRM are studied through current published-paper readings.

IMEN781 Distributed Information System

This course covers the efficiently distributed information system and its effective operational methods, distributed database, and the distributed decision support system. Above knowledge is essential for the communications between systems, re-organization of systems and the recovery from errors when the organization is enlarged and the amount of information grows rapidly.

IMEN786 Advanced Investment Theory

The objective of this course is to introduce the recent topics about the continuous-time finance to the students. For this, we explore: 1. advanced theory of stochastic differential equations, 2. the continuous-time portfolio theory of Merton and related topics, and 3. other topics in continuous-time finance such as continuous-time option pricing theory.

IMEN800 Special Topics in Advanced Industrial Engineering

This course is designed to present and discuss the current researches in the area of common interest in industrial engineering.

IMEN801 IME Seminar I

The purpose of this course is to let the students in master’s program to participate in the regularly held departmental seminars to increase the ability to apply the theories learned to real-world problems.
The purpose of this course is to let the students in master’s program to participate in the regularly held departmental seminars to allow indirect experience of real-world problems and to help with deciding the right path of their research.

This course is designed to present and discuss the current researches in the area of management engineering for acquisition of new knowledge.

This course is designed to present and discuss the current researches in the area of manufacturing engineering for acquisition of new knowledge.

This course is designed to present and discuss the current researches in the area of human factors engineering for acquisition of new knowledge.

This course is designed to present and discuss the current researches in the area of operations research for acquisition of new knowledge.

We will review new theories about schedule planning and for solving real scheduling problem. Furthermore, we will learn the information technology that is necessary to build a useful and efficient scheduling system.

This course is designed to present and discuss the current researches in the area of information systems for acquisition of new knowledge.

This course is designed to present and discuss the current researches in the area of industrial and management engineering for acquisition of new knowledge.

This course is designed to present and discuss the current researches in the area of information systems for acquisition of new knowledge.
Department of Electrical Engineering

1. Learning Goal

The education objective of the graduate program in Electrical Engineering is to pursue both the academic excellence and the technological innovation in electrical and electronic engineering. The graduate program also emphasizes the heightening of creativity and cultivating of research ability of students. In addition, it aims to educate the engineering talents by providing the deep theory education combined with through experiments, who can lead the highly advanced information society of the 21st century. The fields of education are currently classified into control and power electronics, communication and signal processing, computer engineering, electromagnetic field and microwave engineering, semiconductor and quantum electronics, electronic circuits and VLSI design.

2. Program Overview

The graduate school of Electrical Engineering offers MS/PhD students a variety of courses for education of a high standard. The followings are education goals and research fields in the six study areas of the graduate school.

- Control and Power Electronics

In modern industrial society, the importance of control and system engineering using computer technology is increasing. Researchers in control and power electronics in the department are constantly developing innovative technology in automation control and transportation that are necessary for national industrial development. Therefore, the research and education program aims at developing new control theory which will become influential worldwide.

The main fields of ongoing research are Control Theory (Control in Robotics, Nonlinear Control, Robust Control, Intelligence Control, Adaptive Control, Optimal Control, and Power Electronics), large-scale of Distributed Control, Real-Time Control Systems, PLC and VME Systems, Electronic electrical switches, Electric Power Compensators, High Power AC Motor Drives, Application of Fuzzy and Neural Networks, Process Control, and advanced Vehicle Control.

- Communications and Signal Processing

The fields of communications and signal processing form the core of the Information Industry. Research in this field aims to develop technology to process signals from diverse sources. Communications research addresses technology such as coding, transmission and security of information. Signal processing addresses the technology for converting electrical impulses from signal and data using digital systems.

The fields of ongoing main research are Wiretapping, Spread-spectrum Technique overcoming of wiretapping and signal interference, Next Generation Digital Telecommunication Technology, Cryptography, Error-Correction Coding, Smart Cards, Video Telephones, Web Conference Systems,
High Definition Television (HDTV), Information Coding, Signal Processing Applications, and Color Image Processing.

- **Computer Engineering**
  Computer engineering is divided into two groups: Computer Design and Computer Applications. Computer Design has extensive application because of the advent of Application Specific Integrated Circuits (ASIC), which optimize both General Purpose High Performance Computers and specific applications. The Computer Applications work involves Real-Time Digital/Analog Hardware Systems and Intelligent Robots.

  The fields of ongoing research in Computer Design address several subjects, including distributed computing hardware and software considering High Performance, Low-power SoC, Real-Time processing, and Fault-Tolerance. The Computer Applications research concentrates on developing various aspects of Machine Intelligence.

- **Electro-magnetics and Microwave Engineering**
  This field will be very important in future society. The most advanced electromagnetic wave environment and instruments are required by Telecommunications and Information Services. Also novel fields of research are being developed in such areas as Space Science, Defense Industry, and Environmental Engineering.

  The main areas of concern are Device Modeling using in Super High Frequency, Design and Production of circuits, microstrip antennas and phase array antennas of every kind, Human Response to Radio Waves, Radar systems and Data processing for use in remote sensing, Automobile-based SAR System Development, Random target Recognition, Development of Code for calculating various targets’ RCS, and research into the Characteristics of Electromagnetic Wave Propagation.

- **Solid State and Quantum Electronics**
  Research in these fields focuses on semiconductors and other solid state materials, devices, and Fabrication processes. To facilitate this research, POSTECH has built infrastructure including a state-of-the-art clean room facility and 8 laboratories for test and measurement of semiconductor devices and materials.

  The main research areas are Display Devices and Control Circuits for LCDs and PDPs, Monolithic Microwave Integrated Circuits (MMIC), Advanced Lithography, Nano Devices and Circuits, Biomedical Imaging and Electronics, Quantum Photonics for Advanced Semiconductor LEDs and Lasers, and Nano–Bio Terahertz Photonics for Nano and Bio Photonic Devices.

- **Integrated Circuits and SoC Design**
  The field of Integrated Circuits and SoC Design consists of the design and measurement of integrated circuit (IC) chips, signal integrity, SoC design methodology, and SoC design for display applications.
In this field, the ongoing research includes high-speed CMOS interface circuits such as Gbps DRAM cross-talk compensation and TV intra-panel interface, CMOS analog circuits such as analog-to-digital converters and sensor circuits, IP infrastructure systems, low-energy circuits, and high-speed modeling of TV intra-panel interface channel. The ongoing research also includes developing the SoC design methodology under process variations and designing advanced SoCs for display applications.

[Credits Required for Graduation]

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<th>Programs</th>
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<tr>
<td>MS/PhD Integrated Program</td>
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</table>

[Special Remarks on Graduation Requirements in Areas of Electrical Engineering]

1) Postgraduate course credits include underneath courses.
   (However, Master’s and Doctoral articles research and seminars are excepted.)
   - Graduate courses offered by the Department of Electrical Engineering and other Departments
   - Up to 6 credits of 400-level undergraduate courses offered by the Department of and other Departments

2) Graduate Seminar (EECE595) is mandatory.
   - A Master’s Program student must pass EECE595 twice before graduation.
   - A Ph.D. Program student must pass EECE595 twice before graduation.
   - A MS/PhD Integrated Program student must pass EECE595 four times before graduation.

[Guide for attending EECE 802/803]

- IT Scientific Writing (EECE802) is mandatory for all graduate students.
- IT Research Paper Presentation Skill (EECE 803) is mandatory for Ph.D. Program students and MS/PhD Integrated Program.

- Those 2 above courses are requirements for graduation but not including in credits to graduate.
 subject are including in grade under the POSTECH regulations.
3. Course Table

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4. Course Description

EECE550 Advanced Computer Design ................................................................. (3-0-3)
Prerequisites: EECE471(Computer Design)
Advanced computer design techniques are taught with design implementation practice using
Verilog HDL and simulation. High-performances fixed and floating-point multiplier and
divider(Wallace tree, Booth, etc.) design, RISC methods (register file TLB, etc), cache, pipeline, super
pipeline, super scalar and other concepts are taught.

EECE551 Digital Image Processing ................................................................. (3-0-3)
Prerequisites: EECE451(Digital Signal Processing)
The purpose of this course is to introduce some basic image enhancement, restoration,
segmentation, edge detection, compression, transformation and properties of human visual system
along with their recent application areas.

EECE552 Computer Vision .................................................................................. (3-0-3)
The course topics include some basic computer vision theories and techniques such as image
formation, edge detection, stereo vision, photometric stereo, and 3D reconstruction from multiple
views. The course will introduce 3-dimensional geometry of imaging systems and high level
computer vision algorithm such as motion segmentation, boundary detection, symbolic image
matching, motion segmentation, 3-dimensional scene reconstruction and object recognition through
inference. In addition H/W and S/ W techniques relating the biological visual perception model will
be introduced as well as the hand-eye coordination theory for the robot control.

EECE553 Introduction to Neural Networks ......................................................... (3-0-3)
Prerequisites: Basic Calculus and Linear Algebra, Signals and Systems, Memory Network
This course and its sequel, EECE 651(Computational Intelligence) together comprise the series of
the Soft Computing courses. It covers the neural network architecture, its learning algorithms, and
its applications to pattern recognition, robotics, and control. The architecture consists of a great
variety of paradigms including the Multi-layer Perceptron along with Back Propagation learning,
Support Vector Machines, Kohonen’s Clustering Network and the Associative Memory Network.
EECE554 Physics of Semiconductor and Display Devices .................................................. (3–0–3)
Advanced Nano devices, semiconductors, quantum devices, statistics, and analyses are covered. Displays like LED, OLED, LCD, PQR are treated.

EECE555 Properties of Optical Materials and Devices .................................................. (3–0–3)
Electronic energy band structure, perturbation theory, effective mass theory, k·p theory, optical gain and absorption in bulk and nano-structures, semiconductor lasers, high speed modulation.

EECE556 Semiconductor Devices I ................................................................................. (3–0–3)
Prerequisites: EECE211(Semiconductor Electronics I)
Graduate level course for advanced bipolar transistor physics course. It covers basics operation principle, p/n junction, heterojunction, emitter-base junction, base-collector junction, high current level behavior and equivalent circuit model for circuit design.

EECE557 Compound Semiconductor Devices ................................................................. (3–0–3)
Prerequisites: EECE554(Physics of Semiconductor and Display)
This course covers basic properties of compound semiconductor, interface analysis and application for compound semiconductor, advanced process technology, high speed device(ex. HEMT, MISFET, MESFET), integrated circuit using compound semiconductor.

EECE558 Semiconductor Crystal Growth ........................................................................ (3–0–3)
Prerequisites: EECE412(Electronic Materials Engineering)
This course covers crystal growth theory, bulk crystal growth, liquid phase epitaxy (LPE), vapor phase epitaxy(VPE), metal organic vapor phase epitaxy(MOVPE), molecular beam epitaxy(MBE). It also deals with computer simulation and evaluation method of crystal growth.

EECE560 Nanoelectronics ............................................................................................... (3–0–3)
Prerequisites: EECE554(Physics of Semiconductor and Display)
This course covers analysis of semiconductor surface, quantum state, conduction mechanism at surface, optical properties and elastic properties, surface processing technique and device application.

EECE561 Semiconductor devices II ............................................................................... (3–0–3)
Prerequisites: EECE 401(Semiconductor electronics II)
Basic principles of semiconductor, junctions and MOS will be reviewed. Then MOSFET device will be studied. The two-terminal, three-terminal and the for-terminal MOS structure, topics on implanted channels and small dimension effect, large signal and small signal modeling will be covered.

EECE562 Applied Quantum Mechanics I ...................................................................... (3–0–3)
Applied quantum mechanics for semiconductor devices, quantum electronics, and solid-state physics: state equation, energy band, quantum statistics, and charge transport.
EECE564 Linear System Theory ............................................................... (3–0–3)
Prerequisite: EECE322(Automatic Control Theory), MATH120(Applied Linear Algebra)
Review of Linear Algebra, Modeling of Physical System in the State space, Solution of State
equations, controllability and observability, Kalman canonical forms, Phase plane portraits, PBH test,
Discrete-time system, observer and pole placement, some nonlinear system examples.

EECE565 Robotics ............................................................... (3–0–3)
To provide an understanding of all the basic principles and techniques of robotic manipulator,
also a comprehensive and up-to-date account of fundamentals of design, analysis and synthesis of
robotic systems.

EECE566 Electrical Machinery ............................................................... (3–0–3)
Magnet system and transformer equivalent circuit are studied. Based on the dynamic modeling of
DC motor torque-speed control methods are covered. Dynamic modeling of AC machines is
described in the rotating(synchronous) coordinate frame. Issues of permanent magnet synchronous
motor design and control are studied.

EECE567 Power Electronics Systems ............................................................... (3–0–3)
The fundamental theory of power electronic systems and power converters such as
phase-controlled rectifier, dc-to-dc converter, PWM inverter, power supply and resonant converter
are covered. Also those waveform is analyzed.

EECE568 Optimal Control Theory ............................................................... (3–0–3)
Prerequisite: EECE564(Linear System Theory)
This course covers an introductory account of the theory of optimal control and its applications
which will provide the students with the background necessary for sound understanding of the
optimal control systems.

EECE569 Analog Integrated Circuits ............................................................... (3–0–3)
Prerequisite: EECE331(Electronic Circuit I ), EECE332(Electronic Circuit II )
Covers CMOS analog integrated circuit design techniques using hand analysis and SIGMA-SPICE
simulation, reviews the operation of single transistor amplifiers such as CS CG CD amplifiers,
frequency response and stability, noise analysis, band-gap voltage source, voltage regulator and
current source bias circuits, single-ended and fully-differential CMOS OP amp circuits’ and
switched capacitor filter. In-depth capability of analog circuit design, hand analysis and circuit
simulation is achieved through extensive homeworks.

EECE570 Digital Integrated Circuits ............................................................... (3–0–3)
Prerequisite: EECE331(Electronic Circuit I )
Covers CMOS digital integrated circuit design techniques using hand analysis and SPICE
simulation. Operation of CMOS inverter circuit, static logic circuit, dynamic logic circuits such as
domino NORA and TSPC, pass transistor and differential logic circuits, VLSI building block circuits
such as adder multiplier and data path, low power circuit technique, memory circuit such as ROM
Fash memory SRAm and DRAM.
EECE571 VLSI System Design

Prerequisite: EECE273(Digital System Design)

The design techniques of VLSI systems are discussed with emphasis on the low design levels such as gate-level/circuit-level and physical-level layout. The top-down and bottom-up design methodology and layout design rules are also discussed. The design styles such as gate array and cell-based design, and various CAD software are discussed. In addition, the cocking schemes for synchronous systems are discussed. The design trends in the UDSM and SoC era are discussed. Then, the impacts of UDSM process technology and low power design techniques are discussed. The class design project will provide chances to get the hands-on design experiences with extensive use of CAD software.

EECE572 Circuits Analysis Algorithm and Software

Prerequisite: EECE231(Circuit Theory)

The algorithms and computational techniques for the computer-aided analysis of electronic circuits are discussed. After device modeling is discussed, the formulation of network equations using the Sparse Tableau Analysis and Modified Node Analysis methods are discussed. The numerical methods to solve a set of linear equations, including Gaussian elimination and LU decomposition, are discussed, and the Newton-Raphson method to solve a set of nonlinear equations is discussed. Numerical integration methods to handle the nonlinear ordinary differential equations, including their circuit analysis interpretation are also discussed. Finally, various circuit analysis schemes of the standard approach used for SPICE, nonlinear relaxation-based methods, waveform newton method, and waveform relaxation newton method are discussed.

EECE573 Parallel Programming Using Clusters

In recent years, a trend has been to use general-purpose personal computers and workstations interconnected by a fast computer network in order to realize a low-cost supercomputer. In addition, larger configurations involving computers interconnected through the Internet (via wide area networks) have also been used to realize super-computing on a massive scale by utilizing idle personal computers and workstations (idle processing resources) - this is referred to as grid computing. However, in order to effectively utilize cluster and grid computers, new parallel programming methods and tools have to be learned and used. Thus, this course will not only teach general parallel programming concepts, but also concepts and tools necessary for the effective utilization of cluster and grid computers.

EECE574 Probability and Random Process

Probability theory and random variables are discussed, which includes the relationship and transformation of random variables. Stochastic or random process is discussed, including stationary and non-stationary random processes, dynamics and filtering problems.

EECE575 Communication Systems

Prerequisite: EECE574(Probability and Random Process)

The objective of this course is to learn the modulation/demodulation theory using amplitude, frequency, phase, pulse and digital communication methods such as ASK, FSK, PSK, etc. In addition, this course deals with random process theory, mathematical model for noise and effect of the noise in the communication system and also compares/analyzes various communication method.
EECE576 Statistical Communication Theory................................................................. (3-0-3)
Prerequisite: EECE574 (Probability and Random Process): Undergraduate level Probability theory, Signal and systems, Linear algebra
- Review the basic principles of linear analysis, probability, statistics, and random processes
- Learn the analysis of linear and nonlinear systems with random inputs
- Learn the design of systems that satisfy some statistical conditions for signal detection and waveform estimation
- Learn about how the information theory is applied to communication systems
- Learn the properties of noise in the communication systems

EECE577 Information and Coding Theory.......................................................................... (3-0-3)
Prerequisites: MATH230 (Probability and Statistics), EECE341 (Introduction to Communication Systems)
This course introduces to the students the Information Theory that serves as the foundation for efficient data storage, compression, transmission, etc. It deals with the mathematical definition and properties of information, entropy, coding theorems, channel capacity, and rate-distortion, etc.

EECE578 Digital Communication....................................................................................... (3-0-3)
Prerequisite: EECE574 (Probability and Random Process)
Digital communication is discussed and compared with analog communication. PCM, DPCM, and DM are discussed for speech coding. Segment companding, multiplexing framing, synchronization, and digital switching are also discussed.

EECE579 Information and Communication Security....................................................... (3-0-3)
This course covers Cryptographic algorithm and protocol, and also explores the adaptation for these privacy protection, message authentication, identity verification, digital signature.

EECE580 Spread-Spectrum Communications.................................................................... (3-0-3)
Prerequisite: EECE574 (Probability and Random Processes)
- Learn the basic principles of the spread-spectrum communications
- Learn the basic principles of Pseudo-Noise (PN) sequence
- Learn the basic concepts of direct-sequence (DS) and frequency-hopping (FH) spread-spectrum communications
- Learn performance analysis of spread-spectrum communications under jamming environments
- Learn about how the spread-spectrum communications are applied to multiple-access communication networks

EECE581 Advanced Digital Signal Processing............................................................. (3-0-3)
Prerequisite: EECE233 (Signal and System)
This course covers chirp Z-transform, design of FIR/IIR digital filter and application to the speech processing or the image processing of new signal processing VLSI after the review about relation between continuous and discrete signal, Z-transform, and DFT (Discrete Fourier Transform).
EECE582 Error-correcting codes

Error-correcting codes are a core part of digital communication systems for reliable communication. Topics include encoding and decoding of error-correcting codes, performance evaluation, and their applications with emphasis on BCH codes, Reed-Solomon codes and convolutional codes.

EECE583 Advanced Linear Algebra

Linear algebra is a basic tool for analysis of linear systems in the areas of communications, control and signal processing. Topics include matrices, determinant, linear equations, vector spaces, eigenvalues and eigenvectors, orthogonal matrices, positive definite matrices, Jordan canonical form, least square approximation, matrix decomposition, and linear programming, etc.

EECE584 Advanced Electromagnetics I

Prerequisite: EECE361(Electromagnetic Waves)

Advanced theories on electromagnetic fields and waves including electrical properties of matter, wave equation and its solutions, wave propagation and polarization, reflection and transmission of plane waves, auxiliary vector potentials, electromagnetic theorems and principles, electromagnetic scattering and Green’s functions.

EECE585 Radar System Engineering I

Prerequisite: EECE361(Electromagnetic Waves)

Introduction to radar systems engineering. Many forms of radar equation, RCS (radar cross section), various clutter and ground effects, detection range, and radar antennas will be treated. Various radar techniques like MTI (Moving Target Indicator), AMTI, MTD, pulse doppler radar, tracking radar, CW and FM radars will be studied.

EECE586 Numerical Techniques in Electromagnetics

Prerequisite: EECE361(Electromagnetic Waves)

Theories on numerical calculations of electromagnetic scattering, coupling and antenna radiation including GO/GTD (Geometrical Optics / Geometrical Theory of Diffraction), PO/PTD (Physical Optics / Physical Theory of Diffraction), MOM (Methods of Moment), FEM (Finite Element Method), FDM (Finite Difference Method), FDTD (Finite Difference in Time Domain) and TLM (Transmission Line Method).

EECE587 Microwave Engineering

Prerequisite: EECE361(Electromagnetic Waves)

This course covers transmission lines, wave-guides, resonators, coupled mode theory, power divider and combiner, scattering parameter, impedance, matching, and plan wave propagation in ferrite medium.

EECE588 Antenna Theory and Design I

Prerequisite: EECE361(Electromagnetic Waves)

This course covers antenna fundamentals, array theory, and the theory and analysis of various antennas such as dipole, loop, helix, bicone, spiral, aperture, reflector, and microstrip patch.
EECE589 Modern Coding Theory

Modern coding theory employs probabilistic approaches rather than algebraic approaches. Recent progresses in coding theory such as turbo codes, low-density parity-check (LDPC) codes and repeat-accumulate (RA) codes are studied. Topics include construction of codes over graphs, iterative decoding based on sum-product algorithm, density evolution and code optimization.

EECE590 Electrical Engineering Laboratory

The topics cover experiments such as grounding system and components characteristics, diode and transistor circuits, function generator, TTL/CMOS characteristics and applications, A/D converters and its applications, OP amplifier and its applications, finally PLL and its applications.

EECE593 Microwave Active Circuit

Prerequisites: EECE587(Microwave Engineering)

This course covers the basic concept of microwave active circuit designs such as s-parameter, two-port network, matching circuit and gain/stability of an transistor amplifier. Followed by the real circuit design methods for the functional block of microwave transceivers such as broadband amplifiers, LNA, power amplifier, mixer and oscillator.

EECE594 Recognition Engineering

Recognition engineering is emerging as HCI and HRI are needed for intelligent systems such as robots, computers, and cellular phones. RE is believed to be a bottleneck in many intelligent systems. Unfortunately, various topics related with recognition is completely dispersed and separated both in curriculum and in research activities. Furthermore, detailed theories and algorithms, make it difficult for students to learn practical applications. The aim of this course is to integrate the most important recognition areas: perceptual function in brain, speech recognition, computer vision, together with programming experiences. As for the computer vision, Open CV as the most representative tool is taught; as for the speech recognition, HTK and SAPI are taught as the most important tools. After taking this course successively, students will be able to go further speech and visual recognition applications and research.

EECE595 Seminars in Electrical Engineering

This course consists of seminars on recent developments in various topics.

ITCE543/EECE596 RFIC design

The important RFIC chip design methods for the transceiver of the wireless communication system are studied. First, the transceiver architecture of the system is described. Then, the important functional blocks of the transceiver are covered. They include passive component design, LNA, mixer, oscillator and phase noise, and frequency synthesizer.

EECE597 Link Circuit Design

Various architectures and circuit schemes of high-speed serial and parallel wire-line links are covered. Each student will conduct a design project of link with actual transistor-level simulations.
EECE598 Nanoscale Devices
This course provides a comprehensive introduction to the MOSFETs and nano-scale devices including operation principles, modeling, electrical characteristics, reliability, and process related variability.

EECE599 Embedded System Architecture
Prerequisite: EECE374 Microprocessor architecture and application
This class addresses solid state disk (SSD) which is gaining more attention as main stream storages. We will study the operation and power/performance/reliability characteristics of NAND Flash memory and high performance/reliability and low power SSD design methods. In addition, we will study phase change RAM (PRAM) which is considered to be a promising emerging memory technology. We will investigate the feasibility of applying PRAM to the main memory.

EECE621 Wireless Sensor Networks
Wireless Sensor Networks (WSNs, otherwise known as Ubiquitous Sensor Networks) is a new research area that has enjoyed increasing popularity in recent years. This technology has been proposed for use in monitoring the environment, disaster prevention, building/campus security, military applications, healthcare and many other applications. Research topics addressed with WSNs include wireless networking, sensor coverage, localization (determining the locations of devices), communication channel assignment, routing, energy conservation and many other interesting technical issues. All of these topics and others related to WSNs will be explored in this class, with a view towards enhancing the research capabilities of the students taking this class.

EECE630 Electromagnetic Plasma Simulation
Various numerical methods for the semiconductor, E&M, plasma issues. Solutions of partial and ordinary differential equations are included.

EECE642 Advanced MOS Devices
Prerequisites: EECE561(Semiconductor devices II)
Approaches to scaling; current trends in MOS process integration; hot carrier effects, hot carrier resistant structures and mechanisms of the MOSFET degradation.

EECE645 Statistical Signal Processing
Statistical inference problems in communications and signal processing are studied in this course. Problems are classified into those with vector observations, sequence observations, and continuous-time waveform observations. They are also classified into detection and estimation problems, and into those with random parameters and non-random parameter. Optimality criteria discussed in this course include MAP, ML, MMSE, MVUE, and LS. For each optimality criterion, an optimal solution is derived and their performance is analyzed.

EECE646 Introduction to space-time communication
Prerequisites: EECE578(Digital Communicaton), EECE645(Statistical Signal Processing)
First, channel models for single-antenna wireless communication systems are studied and appropriate transceiver structures are investigated.
Then, the models and the structures are extended to multiple-antenna space-time communication systems. Performance analysis and system optimization are main topics of the course.
EECE651 Computational Intelligence  
Prerequisites: None but Basic Programming Language Skill.

This course covers the remaining topics of Computational Intelligence encompassing Evolutionary Computation, Fuzzy Logic, and their hybrid systems.

Computational Intelligence attempts to computationally model the process of the human’s amazing capability of inferencing and learning amidst all kinds of uncertainties and imprecision of the environment. First, as simple and efficient optimization techniques, Evolutionary Algorithm as inspired by natural evolution, Particle Swarm Optimization and Ant Colony Systems are dealt with. Then, Fuzzy Logic and Systems are introduced that models the rule-based human reasoning process. Then the biologically-inspired optimization is used to optimize the design of the fuzzy systems. Next, its applications to robotics and automation will be given as examples.

EECE653 Semiconductor Fabrication Processes  
This course covers the unit processes for semiconductor device fabrication. After an overview of process requirements for a state-of-art device, the principle and process details of wafer fabrication, wafer cleaning, epitaxial film growth, thermal oxidation, ion implantation, chemical vapor deposition, wet and dry etching, metalization, and lithography are introduced and discussed.

EECE654 Plasma Processing  
The principles and the applications of plasma etching and deposition technology used in integrated circuits and display manufacturing will be the main subject to be covered. The plasma basics and up-to-dated plasma processing and display equipments will be included.

EECE655 Quantum Electronics  
Lasers and other quantum electronic devices [PQR incl.], field quantization and density matrix, laser theory and applications are covered.

EECE656 Semiconductor Quantum Optics  
Quantum optical issues will be investigated including squeezed and coherent states, quantum distributions, coherence and HBT effects, atom-field interactions, laser photon statistics, and atom optics. Associated photonic quantum ring phenomena will be reviewed.

EECE657 Special Topics in Semiconductor Devices  
Prerequisite: EECE556(Semiconductor Devices I)
Quantum effect devices: physics of the quantum wire and quantum dot devices; electrical characteristics and processing techniques for the quantum devices; circuit design methodology for the quantum effect devices.

EECE659 Nonlinear System Theory  
Prerequisite: EECE564(Linear System Theory)
Describing function, Popov criterion, Lyapunov stability are studied. Existence and uniqueness of the solution of nonlinear differential equation are covered. Utilizing the methodology based on differential geometry, system equivalence and feedback linearizability are studied.
EECE660 Motor Control Theory ........................................................................................................ (3-0-3)
DC motor control theory is studied. Induction motor dynamics are described in the synchronous reference frame. Field orientation control methods are treated. Implementation issues utilizing the DSP processor are covered. Control methods of brushless DC motor and brushless AC motors are treated. Bandwidth of closed loop transfer function is studied.

EECE663 Estimation Theory ............................................................................................................. (3-0-3)
Prerequisite: EECE564(Linear System Theory), EECE574(Probability and Random Process).
This course introduces the conventional linear estimators in frequency and time domains. In the algorithm point of view, two issues associated with the number of computations and the numerical stability are addressed and the modified estimators are provided. Furthermore, modern estimators, mainly designed with linear programming, are tackled under mixed criteria.

EECE664 System Identification Theory ............................................................................................ (3-0-3)
Prerequisite: EECE564(Linear System Theory)
In this course, students get the basic concepts and major results of system identification theory. Then students learn how to obtain plant model from real data and study real time identification algorithms. Students will improve their ability in solving real identification on problems via term projects.

EECE667 Circuit Analysis Algorithms and Software ......................................................................... (3-0-3)
Prerequisite: EECE273(Digital System Design), EECE571(VLSI System Design)
This class aims to provide the background on the computer methods and algorithms for VLSI analysis and design, which helps improve the design abilities of VLSI designers. In the class, the current status of Electronic Design Automation is briefly introduced. Then, various computer algorithms, numerical analysis methods, and graph theory, which are associated with the computer-aided software for the analysis and design of VLSI systems, are discussed. Both theories and applications are discussed, and class projects provide students with chances to have hands-on experiences for software development.

EECE668 Robust Control ................................................................................................................. (3-0-3)
Prerequisite: EECE564(Linear System Theory)
This course summarizes modern techniques, based on linear system theories, for analyzing and synthesizing linear and even nonlinear systems. Especially, so-called LMIs (linear matrix inequality), belonging to convex conditions, are used to design robust controllers against non-linearities or uncertainties under various criteria.

EECE669 High-speed data communication ....................................................................................... (3-0-3)
High-speed data communication is discussed for broadband multimedia services. Theoretical and practical design methods of high-speed communication system are presented with an introductory discussion of broadband network. ISDN, HDSL/ ADSL/ VDSL, CATV, and wireless broadband services are discussed. ATMLAN, Ethernet, and wireless LAN communication systems are also discussed.
EECE670 Signal Design

One major goal of signal design is to design sequences with good (or optimal) correlation properties for spread spectrum communication systems, code-division multiple-access (CDMA) systems, and cryptosystems. Topics include maximal length sequences (or m-sequences), Walsh sequences, Kasami sequences, Gold sequences, quaternary sequences with low correlation and Hadamard matrices.

EECE671 Advanced Electromagnetics II

Prerequisite: EECE584 (Advanced Electromagnetics I)

Advanced mathematical methods and tools in electro-magnetics and microwave engineering including asymptotic methods, variational methods, perturbation techniques, Wiener-Hopf factorization methods.

EECE672 Linear Optimal Control

Prerequisite: EECE564 (Linear System Theory)

In this course, we derive linear optimal controllers including the standard regulator systems and tracking systems for linear systems. We study various properties of regulator systems and design parameter selection. We also study LQG regulator based on the Kalman-Bucy Filter and the loop transfer recovery. Finally we study real application cases via term projects.

EECE673 Radar System Engineering II

Prerequisite: EECE585 (Radar Systems Engineering I)

Radar signal detection and estimation techniques, and the related ambiguity problems will be studied. Special purpose radars used for remote sensing will be emphasized, including SLAR (Side-Looking Airborne Radar), SAR (Synthetic Aperture Radar), altimeters and scatterometers. Various problems associated with the design of these systems will be treated.

EECE675 Electromagnetic Compatibility

Prerequisite: EECE588 (Antenna Theory and Design I)

In complex systems like ship, spacecraft, and airplane, it is very important that each subsystem does not interfere with others and also should not be affected electromagnetically by other subsystems. Various empirical, experimental and computer aided techniques to satisfy the specifications for conducted/radiated emission and susceptibility will be studied. Many computer techniques for the prediction of EMI in a given circuit board (PCB) will also be treated.

EECE676 Guided Wave and Integrated Optics

Prerequisites: EECE587 (Microwave Engineering)

Wave propagation in dielectric waveguide and optical fiber, coupled mode theory, directional coupler, filter, resonator, phase shifter, modulator, photonic crystal devices.

EECE677 Cryptographic Algorithms

This course addresses design and implementation of public-key cryptographic algorithms. The focus is on elliptic curve cryptosystems including underlying finite field arithmetic.
EECE679 Multimedia Algorithms

This is the algorithm fusion course for Ee and CE. One of the major courses in EE/CE/CS, including Multimedia, Communications, Control, and Computers, is the algorithm. Unfortunately the topics and approaches in each department are greatly different from each other despite of their common interests. In this light, this course aims to integrate major topics so that students regardless their major, can be armed with fundamental tools for advanced algorithm development. This course will cover the state-of-the-art topics in vast areas extracted from algorithm and optimization to parallel computation and quantum computation. At the end of the class, students will be able to answer the following questions: What is the efficient algorithm. What kind of approaches are there. How to develop fast algorithms, and How to implement algorithms on parallel architectures?

EECE680 Data Converters

The class covers various architectures and IC design techniques for data conversion between analog and digital signals. Each student will conduct design projects of an ADC and a DAC.

EECE695A/Z Advanced Topics in Electrical Eng. A/Z

Prerequisites: Depends on the topics
This course covers the topics that are not taught in the regular courses and that are related to the current interests and trends. This course can be taught by visiting professors.

EECE699 Master Thesis Research

A research course for Master’s thesis.

EECE750A/Z Special Topics in Computer Engineering A/Z

A research course for Master’s thesis.

EECE751 Speech Recognition and Synthesis

This course is related with the aspects of Bio-physiology, Digital Signal Processing, Natural Language Processing, Linguistics for human language abilities. Extracted from each area, fundamental theories are summarized and taught under the umbrella of mechanisms of the auditory pathways and the speech generation are taught in detail. Next, speech recognition and synthesis are taught in terms with speech signal processing and various pattern matching techniques. Phonetics, morphology, grammars, semantics, pragmatics are further explored together with some of the core theories of Chomskian grammars.

EECE752A/Z Special Topics in Solids and Quanta A/Z

Topics in fundamental and applied science in solids and quantum theories of emerging areas in electronics.

EECE753A/Z Special Topics in System Theory A/Z

New area and recent topics in control engineering are studied.
EECE754A/Z Special Topics in Communication and Signal Processing A/Z (3-0-3)
Prerequisites: Digital Communications, Advanced Digital Signal Processing
In this course, a student learns about current interests and trends in communications and signal processing.

EECE755A/Z Special Topics in Electromagnetics A/Z (3-0-3)
Study on recent topics of electro-magnetics and microwave engineering published on various journals.

EECE802 IT Scientific Writing (3-0-2)
This is a course in writing scientific papers in English. It is a 12-week, credit course for Graduate students. Each student will be required to produce a scientific manuscript. Topics will include strategies for producing the components of a manuscript, for writing a first draft, for designing effective figures and tables, and for revising the draft. The course will include exercises designed to help in this process. There will be no formal examinations: all marks will be based on exercises, assignments, and the final manuscript.

EECE803 IT Research paper Presentation Skill (3-0-2)
This is a course in giving scientific presentations in English. It is a 12-week, credit course for Graduate students. Students will learn how to effectively organize a presentation visually and verbally; how to produce effective graphics, and how to express their ideas in good English. Students will also improve their English grammar, vocabulary and diction.

EECE899 Doctoral Dissertation Research (1-9)
A research course for Ph. D. thesis.
1. Education Aim

The computer science and engineering curriculum is designed to cultivate:
- Creative global talents who will lead R&Ds in the advanced IT field with cutting-edge technologies of computer science and engineering.
- Talents who have theoretical expertise, practical capabilities for developing new software, and self-driven abilities to establish and achieve goals on their own.

2. Program Overview

The Department of Computer Science Engineering offers a variety of courses for M.S. and Ph.D students in the most effective way. To train multi-talented leaders of the digital age, we not only provide education on the fundamentals and applications of computer science, but also help students gain perspectives on the convergence of computer science and engineering with other related fields. The followings are the fields of research in the CSE curriculum and their educational content.

- Digital Media

  Digital Media research focuses on a variety of technologies including artificial intelligence, algorithms, computer graphics, computer vision, machine learning, and virtual reality that are necessary for processing of audio, text, image, video, graphics, and other multimedia data.

  The Computer Graphics Lab carries out a comprehensive research on both theories of various subjects and their applications in the field of graphics and other related studies. The current studies focus on the image and video processing, non-photo realistic rendering, and 3D curved surface reconstruction. Another area of constant interest is industrial application of technologies developed in the lab such as Photoshop plug-ins, image stylization software, and real-time 3D scanning systems.

  The Computer Vision Lab conducts general research on computer vision theories and their practical applications. While doing research on various subjects in the area of video analysis, the Lab puts its primary focus on video surveillance namely moving object detection, foreground/background segmentation, event definition and detection, and human detection and their distribution in the image. The Lab is also developing medical microscopic image analysis algorithms as part of an interdisciplinary research.

  The current mission of the Intelligent Media Lab is to conduct research on enabling technologies such as machine vision and image/video processing technologies and on application technologies such as face analysis, gesture and human behavior analysis, video surveillance, and human robot
interaction, which are to be implemented in digital cameras, hand-held devices, intelligent surveillance system, and intelligent service robots in cooperation with partners in the industry.

The Computational Geometry Lab is dedicated to research on computing theories and identification of diverse geometric problems. And the goal of research is to design efficient algorithms. Major research subjects include design of approximation algorithms for geometric shape matching, geometric algorithm design under uncertainty, and research on efficient data structures. These research activities are carried out in international collaboration with globally renowned research institutes.

The Haptics and Virtual Reality Lab is actively engaged in joint interdisciplinary research on enabling technologies such as haptics and its applications including virtual reality, human-computer interaction, robotics, mobile phone, and medical training. Currently under research and development are haptic augmented reality, mobile haptic interface, haptics technology for modeling and transfer of sensorimotor skills, efficient vibration perception and rendering, and graphical editor for vibration pattern design.

- AI & Data Analysis

AI and data analysis focuses on technologies of artificial intelligence, natural language processing, machine learning, database, and data mining that enable processing of multimedia data such as voice, text, image, and video.

The Machine Learning Lab conducts fundamental research on theories and algorithms for statistical machine learning, probabilistic graphical models, Bayesian learning and probabilistic inference, with their applications to computer vision, pattern recognition, and data mining by utilizing machine learning.

Research conducted in the Intelligent Software Lab mostly focuses on areas such as spoken dialogue system, statistical machine translation, intelligent search and semantic web, and emotional speech synthesis, all of which are based on human language processing technology and artificial intelligence technology and can be used for intelligent robot, smart home, intelligent car, and video search.

The Knowledge and Language Engineering Lab is studying text language analysis and application in a multi language environment for Korean, Japanese, Chinese, and English. In particular, active research is under way regarding dependency parsing in both Korean and Chinese, Chinese machine translation (Chinese-Korean, Chinese-Japanese), (micro) blog searching, news ranking algorithms, subtopic mining, and smart agent in a mobile environment.

The Information and Database Systems Lab is making progress in the research areas of intelligent data/document/object retrieval, data mining, personalization, and spatial databases.

Data mining (or “big data”) is a convergence science with close relation to database, machine learning, information retrieval, natural language processing and computer vision. Data mining lab therefore carries out a research on big data related convergence. Their on-going research includes machine learning for big data, text mining, recommender system, and video and multimedia processing and analysis.
- System and Software

Computer system is an area that has seen tremendous advancement thanks to the development of processor, memory and other computing components. Nonetheless, the system needs further research as its areas of application expand. In an environment where the complexity of the computer system increases due to the use of new system components such as multi-core processor, high speed memory, flash memory, and storage area network, studies are being conducted not only on the operating system that makes the most of each resource and maintains the optimal performance of the computer system, but also on task partitioning and allocation methods suitable for multi-core processor, on operating system for embedded system, on system performance enhancement using flash memory, and on I/O components performance enhancement to match high-speed processing unit.

Software development has also advanced significantly thanks to introduction of various development methodologies and tools. However, we still need to do more for better software development tool or methodology that ensures accuracy, easiness, and productivity when developing a large-scale software or a software for an embedded system. For this, our school is currently conducting research on programming language, software reuse and, software specification action tool to be used in the areas with real-time requirements. In addition, research is underway also on data-mining technology that goes beyond database management and extracts new related information automatically from the stored data.

As computer systems are used in an increasing number of areas of application, user dependency on computer system also becomes higher. This inevitably results in adverse effects such as possible malfunctioning or hacking of the system that entails leakage of confidential information. Therefore, research on fault-tolerant methods and computer system security/dependability enhancement is underway so that users can use their system with confidence.

- Computer Network

In the field of Computer Network, we are conducting research on Network Management, Wireless Network, Wireless Sensor Network as well as Wired-Wireless Network Integration, and Multimedia Communication.

Network Management research focuses on management of SNMP/Web/Web service-based networks, management of next generation network, traffic analysis of internet, enterprise and mobile networks, and detection and analysis of abnormal traffic, worms and viruses. As well as conducting research on Soft-Defined Networking (SDN), Network Function Virtualization (NFV) and Data Center Networking (DCN).

Wireless Network research concerns wireless LAN MAC Protocol, mobile IP, multi-cast for mobile host, mobile ad-hoc network, wireless TCP, wireless PAN, Home-networking, and 4G and 5G mobile system. Subjects such as overlay multi-cast, internet QoS, media control, IPTV, future internet, and video streaming codec and transmission algorithms are the main areas of research in Multimedia Communication.

[Credits Required for Degree]

<table>
<thead>
<tr>
<th>Program</th>
<th>Coursework Credit</th>
<th>Research Credit</th>
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<td>Ph.D</td>
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<tr>
<td>Integrated</td>
<td>30</td>
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</table>

[Guidelines for Coursework]

1) Course credit requirements for a graduate degree may be fulfilled by:
(Note: Credits from Master’s Thesis/ Doctoral Dissertation research and seminar courses may not be counted toward a graduate degree)

- CSE graduate courses
- Graduate courses from other departments at POSTECH (as per the Department’s internal rules):
  - 400-level undergraduate courses from CSE and/or other departments at POSTECH (up to 6 credits to be counted toward a graduate degree)

2) Common required courses
A. Seminar [CSED800]
   - Both Master’s and PhD program students must complete CSED800 at least twice to fulfill the major requirements.
   - Integrated program students must complete CSED800 at least four times to fulfill the major requirements.

B. Dept. of Electrical Engineering Opened (EECE802/ 803)
   - EECE802 IT Scientific Writing is a required course for all students in the Master’s, PhD, and Integrated programs.
   - EECE803 IT Research Paper Presentation Skill is a required course for students in the PhD and Integrated programs
   * Note: The two required courses above, EECE802 and EECE803, do not count as part of the credits required for graduation but are included in GPA calculations.
### 3. Program Overview

<table>
<thead>
<tr>
<th>Category</th>
<th>Area</th>
<th>Course No.</th>
<th>Title</th>
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<td>Discrete and Computational Geometry</td>
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<td>Topics in Computer System A-</td>
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</table>

- 101 -
4. Course Description

CSED502 Theory of Computation ................................................................. (3-0-3)

Recommended Prerequisites: CSED341 (Automata and Formal Languages)

This is the second course on theory of computation, which comes after the first theory course ‘Automata and Formal Languages.’ It introduces models of computation, Turing machines, and Church-Turing thesis. Then it examines the computability issues by considering the halting problem, problem reductions and undecidability, which connects to investigation of the computational complexity. The complexity classes P versus NP, NP-completeness, and NP-complete problems are also examined. Other topics of discussion includes space complexity and a few of its results, approximations, probabilistic algorithms, interactive proof system, and cryptography.

CSED503 Advanced Computer Architecture ............................................. (3-0-3)

Recommended Prerequisites: CSED311 (Computer Architecture)

This course is a study of the evolution of computer architecture and the factors influencing the design of hardware and software elements of high-performance computer systems. The emphasis is on the major component subsystems of high performance computers: pipelining, instruction level parallelism, memory hierarchies, input/output, and network-oriented interconnections. Topics may include: instruction set design; processor micro-architecture and pipelining; cache and virtual memory organizations; protection and sharing; I/O and interrupts; in-order and out-of-order superscalar architectures; VLIW machines; vector supercomputers; multi threaded architectures; low-power designs; symmetric multiprocessors; memory models and synchronization; embedded systems; and parallel computers.

CSED504 Advanced Operating System ...................................................... (3-0-3)

Recommended Prerequisites: CSED312 (Operating Systems)

In this course, students will gain in-depth knowledge on how modern operating system works through Linux. Topics about resource management algorithms and data structures used in Linux will be discussed in detail. In addition, evaluation of micro kernel and module-based monolithic kernel structures will help students understand full spectrum of operating system structure alternatives.
CSED505 Network Performance Analysis

Recommended Prerequisites: MATH230 (Probability and Statistics)

This course offers a comprehensive study of computer systems modeling, distributed systems and computer networks, and evaluation of their performance. Other topics of study include stochastic processes, queueing theory, operational analysis, and mean value analysis.

CSED506 Digital Logic Testing

Recommended Prerequisites: CSED273 (Digital System Design)

As the circuit density increases, the probability of a manufacturing defect increases. The higher expectation of reliability can only be met by more thorough and comprehensive testing of ICs. IC testing can be performed at different levels of abstraction. The objective is to find manufacturing defects, which cause a fault and, hence, failure, or a potential fault or failure.

The topics covered in this course include fault modeling, test generation, fault simulation, testable design, and fault-tolerance circuits.

CSED507 Software Engineering

The purpose of this course is to introduce various software engineering concepts, techniques, and related issues to students. This introductory course covers a broad range of software engineering topics including software development life cycle models and processes, software development methods, testing, project management, and metrics. Software engineering principles such as abstraction, information hiding, and modularity are also introduced. A number of seminal papers in software engineering will be discussed in the class. A small team project will be assigned.

CSED508 Discrete and Computational Geometry

Discrete geometry is intimately connected to computational geometry. This course will cover basic concepts of discrete geometry including convexity, incidence problems, convex polytopes as well as arrangements of geometric objects, lower envelopes, and crossing numbers. In addition, we will study how to design optimal algorithms for geometric problems by exploiting combinatorial and geometric properties.

CSED509 Computer Animation

Recommended Prerequisites: CSED451 (Computer Graphics)

This course covers various topics and techniques for producing an animation. Main topics include construction and representation of 3D objects and motion control techniques for 3D object movements in an animation. Animation packages for high quality rendering and animation are briefly introduced. Students are required to produce a short animation to gain experience on the animation production pipeline.

CSED511 Introduction to Virtual Reality

Constructing and implementing a virtual environment takes an understanding of many different disciplines. This course covers basics of such knowledge as modeling of virtual objects and their interactive behavior, managing and using various VR devices and sensors, stereoscopic display and immersive effects, basic physical simulation including collision detection, and most importantly, various theories for creation of presence. Students are required to turn in term papers and encouraged to participate in a group project in the final phase of the course.
CSED513 Simulation

Recommended Prerequisites: Basic computer programming skills and basic knowledge about statistics. In this course, students learn various concepts and techniques for computer-based simulation and application to real problems. The course covers topics such as system modeling techniques, discrete system simulation, continuous system simulation, simulation languages, and real world applications.

CSED514 Pattern Recognition

Recommended Prerequisites: MATH230 (Probability and Statistics)

This course deals with pattern classification theory and practice. Among several pattern classification areas, emphasis is given to statistical pattern recognition. Students are strongly required to study probability and random process before taking this course. We deal with basic pattern classification technique, Bayes theory, parameter estimation, supervised learning, un-supervised learning, clustering and other advanced topics. Programming assignments will be given to students to strengthen their knowledge about the pattern classification theory.

CSED515 Machine Learning

Recommended Prerequisites: MATH230 (Probability and Statistics)

Machine learning is a study of computer algorithms that allow computers to "learn." It is a method of creating computer algorithms that enable computers to perform pattern recognition, prediction, and decision. This introductory course on machine learning will address mathematical and statistical methods involving current statistical machine learning as well as various applications. Topics to be covered include density estimation, Bayes decision theory, latent variable models, mixture models, discriminant analysis, clustering, classification dimensionality reduction, regression, kernel methods, VC-dimension, HMM, MLP, and RBF. Main focus will be given to statistical and probabilistic methods for machine learning, involving supervised, unsupervised, and semi-supervised learning.

CSED518 Linguistics Basis for Natural Language Processing

This course provides an introduction to the field of computational linguistics, also called natural language processing. First the students will be introduced to linguistics terms and concepts and Korean grammar from a data processing point of view. Topics of study also include multi-lingual text processing techniques and a variety of grammar theories and linguistic analysis models necessary for the text processing. Students will have the opportunity to see how these techniques are applied in the areas such as machine translation and information retrieval.

CSED519 Introduction to Human-Computer Interaction

Recommended Prerequisites: CSED233 (Data Structure)

This course teaches the fundamental concepts and techniques in human-computer interaction. The students first study the human factors that affect the usability of computer systems and learn various forms of interfaces ranging from the traditional menus and forms to more innovative ones including 3D multimodal interfaces. Programming techniques and tools for HCI are introduced as well. The final phase of the course looks at various cases of HCI, those that were successful and not so, and students put the concepts to practice through class projects.
CSED521 Fuzzy and Intelligent Systems 

The purpose of this course is two-fold. First, the course helps students understand the operational principle of soft computing techniques such as fuzzy systems, neural networks, and evolutionary systems and their implementation. Second, it teaches students how to integrate these constituent techniques into a hybrid intelligent system that provides a more powerful and robust system performance and how to apply it for a variety of optimization problems such as time series prediction, protein structure prediction, optimal trajectory determination, optimal classifier design, location-based services, human robot interaction, and ubiquitous and pervasive computing.

CSED523 Statistical Natural Language Processing

This course introduces various recent statistical methods in natural language processing. To be addressed in this course are basic statistical tools for computational linguistics and their application to part-of-speech tagging, statistical parsing, word sense disambiguation, machine translation, information retrieval and statistical discourse processing. If time permits, some topics of statistical language models for speech recognition and text-to-speech systems will briefly discussed.

CSED524 Probabilistic Graphical Models

Probabilistic graphical models are a happy marriage between probability theory and graph theory. Probabilistic graphical models are graphs in which nodes are random variables and on which conditional independence are encoded. They provide a natural and powerful tool to deal with uncertainty and complexity which are playing an increasingly important role in the design and analysis of machine learning algorithms. The three topics that are mainly covered are representation (directed graphs, undirected graphs, factor graphs), probabilistic inference (sum product, belief propagation, junction tree, variational approximation, sampling methods) and learning (maximum likelihood, MAP, Bayesian estimation, expectation maximization). Students work on a term project of his/her choice on application such as computer vision, bio-informatics, natural language, data mining, and networking and learn how probabilistic graphical models are applied.

CSED526 Data Mining

Data Mining is a study of computer algorithms that analyze and extract information or knowledge from large data. This introductory course addresses fundamental concepts and techniques of data mining. Topics to be covered are data preprocessing, data warehousing and OLAP, frequent pattern and association analysis, prediction, classification clustering, and ranking. Students are required to have some backgrounds in probability and statistics. This course is designed for senior undergraduate or graduate students.

CSED527 Introduction to Haptics

Haptics is an emerging interdisciplinary scientific field which aims to understand the somatosensory characteristics of our body and develop a computer-controlled system that allows users to physically interact with remote or virtual environments, i.e. through their sense of touch. In this course, students will learn the basic concepts and theories of haptics and get ample opportunities for hands-on experiences. This course also emphasizes the topics relevant to kinesthetic (force-feedback) rendering.
CSED536 Advanced Algorithms
Prerequisites: CSED331 (Algorithms)
This course covers advanced topics of algorithms including graph algorithms, geometric algorithms, approximation algorithms, and randomized algorithms. We study how to design efficient algorithms using essential design and analysis methods.

CSED600 Distributed Processing
Recommended Prerequisites: CSED312 (Operating Systems)
This course will study the fundamental aspects of modern distributed systems. This course covers issues concerned with distributed systems such as transparency, communication, resource sharing, fault tolerance, scalability, consistency, and security as well as those concerned with designing, developing, and managing distributed applications and services. Special emphasis will be put on emerging Peer-to-Peer computing.

CSED601 Dependable Computing
Recommended Prerequisites: CSED311 (Computer Architecture), CSED312 (Operating Systems)
In this course, students will study system faults including hacking, error, and failures and learn how to design dependable systems using redundant components such as hardware, software, time, and information. Techniques of quantitative and qualitative analyses of dependable systems are also taught. The course will look at case studies where dependable computing is applied as well as recent research trends of dependable computing design methodology. Relation between dependable computing and security is also discussed in depth.

CSED602 Advanced Database
Recommended Prerequisites: CSED421 (Databases systems)
In this course, we study advanced concepts and techniques in database systems including distributed/parallel databases and advanced indexing. We also look at some of state-of-the-art database applications such as data warehouse, OLAP, data mining, and XML.

CSED603 Parallel Algorithm
Recommended Prerequisites: CSED436 (Graph Theory and Algorithm), CSED503 (Advanced Computer Architecture)
This course covers an efficient parallel algorithms design for parallel computation and the analysis of it. In other words, students learn how to design and analyze algorithms that minimize the execution time and the number of processors, which are required in a variety of parallel system structures when addressing problems such as sorting, matrix multiplication, and graph ordering.

CSED604 Parallel Processing
Recommended Prerequisites: CSED503 (Advanced Computer Architecture)
This course will deal with a number of topics including job scheduling, system partition allocation, load balancing, routing, and embedding that are necessary for effective operations of topology for high-performance parallel computers. The course will also discuss recent research in this area.
CSED605 Real-time Systems

Recommended Prerequisites: CSED504 (Advanced Operating System)

This course teaches the fundamental aspects of real-time operating systems such as scheduling, concurrency, and distributed real-time communication. In addition to class lectures on theory, each student of this course will be required to make presentations on the related papers and conduct a team project in order to understand how the practical real-time system works.

CSED607 Network Management System

Recommended Prerequisites: CSED353 (Computer Network)

Network management involves monitoring and controlling of various devices on today’s networks to ensure a more reliable, secure and efficient network environment. This course covers the basic concepts and techniques used in network management. Also, international standards such as Internet Network Management Framework and OSI Network Management Framework will be studied. The students will get a chance to develop a prototype network management system.

CSED608 Advanced Computer Network

Recommended Prerequisites: CSED353 (Computer Network)

The main goal of this course is to study advanced topics in network technologies. The course begins with the basic concepts of and techniques in computer networks, and discusses in detail advanced topics in computer networks. This course also looks at the state-of-the-art protocols in networking technology.

CSED609 Applications of Random Variable and Process in Computer Engineering

This course provides an broad overview of probability theory, and random variable, and random process for the graduate students of computer science engineering.

CSED610 Information Retrieval

Recommended Prerequisites: CSED518 (Linguistics Basis for Natural Language Processing)

The objective of the course is to introduce students to the theoretical underpinnings of information retrieval (IR). This course will examine the design, usage, and evaluation of retrieval systems with a focus on the underlying retrieval models, databases and system implementations. Retrieval technology both on and off the WWW will be examined.

CSED611 Machine Translation

Recommended Prerequisites: CSED518 (Linguistics Basis for Natural Language Processing)

This course covers Machine Translation (MT), i.e. the use of computers to translate (or help humans to translate) between natural languages. It provides a theoretical overview and considers the essential linguistic and practical problems of MT in general. And then we look in detail at a number of paradigm systems and the work of various research centers. We also touch on evaluation issues.

CSED613 Formal Specification Techniques

Recommended Prerequisites: CSED507 (Software Engineering)

Most software engineering techniques are informal or semi-formal. Specifications made with these techniques are very difficult to analyze due to their informality. In this course, students will study
various formal specification and analysis techniques with mathematical foundation. Representative techniques from the state, process, and data based paradigms will be studied as well. Each team of two to three students will carry out a team project throughout the course and make presentations to the class periodically to stimulate discussions.

CSED615 Advanced topics in Virtual Reality

Recommended Prerequisites: CSED511 (Introduction to Virtual Reality), CSED451 (Computer Graphics)

This course covers three major topics in Virtual Reality (VR): Presence and Immersion, Image-based Modeling/Rendering, and Time Critical Rendering Techniques and Distributed VR. Basic concepts are introduced through the textbooks and lectures while more in-depth topics are addressed by reading, presenting and discussing selected papers. Students will conduct several small-scale projects instead of one big final project.

CSED616 Human Language Technology

Human Language Technology (HLT) has recently been emerging as an area of research that pursues synergy among all related technologies such as speech recognition, natural language processing, information retrieval, and other human language related disciplines. This course aims to teach recent progress and applications in HLT. We will cover the spoken dialogue systems, multimedia information retrieval, statistical machine translation, and multi-modal systems.

CSED617 Advanced Haptics

Currently vibrotactile rendering is widely used for haptics applications such as information delivery in mobile devices and collision warnings in automobiles. This course aims to provide fundamental interdisciplinary background necessary for vibrotactile rendering and opportunities to gain practical experiences. Topics of study include psychophysics, human tactile perception, signal and system theory, sensors and actuators, theory and algorithms for vibrotactile rendering, and associated applications. On completion of this course, students should be able to utilize the knowledge and experiences in developing vibrotactile applications, e.g., for the haptic phone.

CSED620 Mobile Networks

Recommended Prerequisites: CSED353 (Computer Network)

Recently, a variety of wireless mobile networks have been deployed. This course provides an in-depth understanding of the fundamental problems in the area of mobile networks and studies the state-of-the-art solutions to the problems. This course also covers a number of important issues in the wireless mobile networks area.

CSED626 Multimedia Networking

Recommended Prerequisites: CSED353 (Computer Network)

Recently, a variety of wireless mobile networks have been deployed. This course provides an in-depth understanding of the fundamental problems in the area of mobile networks and studies the state-of-the-art solutions to the problems. This course also covers a number of important issues in the wireless mobile networks area.
CSED699 Master Thesis Research
A research course for Master’s thesis.

CSED700A- Topics in Computer Science A-
This course covers recent research topics in the area of computer science.

CSED701A- Topics in Computation Theory A-
This course covers recent research topics in the area of computer theory.

CSED702A- Topics in Computer Systems A-
This course covers recent research topics in the area of computer systems.

CSED703A- Topics in Artificial Intelligence A-
This course covers advanced topics in artificial intelligence research.

CSED800A/B Computer Science Colloquium A/B
In this course, students are required to conduct individual research on the topics of their choices under the guidance of their advisors.

CSED801 Individual Study
In this course, students are required to conduct individual research on the topics of their choices under the guidance of their advisors.

EECE802 IT Scientific Writing
This course is aimed at those writing scientific papers in English. It is a 12-week credit course for graduate students. Each student is required to produce a scientific manuscript. Topics of study include strategies for producing the components of a manuscript, for writing a first draft, for designing effective figures and tables, and for revising the draft. The course provides writing exercises designed to help students in this process. There will be no formal examinations; all marks will be based on exercises, assignments, and the final manuscript.

EECE803 IT Research paper Presentation Skill
This course is aimed at those who give scientific presentations in English. It is a 12-week credit course for graduate students. Students will learn how to organize a visually and verbally effective presentation: how to produce effective graphics; and how to express their ideas in good English. This course will also help students improve their English grammar, vocabulary, and diction.

CSED899 Doctoral Dissertation Research
A research course for Ph. D. thesis.
1. Education Aim

The study of Chemical Engineering embraces both the fundamental and the latest knowledges of Physics, Chemistry, and Biology. The department of Chemical Engineering aims to provide and foster the creative and progressive research environment for students so that they would become independent and leading professionals with a deep understanding of nature and society.

2. Program Overview

The graduate program in Chemical Engineering offers both the fundamental core subjects and the specialized sub-disciplines. The specialized sub-disciplines are described as follows

[Biotechnology]

[Energy and Environment Technology]
Chemical and biological approaches are taken to develop energy and environmental technologies. Among the energy technologies, the following are representative topics of current research: hydrogen generation from water and solar energy by using photo-catalysis and biological methods; development of solid hydrogen storage materials; and materials and system development for fuel cells, solar cells, batteries, ultra-capacitors and optical devices. The development of nano-structured materials for energy applications is the focus of many related research projects currently performed in this area. Environmental technologies include both the end-of-the-pipe cleaning technologies as well as intrinsically clean and benign technologies. Topics include air pollution control (NOx, SOx, VOC, dioxins, etc.), water and wastewater treatments, bio-remediation, and development of energy efficient and environmentally-acceptable chemical processes. Related faculty members have strong backgrounds in heterogeneous/photo catalysis and biotechnology.

[Information Technology]
Chemical technology plays a critical role in information technology. Numerous materials and processes are utilized in the IT industries for electronic, photonic and display devices. High dielectric constant materials, phase change materials, ferroelectric materials, organic insulators and
semiconductors, light emitting materials and other nano-structured materials for IT devices are studied. Also materials and processes for molecular electronics are studied including self-assembled monolayers for device applications. Chemical vapor deposition, atomic layer deposition, spin coating, evaporation, vapor phase deposition, dipping and other process technologies are studied to make various thin films, organic layers and other nano-structures. Many of the research activities are sponsored by national projects and also by many companies in IT industry. Faculty members are also actively involved in the interdisciplinary research programs with the Nano Integration Research Center established in POSTECH. Some of the ongoing projects include process and materials development in nano-CMOS, organic thin film transfers, and field emission devices.

[Nanotechnology]

Nanotechnology is the true driving force of the technological revolution in the 21st century. The fundamental understanding of the scientific principles at a nanometer scale is essential in this area, and new courses are continuously being developed. Quantum mechanics and band theory is as important as reaction engineering or transport phenomena. Researches currently pursued in the chemical engineering department are focused in three major areas: Nanomaterials, Nanodevices, and Nanoprocessing. Topics include the synthesis of nanotubes, nanowires, nanoparticles and nanotemplates, the fabrications of semiconductors, vacuum tubes, microbatteries, microsensors and microfuel cells, and the processing technologies such as atomic layer deposition, rapid microwave annealing and self-assembly monolayers.

[Courses]

Advanced degrees in chemical engineering are the Master of Science and Doctor of Philosophy degrees. As dissertation research stresses originality and creativity, it is expected that the results of the research be published in international journals of high standing. The basic requirements for graduate degrees are as follows:

<table>
<thead>
<tr>
<th>Program</th>
<th>Course Credits</th>
<th>Research Credits</th>
<th>Total</th>
</tr>
</thead>
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<tr>
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<td>M.S-Ph.D Integrated Program</td>
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## 3. Course Table

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<tr>
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<td>3-0-3</td>
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<tr>
<td></td>
<td>CHEB551</td>
<td>Engineering Optimization</td>
<td>2-2-3</td>
</tr>
<tr>
<td></td>
<td>CHEB553</td>
<td>Clean Process and Energy System</td>
<td>2-2-3</td>
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<tr>
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<td>CHEB561</td>
<td>Integrated Circuit Processing</td>
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</tr>
<tr>
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<td>Advanced Thermodynamics</td>
<td>3-0-3</td>
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<tr>
<td></td>
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<td>3-0-3</td>
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<tr>
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<td>CHEB641</td>
<td>Advanced Chemical Engineering Mathematics</td>
<td>3-0-3</td>
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<tr>
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<td>CHEB642</td>
<td>Advanced Transport Phenomena</td>
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<td></td>
<td>CHEB644</td>
<td>Transcriptional Regulation for Synthetic Biotechnology</td>
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<tr>
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<tr>
<td></td>
<td>CHEB713</td>
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<td>CHEB737</td>
<td>Advanced Molecular Biotechnology</td>
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<tr>
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<td>CHEB738</td>
<td>Introduction of Marine Environments and Biotechnology</td>
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<tr>
<td></td>
<td>CHEB744</td>
<td>Statistical Fluid Mechanics</td>
<td>3-0-3</td>
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<tr>
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<td>CHEB752</td>
<td>Process Synthesis and Analysis</td>
<td>2-2-3</td>
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<td>CHEB760</td>
<td>Polymer Blends</td>
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</tr>
<tr>
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<td>CHEB763</td>
<td>Conducting Polymers and Characterization</td>
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<td>3-0-3</td>
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<td>CHEB781</td>
<td>Photocatalysis for Energy and Environmental Applications</td>
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<td>CHEB801A-Z</td>
<td>Special Topics in Chemical Engineering</td>
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<td>CHEB811A-Z</td>
<td>Graduate Seminar</td>
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<td>CHEB899</td>
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<td>Research</td>
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</table>
4. Course Description

CHEB511 Catalysis ................................................................. (3-0-3)
Basic principles of catalytic phenomena are discussed in the molecular level. Catalyst preparation, characterization of catalyst surface, measurements of reaction rates are covered together with the relationships between catalyst structure and activity, or between kinetics and reaction mechanism. The characteristics and working principles are discussed for various classes of catalysts.

CHEB551 Engineering Optimization ........................................ (3-0-3)
Mathematical formulation and its solution methods of optimization problems in chemical process are treated. Linear Programming, Nonlinear Programming, Mixed Integer Programming, multi variable optimization and constraints are dealt with practical examples.

CHEB553 Clean Process and Energy System ................................ (3-0-3)
Specific energy/environmental processes, e.g., water purification process, are studied thoroughly from the view points of chemical engineering, environmental engineering, and energy engineering.

CHEB561 Integrated Circuit Processing .................................... (3-0-3)
Basic principles involved in silicon integrated circuit manufacturing are covered. Unit processes such as crystal growth, cleaning, oxidation, diffusion, vapor deposition for thin films, etching, lithography, ion implantation and metalization are included.

CHEB611 Advanced Reaction Engineering ................................ (3-0-3)
Instruction on chemical kinetics and reactor design. Course covers derivation of rate law, application of reaction kinetics for reactor design, analysis and design of reactors in homogeneous and heterogeneous phase. Application examples cover catalytic reactors, biochemical reactors, CVD reactors and polymerization reactors.

CHEB621 Advanced Thermodynamics .................................... (3-0-3)
Law of conservation of energy, Entropy, Energy are taught in a unified frame of the law of conservation, and ideal mixture, excess Gibbs free energy, fugacity, activity are covered with realistic examples. Diverse phase equilibrium problems are also taught with the general phase equilibrium principle to enhance problem-solving ability.

CHEB631 Advanced Biochemical Engineering .......................... (3-0-3)
Instruction of basic principles on core technologies for recent biochemical engineering research area such as cell culture technique, enzyme reaction technology, protein engineering, recombinant DNA technology, metabolic engineering, separation & purification techniques, bio-system modeling & simulation, and bio-informatics and their applications.

CHEB641 Advanced Chemical Engineering Mathematics ............ (3-0-3)
Mathematical methods for solving chemical engineering problems: linear operator theory, eigen-function expansion, special functions, Green’s function, spherical harmonics, integral transform, integral equations.
CHEB642 Advanced Transport Phenomena....................................................................................... (3-0-3)
Flow and transport phenomena in microsystems: equations of changes for mass, momentum, and energy. Stokes flow, Brownian diffusion, effective transport property, flow with electrostatic body force, inter-particle forces, electrical double layer, electrokinetics, micro-fluidics.

CHEB643 Advanced Metabolic Engineering.................................................................................. (3-0-3)
This course deals with the redesign of biological systems in the level of metabolism and covers the basic review of metabolism and various experimental methods to understand metabolic pathways. In addition, applications to industrial, medical, and agricultural biotechnology are illustrated.

CHEB644 Transcriptional Regulation for Synthetic Biotechnology.............................................. (3-0-3)
This course aims to provide intensive knowledge of transcription mechanism and regulation system for synthetic biology especially for the purposeful redesign of the biological system.

CHEB645 Protein Biosynthesis.................................................................................................. (3-0-3)
This is an intensive course to study protein synthesis mechanism as well as regulation network in the biological system.

CHEB661 Advanced Polymer Engineering.................................................................................. (3-0-3)
Special topics in polymer science and engineering are studied, including rubber elasticity, thermodynamics, structure and characterization. Organic electronics such as organic light emitting diode and organic field effect transistors are also discussed.

CHEB699 Master Thesis Research.............................................................................................. (1~9)
Experimental and theoretical research in all areas of chemical engineering needed for obtaining Master of Science.

CHEB713 Chemical Reactor Analysis and Design....................................................................... (3-0-3)
This is an advanced graduate chemical reaction engineering course which will cover an engineering methodology related to the design of chemical reactor including kinetic modeling and catalyst deactivation. However, the fundamentals for the design strategy will never be missed.

CHEB737 Advanced Molecular Biotechnology........................................................................... (3-0-3)
Instruction of basic principles and core technologies for molecular biotechnology that is based on recombinant DNA technology and traditional industrial microbiology. Deep introduction of practical applications of molecular biotechnology on several research fields such as chemicals, medicals, pharmaceuticals, environment, and agriculture.

CHEB738 Introduction of Marine Environments and Biotechnology.......................................... (3-0-3)
Marine covers about 80% of the earth and is mainly undiscoverable area. Lecture consists of two parts: the first half instruction is introduction of marine environment and importancy and the latter half is introduction of biotechnology researches using marine organisms and their applications.
CHEB744 Statistical Fluid Mechanics


CHEB745 Numerical Analysis in Chemical Engineering

Various numerical techniques are studied for problems in transport phenomena, reaction engineering, and other areas in chemical engineering: finite difference method, grid generation, boundary element method, and the Monte-Carlo technique. In addition each student is required to perform two term projects related to his/her own thesis research.

CHEB751 Advanced Process Design

Based on the fundamental theory of chemical engineering, processes are optimized from the practical point of view of chemical process design. Engineering economics and profitability, process analysis for subsystems, elementary optimization and sensitivity studies, process synthesis and strategies are treated.

CHEB752 Process Synthesis and Analysis

Various synthesis and analysis methods of processes are treated with artificial intelligence, heat exchanger network, control system, risk analysis, knowledge based expert system, etc.

CHEB760 Polymers Blends

Introduction of multi-components and multi-phases polymer systems such as polymer blend, block copolymer, and liquid crystal polymer. Emphasis on the relation between morphology and mechanical properties. Nanophase separation and block copolymer thin films applied for new functional materials are introduced.

CHEB763 Conducting Polymers and Characterization

Basic organic chemistry, polymerization of conventional polymers and characterization, synthesis of conducting polymers and characterization, and application of conducting polymers.

CHEB766 Advanced organic Material Chemistry

The course deals with organic and material chemistry for bottom-up nano-fabrication. Supra-molecules, self-assembly, organized films, and their applications are discussed.

CHEB768 Ceramic Materials Processing

Chemical and physical phenomena related with ceramic materials processing are covered. Reaction mechanism and particle formation mechanism are also included in this lecture. Sol-gel process, colloid chemistry, stability, gas phase reaction mechanism and other material processing are also included.

CHEB769 Semiconductor Materials Processing

Surface chemistry and analysis related with electronic materials processing are introduced. Especially basic surface atomic structure and surface reaction phenomena are dealt with. Also
ultra-high-vacuum surface analysis techniques are introduced in the points of basic principle and applications in semiconductor material processing.

**CHEB776 Interface and Adhesion for Electronic & Information Materials** ........................................... (3-0-3)

Intermolecular interactions between polymer and polymer, polymer and metal, and polymer and ceramic are discussed. The origin of intermolecular forces is studied in depth. Organic Electronics such as organic field effect transistors and interfacial electronic structures at organic/metal interfaces are discussed.

**CHEB777 Advanced Functional Nanomaterials** ................................................................................. (3-0-3)

New research trends in Chemical Engineering are introduced.

**CHEB781 Photocatalysis for Energy and Environmental Applications** ........................................... (3-0-3)

To understand the basic principles and characteristics of semiconductor photo-catalysis and review and discuss a wide range of related research papers.

**CHEB801A-Z Special Topics in Chemical Engineering A-Z** ............................................................. (3-0-3)

New research trends in Chemical Engineering are introduced.

**CHEB811A-Z Graduate Seminar A-Z** ............................................................................................. (1-0-1)

Seminars for graduate students, which are related to all areas of chemical engineering are delivered by invited speakers.

**CHEB899 Doctoral Dissertation Research** ....................................................................................... (1~9)

Experimental and theoretical research in all areas of chemical engineering needed for obtaining Doctoral Degree. methods are introduced for graphical models.
Division of Environmental Science and Engineering

1. Education Aim

Environmental research in Korea has been quite limited to the traditional fields such as water and waste treatment and air pollution control engineering, which have been mainly approached by environmental engineers, civil engineers and some chemical engineers.

However, the diversifying industrial and social needs for a cleaner environment and the sustainable development are compelling environmental researchers to have a comprehensive view which extends to almost all aspects of science and engineering.

Nowadays, environmental research has become so multifaceted that it can be no longer classified into a few academic disciplines. Responding to the need of change in environmental education and research, POSTECH now plays a pivotal role by creating a unique graduate program in environmental science and engineering. The Division of Environmental Science and Engineering (DESE) at POSTECH was established in 1995 under the financial support of the Ministry of Education, Korea. It was also designated as a Graduate School of Excellence in environmental engineering by the Ministry of Education.

DESE offers master’s and Ph.D. programs in both environmental science and environmental engineering, which are open to students with any background in science and engineering. DESE admitted its first graduate students in the fall semester of 1996 and has continued attracting top-quality students not only from domestic universities but also from foreign universities.

Graduating students from DESE are expected to play leading roles in various environment related fields such as industries, research institutes, universities, governmental and non-governmental organizations, small businesses, and others.

2. Program Overview

The Division of Environmental Science and Engineering (DESE) welcomes applicants with backgrounds in all areas of science and engineering who are interested in applying their specialized abilities to managing environmental problems.

The DESE graduate program is designed to educate students to get a balanced overall view and understanding of diverse environmental problems, to gain specialized knowledge and experience in their own interest areas, to have the ability to identify and solve the problems encountered in the real world, and ultimately be independent environmental researchers.

[Degree Program & Requirements]

The DESE program offers degrees of Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) in both environmental science and environmental engineering. SEE does not have an undergraduate
To complete program, minimum credit must be acquired is 28 for Masters, 32 for Doctorate, and 60 for Integrative candidates.

<table>
<thead>
<tr>
<th>Program</th>
<th>Course Credit</th>
<th>Research Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S.</td>
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<tr>
<td>Ph.D</td>
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</tr>
<tr>
<td>Ms-Ph.D Integrated</td>
<td>24</td>
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</table>

All DESE student should take three or more Environmental core subjects among eight to acquire of basic environmental knowledge.

### Environmental core subjects

<table>
<thead>
<tr>
<th>No.</th>
<th>Number of Subject</th>
<th>Name of Subject</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>EVSE510</td>
<td>Introduction to Environmental Engineering</td>
</tr>
<tr>
<td>2</td>
<td>EVSE540</td>
<td>Environmental Biotechnology</td>
</tr>
<tr>
<td>3</td>
<td>EVSE575</td>
<td>Global Environment</td>
</tr>
<tr>
<td>4</td>
<td>EVSE579</td>
<td>Environmental Statistics</td>
</tr>
<tr>
<td>5</td>
<td>EVSE581</td>
<td>Environmental Physical Chemistry</td>
</tr>
<tr>
<td>6</td>
<td>EVSE583</td>
<td>Environmental Inorganic Chemistry</td>
</tr>
<tr>
<td>7</td>
<td>EVSE584</td>
<td>Earth Environmental Fluid Dynamics</td>
</tr>
<tr>
<td>8</td>
<td>EVSE587</td>
<td>Environmental Organic Chemistry</td>
</tr>
</tbody>
</table>

* Subjects can be changed depend on situation

### For All DESE Student

Considering rapid growth and diversity of environmental related field, DESE opens various courses and starts On-site Process Study and Independent Project. To promote capability of research, students in Masters Program should take seminars for two semesters, students in Doctorate Program should take seminars for four semesters and students in Integrative Program should take seminars for six semesters.

### Qualification Examination

To be admitted to the candidacy of Ph.D. degree, students in the Ph.D. program must pass the qualification examination usually tested in their 4th semester. Should select three subjects for examination among eight subjects listed below. However, the examination can be exempted for students obtaining grades above ‘A0’ from the courses of selected subject and students will thereby be recognized to have passed the qualification. The student who fails to pass the exam is given one more chance. The second exam tests only the subjects that the student failed in the first exam. Students who fail both exams maybe expelled from the Ph.D. program.
### 3. Course List

<table>
<thead>
<tr>
<th>Category</th>
<th>Course No.</th>
<th>Title</th>
<th>lec-lab-cr.</th>
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<td>Introduction to Environmental Engineering</td>
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<td>Air Pollution</td>
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<td>EVSE579</td>
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<td>EVSE582</td>
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<td>EVSE711A-D</td>
<td>Advanced Environmental Processes A-D</td>
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</table>
4. Course Description

**EVSE501 Introduction to Environmental Studies**........................................................................................................ (3-0-3)
Ancient regional history of Korean peninsula is restructured while focusing on Homo sapiens coastal migrations and its ancient cultural developments through Pacific rim (PR) route. Paleo-ecology & paleo-archeology, ancient anthropo-bio-geo environment changes, ancient world history, primitive religions are highlighted. While paying special attention to the sudden PR environmental shift in around Holocene ice age, and comparative social and religious studies of ancient American societies and Far-East and South-East Asia societies, PR environmental science is projected upon 21st sociological stage of Korea.

**EVSE510 Introduction to Environmental Engineering**.................................................................................................... (3-0-3)
The course covers introduction of various environmental pollutions such as air and water. The course also covers characteristics, sampling methods, analytical methods of industrial wastes along with treatment methods.

**EVSE520 Air Pollution**....................................................................................................................................................... (3-0-3)

**EVSE525 Water Pollution**..................................................................................................................................................... (3-0-3)
A detailed analysis of various water pollutants, their physicochemical characteristics, and their transformation and fate in the aquatic environments will be presented and discussed with a strong focus on aquatic chemical principles.

**EVSE535 Waste Management**.............................................................................................................................................. (3-0-3)
Definition and characteristics of hazardous and industrial waste. Investigation of generation, reduction, stabilization of wastes. Physicochemical, biological, and thermal treatment etc.

**EVSE540 Environmental Biotechnology**.............................................................................................................................. (3-0-3)
Basic concepts of microbiology and biochemistry are introduced. Various microbial groups along with metabolic pathways are discussed. Introductory level of typical bio-processes is also discussed.

**EVSE550 Environmental Engineering Laboratory**.................................................................................................................. (1-6-3)
This course is concerned with designing experiments for treating pollutants in atmosphere, soil, and water.

**EVSE565 Reaction Engineering**............................................................................................................................................ (3-0-3)
Environmental Reaction Engineering deals with systems within which environmental reactions are occurring, concentrating on trying to define the size of reactor required for a specified duty and the desirable flow mixing pattern which should be promoted within the reactor. It does not concern itself with the materials from which the reactor should be made, nor the thickness of its walls for instance. Reactor design utilizes knowledge of thermodynamics, fluid mechanics and chemical kinetics, coupled of course with an economic assessment of whether the proposed design is
financially attractive. The purpose of this course is to enable Environmental Engineering students to develop a clear understanding of the fundamentals of environmental reaction engineering. The goal will be achieved by presenting a structure that allows the students to solve reaction engineering problems through reasoning rather than through memorization and recall of numerous equations and the restrictions and conditions for reactor design.

**EVSE575 Global Environment**

The earth as a chemical system, including composition, physical-Chemical aspects, role of nutrients, trace metals, interaction between the bottom and overlying water, organic matter, and stable and radioactive isotopes.

**EVSE579 Environmental Statistics**

Students learn general concepts of statistical methods commonly used in environmental and earth sciences. They also learn how to carry out statistical analyses and how to interpret results by applying statistical softwares to real data from their research fields.

**EVSE580 Polymers and Environment**

Covers polymer theories: polymer chemistry; polymer physics; Bio-polymers (Carbohydrate, lipid, proteins); Environmental stability of polymer; Management of polymer wastes; Biodegradable polymer.

**EVSE581 Environmental Physical Chemistry**

To introduce the key principles of physical chemistry, with strong emphasis on their applications to environmental problems, to students who have weak background in chemistry. Basics of thermodynamics and thermochemistry, chemical kinetics, photochemistry and spectroscopy, surface chemistry and catalysis will be covered.

**EVSE582 Introduction to Climate Change**

Students understand basics of climate change science including human and natural drivers of climate changes, how climate has been changing, how to model climate, and how we can predict future climate change and its impact. Recent topical issues like high-impact weather and climate extremes are also discussed.

**EVSE583 Environmental Inorganic Chemistry**

The main aim of this lecture is to deliver the basic concepts in the inorganic and solid-state chemistries, including the structure, synthesis and characterization of solid materials. The principles and examples of various analytical tools for the solid-state materials, including both inorganic and inorganic-organic hybrid ones, are also covered in the class.

**EVSE584 Earth Environmental Fluid Dynamics**

Give a lecture on the fundamental dynamical processes of ocean and atmosphere in order to understand and predict Earth climate and environmental changes.
EVSE585 Basic Principles in Environmental Materials ......................................................... (3-0-3)
Basic concepts in the solid-state chemistry, including the structure, synthesis and characterization of solid materials are introduced. The adsorption and reaction on solid surfaces are also covered in the class.

EVSE586 Environmental Nanoporous Materials ............................................................. (3-0-3)
Deliver the principles in the crystal structure and synthesis of ordered nano-porous materials such as zeolites and meso-porous molecular sieves, together with their physicochemical characterization techniques.

EVSE587 Environmental Organic Chemistry ............................................................... (3-0-3)
Utilization of the structure of a given chemical to deduce that chemical’s intrinsic physical properties and re-activities, and Emphasis on quantification of phase transfer, transformation, and transport processes at each level.

EVSE590 Bioemediation Engineering .............................................................................. (3-0-3)
The course covers re-mediation of contaminated soil and ground water focusing on biological methods (bio-re-mediation). Theoretical background of various bio-re-mediation technologies are introduced by using case studies.

EVSE599 Seminar .......................................................................................................... (1-0-1)
Invited speakers who are working on a variety of environment-related issues in academia, industry, and government give special lectures on specialized subjects.

EVSE621 Wastewater Treatment Engineering ............................................................... (3-0-3)
This class focus on various sources, characteristics, and typical processes for wastewater treatment. Concepts and application of physical and biological processes are discussed.

EVSE655 Ocean Bioeochemical Cycle ............................................................................ (3-0-3)
This course primarily covers chemical and biological processes influencing the fate of pollutants within the ocean. Of those pollutants, it primarily covers the behavior of anthropogenic CO2 in the oceans.

EVSE661 Environmental Instrument Analysis and Experiments ..................................... (1-6-3)
Introduction to various chemical instrumental analysis: basic principles and applications (MS, ICP, AA, GC, HPLC, Gas Analyzer etc.).

EVSE665 Mass Spectrometry ........................................................................................ (3-0-3)
Further understanding of the mass spectrometry principle. The application, data analysis, and operation system of mass spectrometry.

EVSE667 Pollutant Analysis .......................................................................................... (3-0-3)
Practical sampling, concentration, separation of the environmental sample. Optimal selection of the analytical method and comprehensive analytical systems for various organic and inorganic compounds.
EVSE680 Special Topics in Environmental Engineering A-Z ........................................... (3–0–3)
Special topics in environment-related issues that are not covered by regular courses can be offered through this course when needed.

EVSE681 Alternative Energy ......................................................................................... (3–0–3)
Scientific theories and applications of solar energy, wind power, biomass, and bioenergy are introduced.

EVSE695 On-site Process Study ...................................................................................... (0–3–2)
Students learn and practice various environmental processes and techniques on sites through visiting industrial facilities.

EVSE699 Master Thesis Research .................................................................................. (1–9)

EVSE711 Advanced Environmental Process A-D ....................................................... (3–0–3)
Advanced topics in environmental processes for conservation and pollution prevention that are newly emerging are offered through this course when needed.

EVSE720 Photocatalysis for Energy and Environmental Application ....................... (3–0–3)
The basic principles and characteristics of semiconductor photocatalysis for solar energy conversion and environmental remediation are introduced and discussed and a wide range of related research papers are reviewed.

EVSE725 Environmental Bioprocess Engineering ....................................................... (3–0–3)
This class deals with basic theories of environmental biotechnology, wastewater treatment, and engineering economics. Economic concerns of bio-processes for environmental management are introduced.

EVSE730 Introduction of Marine Environments and Biotechnology ......................... (3–0–3)
The coverage is intended to provide a general base of marine science and biotechnology. The first half primarily covers the interactions between marine environments and marine organisms and the latter half covers the origin of marine organisms and engineering applications of those organisms.

EVSE795 Independent Project ....................................................................................... (3–0–3)
Students plan and carry out independent research projects under the guidance of advisors.

EVSE899 Doctoral Dissertation Research .................................................................... (1–9)
1. Education Aim

The School of Interdisciplinary Bioscience and Bioengineering, an interdisciplinary graduate program, was launched in 2005 with an aim of training and educating world-class scientists and engineers equipped with both quantitative, systematic, and integrative orientations and hands-on experience, and committed to working at the interface of the basic sciences and various applications. The program offers a unique combination of the basic sciences courses and is run under innovative educational systems in which the core sciences such as biology, physics, chemistry, and mathematics are combined with the knowledge, techniques, and insights from a variety of disciplines, including electronic and electrical engineering, chemical engineering, and environmental engineering.

2. Program Overview

[The need-and track-based curriculum]

The need-and track-based curriculum mirrors the philosophy of the program to train scientists and researchers with interdisciplinary knowledge and experience. To accomplish this mission, the program offers a track-based curriculum that is linked to the background and research interests of each student. The curriculum consists of two tracks: 1) Systems Bio-sciences 2) Systems Bioengineering

Track 1: Systems Biosciences

The track provides an education for quantitative, systematic and dynamic analyses of various life phenomena ranging from molecules to organisms. It adopts methodologies of mathematics, chemistry, life science, physics, electronics, electrical engineering and computer science: 1) modeling and analysis of complex biological systems via system-level spatio-temporal investigations, and 2) bio-technological research based on the quantitative, systematic and dynamic understanding of the phenomena of living organisms (e.g. development of new concepts in medicine, bio-materials, and elucidation of metabolic mechanisms.)

Track 2: Systems Bioengineering

The track provides an education for engineering biological systems by integrating the methodologies of life science, material science, mechanical engineering, industrial engineering, electronics and electrical engineering, and chemical engineering: 1) development of devices to understand life phenomena (e.g. bio-imaging techniques, substitute bio-materials, and NEMS/MEMS-based medical engineering, 2) reverse engineering to solve biological problems (e.g. simulation of a neural network of a living organism), and 3) forward-engineering in analysis of biological systems with the aim to increase metabolic products such as ethanol and hydrogen.
Curriculum

In accordance with Chapter 4 Article 23 of the Rules and Regulations of the Graduate School, “The minimum number of overall credits to be completed for the awarding of degrees is 28 for the Master’s Program, 32 for the Doctoral Program, and 60 for the MS/PhD Integrated Program. The number of course credits and research credits to be completed in each degree is specified in the department bulletin”, the School of Interdisciplinary Bioscience and Bioengineering has set the minimum number of credits as 60 for the MS/PhD Integrated Program (27 course credits and 33 research credits), 28 for the Master’s Program (21 course credits and 7 research credits) and 32 for the Doctoral Program (18 course credits and 14 research credits) (Refer to the table for details).

The I-Bio graduate program offers doctorate degree in both science and engineering. The goal of the graduate program is to train students into world-class leading scientists and engineers. To achieve this goal, the School provides the students with several unique education policies and programs for interdisciplinary, integrative and quantitative study. Thus, each student has several thesis advisors, one from the life science field and one or two from other related scientific disciplines. The curriculum is adjusted to meet every student’s educational background and research interests so that he or she acquires the fundamental knowledge necessary to perform required interdisciplinary research activities. The students are also encouraged to establish external partnership through collaboration with their external thesis co-advisors or I-Bio’s international student exchange programs which are currently connected with several renowned institutions worldwide.
The following two track-based curricula are offered at the I-BIO:

1) Systems Biosciences
2) Systems Bioengineering

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<tr>
<th>Research Credits</th>
<th>MS/PhD Integrated Program</th>
<th>Doctoral Program</th>
<th>Master’s Program</th>
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<td>33</td>
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<tr>
<th>Major Requirement (3 credits)</th>
<th>Frontiers in Interdisciplinary Bioscience</th>
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<tr>
<td>Required Electives (3 or more credits)</td>
<td>Biophysics, Advanced Bio-Imaging, Advanced Metabolic Engineering, Advanced Molecular Genetics, Advanced Molecular Biology I, Tissue Engineering, Biofluid Mechanics, Nano-Biomaterials, Biopolymer Chemistry, BioMEMS, Biology of Aging</td>
</tr>
<tr>
<td>Major Electives (21 or more credits)</td>
<td>Physics/Chem/Math/Computer Science (12 credits), Biosciences (9 credits)</td>
</tr>
<tr>
<td>Engineering (12 credits), Biosciences (9 credits)</td>
<td>18 course credits (required course: 6 credits &amp; elective course: 12 credits)</td>
</tr>
<tr>
<td>Engineering background</td>
<td>21 course credits (required course: 6 credits &amp; elective course: 15 credits)</td>
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<tr>
<th>TRACKS</th>
<th>Track I Systems Biosciences</th>
<th>Track II Systems Bioengineering</th>
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I-Bio’s curriculum serves as a bridge between education and interdisciplinary research.

Each student is advised by his advisor and the education committee to choose one of the tracks based on his or her research interests. The Major Requirement and required electives provide the fundamentals of interdisciplinary bio-sciences while the track-based curriculum presents specific features of each track. The students are also encouraged to take courses offered by other programs.
[Requirements for the Awarding of Degrees]

A number of credits required for the awarding of degrees are determined by the curriculum committee. However, students can take courses that fit their track and research fields. While the track-based curriculum is the core of the program, a student, supervisor and curriculum committee work together to meet every student’s needs.

3. Course Description

IBIO511 Bio-Imaging

The course is designed to present the state-of-the-art technology for high resolution imaging of the micro structure of living organisms. The course also offers in-vivo dynamic research of the micro structure of cells and living organisms.

IBIO512 Biostatistics

The course covers the basics of mathematical analysis and mathematical modeling with applications into biology. It deals with reaction dynamics, system dynamics, oscillations, pattern formations, waves in biological systems, neural dynamics, and infectious disease dynamics.

IBIO513 Information Processing for Genomics and Proteomics

The course provides an understanding of information processing for genomics and proteomics. The course introduces a variety of research methods and covers information processing techniques for gene isolation, comparative genomic studies, analysis of gene expression, computing techniques for the analysis of protein expression, protein interactions and E cell simulation.

IBIO514 Nano-Biomaterials

The convergence of recent advances in nano-biotechnology and medicine has created the new research domain of nano-medicine. This course will provide students with an in-depth understanding of nano-bio-materials for nano-medicine in terms of life science, chemistry, physics, and materials science.

IBIO515/MECH579 Introduction to Microfluidics

The course provides the basic theories of micro-fluidics, such as the governing equations for transport phenomena, electrokinetics, and di-electro-phoresis, and examines applications of micro-fluidics to study biological phenomena. The course helps students offer their abilities to interpret movements of particles under the effects of viscous and electrokinetic forces and electro-osmotic flow in a micro channel, including convection diffusion.

IBIO516 Method in Interdisciplinary Research

Supervisors advise students on the progress of their research, research methods and interpretation of results. It encompasses the purpose, background, assumptions or motivation of research, research findings, and their interpretation and suggestions for further research.
IBIO518/LIFE509 Advanced Cell Biology

The course studies the structure of cells using methods of light and electron microscopy techniques in relation to their functions.

IBIO519/EECE551 Digital Image Processing

The course offers methods of computer-based image processing and analysis. The structure and principles of the human vision system and a variety of image processing techniques such as modeling, sampling, quantization, enhancement, restoration and two-dimensional data filtering and conversion theories are introduced. Image analysis techniques such as edge detection, image division and matching are covered. In addition, image coding using various conversion techniques and the structure of the up-to-date image processing computer are introduced.

IBIO520/CSED515 Machine Learning

The course offers basic principles of computational skills that are needed to study neural networks. Perceptron, RRB, Cohonen Networks and Hop field Network models are analysed. Students study methods of pattern recognition, regression analysis and predictions and various applications.

IBIO521/CSED514 Pattern Recognition

The course introduces basic principles of pattern recognition, and teaches students how to apply the learning to a variety of situations. The course focuses on statistical pattern recognition and its relationship with artificial neural networks.

IBIO522/LIFE414 System Biology

This is an introductory course to systems biology. It covers principles of genomics, transcriptomics, proteomics, network analysis, and network modeling. The course is based on analysis of research papers published in scientific media on the subject. The course is designed for advanced undergraduates and graduate students with strong backgrounds in molecular biology.

IBIO523/MATH443 Mathematics for Biologists

The course aims to provide an introduction to mathematical modeling in biology. Deterministic and stochastic models are explored alongside with analytical and numerical techniques. The course covers ordinary differential equations, partial differential equations, stochastic differential equations, stochastic simulation algorithms, networks, numerical algorithms and difference equations.

IBIO524/PHYS420 Single-molecule biophysics

Interdisciplinary approaches have successfully explored an increasing number of biological problems. The inherent averaging associated with the conventional biochemical tools makes it difficult to unravel the salient features of molecular mechanisms. The development of physical techniques that allow the observation and manipulation of individual molecules has enabled the study a variety of biological processes at an unprecedented level of detail. Starting with the physics related to biological molecules and cells, the course advances to the microscopy and spectroscopy of the single-molecule biophysics.
IBIO528/ITCE566 Advanced Molecular Genetics

This course is designed to help students learn recent exiting advances in the molecular genetics. The topics include functional genetics, model organisms, molecular genomics. In addition, students will discuss breakthrough findings in the molecular genetics field.

IBIO611 Advanced Systems Biology

A novel feature of the graduate level course is an integrative analysis of complex biological systems. The course aims to develop fundamental principles for systems approaches: 1) formulation of key biological problems, 2) technologies for global data sets and 3) computation for modeling and analysis via mining of such global data sets and 4) integration of such data sets with other relevant data. In the first half of the course, the course takes a rigorous mathematical approach with emphasis on the development of application of modern mathematical and computational methods. In the second half of the course, the course takes to develop basic principles to study spatio-temporal behaviors of biological systems via data integration at the system level.

IBIO612/PHYS667 Quantitative Theoretical Biology

This is a basic course geared to the quantitative analysis and modeling which is necessary for the theoretical understanding of biological phenomena. The course especially focuses on bio-statistics, non-linear mechanics, bio-informatics, thermo-dynamics, bio-dynamics, data analysis and data mining.

IBIO613/MECH598 Biomechanics

The course introduces the dynamic phenomena of cells and molecules of living organisms and analyses relationships among dynamic phenomena and life phenomena.

IBIO614 Frontiers in Interdisciplinary Biosciences

The course helps students choose research topics.

IBIO615 Advanced Bioengineering

The course analyses the emerging biotech industry, its prospects and research directions. In addition, the course introduces basic and novel technologies in biotech industry.

IBIO616/MECH624 Biofluid Mechanics

This is a basic course with the aim to provide the understanding of the cardio-vascular system.

IBIO617/MECH646 Nanobiotechnology

The course explores conversion and material transport of fine energy, related devices and behaviors through the mechanical, material, physical, chemical, and biological analysis of fine bio-materials and reactions. This course discusses cases of Bio-MEMS devices and Micro/Nano Electro Mechanical Systems development for the high throughput analysis and treatment of fine bio-materials and related scientific and technological issues.

IBIO631/PHYS666 Physics of Soft Condensed Matter

The course studies polymers as one- and two-dimensional soft matter and transport phenomena in membranes and liquid crystals. In the course we cover ideal chain theory, semi-soft polymer
solutions and melt, bio-polymers, fluctuation and interactions on interfaces, self-assembled interfaces and membranes.

IBIO632/PHYS720 Special Topics in Brain Science

The course analyses the basics of the structure and functions of the brain including sight, memory, emotion, bio-rhythms (circadian rhythms), motion control, parallel functions, neural coding, linguistic functions, and non destructive measurement of brain functions. The course hosts seminars on basic matters of brain science and modern trends in this field.

IBIO633/PHYS662 Biological Statistical Physics

The course adopts statistical physics approaches to interpret dynamic biological life phenomena. It studies physical processes in electrolyte solutions, bio-polymers, bio-membranes, ion channels and delves into processes of protein folding and transitory events in cells, eg, electrical signal transfer in a nerve fiber.

IBIO634/PHYS665 Nonlinear Dynamics and Chaos Theory

The course provides the non-linear origins of chaos and synchronization by modeling dynamic phenomena that occur in complex biological systems. Network pattern formation, stochastic resonance and neural networks of coupled oscillators are rigorously analyzed in this course.

IBIO635/LIFE616 Biocommunicatoins

The course introduces principles of various cell-molecule interactions in a multicellular organism. The course investigates functional modules and motives of receptor-ligand and signal proteins. The course hosts tutorial lectures given by experts in this field and provides mathematical background for understanding of interrelations that exist within bio-systems.

IBIO636/LIFE617 Tissue Biochemistry

The course provides an overview of functions of the human body such as neural signaling, circulation, digestion, excretion and reproduction in normal and pathological conditions. The course hosts invited lectures from different medical field in order to learn more about the methods of treatment of diseases and the current status and prospects in medicine.

IBIO637/LIFE618 Proteomics & Molecular Networks

The course presents modern findings in proteomics. The course is focused on the structure and traits of protein machines, which consist of protein multi-complexes such as proteasome, spliceosome, focal adhesion complex, and post-synaptic density complex. The state-of-the-art technology is introduced and applied to analyze the molecule network derived from protein interactions.

IBIO638/LIFE619 Bioinformatics

The course illustrates ways of search and analysis of biological data and describes modern trends and prospects of bio-informatics.

IBIO639/LIFE620 Advanced Biostatistics

The course introduces advanced statistical analysis methods that are required to analyze and biological systems.
IBIO640/LIFE719 Molecular Biophysics ................................................................. (3-0-3)

The course covers general principles of physics, biochemistry and biology. A special emphasis is given to physical chemistry approach to study molecular phenomena. The course focuses studies of the structures of biopolymers, relationships between molecules and physical methods used in the characterization of proteins and nucleic acid.

IBIO641/CHEM721 Biological Molecular Chemistry ........................................... (3-0-3)

The course teaches how to design and synthesize chemical compounds of known physiological activity. This course especially focuses on the development of materials which interfere with catalytic functions by acting selectively on special enzymes.

IBIO642/CHEB731 Biomedical Transport Phenomena ........................................... (3-0-3)

The course presents ways to analyze and interpret transport phenomena in a living organism. It demonstrates applications of principles of chemical engineering to medical engineering and genetic engineering research.

IBIO643/CHEB732 Bioseparataion Processes ......................................................... (3-0-3)

The course studies technical separation methods of biological macromolecules that take are common in bioengineering applications. It covers basic principles and applications of thermodynamic analysis of diluted solutions, thin membrane filtration chromatography, centrifugal separation and electrophoresis.

IBIO644/CHEB733 Cell Culture Engineering ......................................................... (3-0-3)

The course studies cell cultures, ie, plant and animal cells, mold and algae, and microorganisms such as bacteria from the physical chemistry engineering perspective.

IBIO645/CHEB734 Biochemical Process Engineering ........................................... (3-0-3)

The course covers basic features of biochemical processes and systematic approaches to analysis, evaluation and optimization of biochemical processes.

IBIO646/CHEB737 Advanced Molecular Biotechnology ......................................... (3-0-3)

The course introduces basic principles and applications of molecular biology, biochemistry, and microbiology and provides the understanding of molecular biotechnology, based on DNA recombination technology. It delves into the protein recombination manifestation system of bacilli, enzymes, insects, plants and animals as well as applications of molecular biotechnology in the fields of chemistry, medical science, the environment and agriculture.

IBIO647/MECH643 Biomechanics ................................................................. (3-0-3)

Students learn to design models to simulate movements and operations of the human body. This course covers an thropoftry, human body modeling and control theory.

IBIO648/MECH647 Bioengineering ................................................................. (3-1-3)

The course focuses on mechanical and electrical interpretations of the human body. During the course students investigate functions of the limbs and study computational methods for data collection and interpretation.
IBIO649/LIFE622Z Molecular Imaging

This course explores the latest trends in and the future of various disciplines in the rapidly developing life sciences of today.

IBIO650/CHEB643 Advanced Metabolic Engineering

This course explores the latest trends in and the future of various disciplines in the rapidly developing life sciences of today.

IBIO651/CHEM669 Special Topics in Biochemistry

Selected topics from bio-organic, biophysical, or biological chemistry will be discussed. The contents of this course will vary.

IBIO652/LIFE601 Advanced Molecular Biology I

This course explores in depth DNA replication in lower cells, genetic recombination, DNA repair, structures and functions of genes, transposable elements, and gene expression regulation through the latest research and literature.

IBIO654/CHEB644 Transcriptional Regulation for Synthetic Biotechnology

This graduate-level course aims to provide intensive knowledge of transcription mechanism and regulation system for synthetic biology especially for the purposeful redesign of the biological system.

IBIO655/ITCE562 Biology of Aging

The focus of this course is on current understanding of aging process at an organismic level. Emphasis is placed on genetic control mechanisms that regulate aging and age-related diseases. Moreover, students will discuss key molecular signaling pathways that regulate aging processes, which are conserved across phyla.

IBIO656/LIFE508 Advanced Developmental Biology

This course explores the mechanisms through which the fertilized egg develops into an entity composed of various cells, tissues, and organs.

IBIO657/MECH532 Tissue Engineering

Tissue engineering is the use of a combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to improve or replace biological functions. This course teaches fundamentals that span several academic areas related to tissue engineering to students who have a mechanical engineering background, and introduces various approaches to research. Topics include basic cell biology, chemistry, bio-materials, anatomy, computer-aided design/computer-aided machining (CAD/ CAM), and manufacturing technology. Various mathematical and mechanical tools for simulating cell behavior are introduced. In addition, basic experimental laboratory instruction covers cell culture and scaffold fabrication.

IBIO658/LIFE503 Advanced Immunology

This course explores the principles of and techniques for conducting research on immunity and application for the resolution of major biological problems. In particular, emphasis is placed on the
reactions of antigens and antibodies, immuno assay, structures and reactions of immuno globulins, genes governing the immune system, processes through which antibodies are formed, principles of cell-mediated immunity, complements, tolerance, and transplantation, and techniques for producing and applying monoclonal antibodies.

**IBIO659/LIFE505 Neurobiology**

This course explores the basic principles of the organization and reactions of the nervous systems of various life forms. In particular, emphasis is placed on neurocytology, the structure of the nervous system, the development of nerves, and the biochemical mechanisms of action potential and transmission and of sensory transduction.

**IBIO661 Molecular Spectroscopy**

Development of molecular quantum mechanics and its application to the spectroscopy of atoms and molecules. Topics include interaction of the electric field with matter, group theory, rotational and vibrational spectroscopy of molecules, electronic spectroscopy of atoms and molecules, and photoelectron spectroscopy.

**IBIO662/CHEM542 Analytical Spectroscopy**

This course provides a thorough treatment of the instrumental principles, terminology, methodology, and instrumentation to analytical spectro-chemical methods. It also discusses specific spectro-chemical analysis techniques in terms of their implementation and characteristics, where appropriate, representative examples of practical applications of the techniques are given.

**IBIO663/LIFE611 Biomacromolecular Structures**

This course addresses a structural understanding of the functions of proteins a structural understanding of protein-DNA, protein-sugar, protein-steroid, and protein- protein interactions; a structural understanding of enzyme protein reaction mechanisms and protein structures as means to functional genomics to arrive at an advanced understanding of the functions of proteins, which dictate a majority of biological phenomena.

**IBIO665/EVSE540 Environmental Bio-processing**

Basic concepts of microbiology and biochemistry are introduced. Various microbial groups along with metabolic pathways are discussed. Introductory level of typical bio-processes is also discussed.

**IBIO666/AMSE612 X-ray Imaging**

In-situ microscopic observation is getting important in nano-technology or biotechnology. Conventional microscopes have limitations on surface observation (optical microscope, scanning electron microscope, atomic microscope, etc) or in environments (mostly vacuum). The only in-situ microscopic method to overcome such limitations is X-ray imaging. In this lecture the basic principles of X-ray imaging are introduced together with cases of recent researches. Practical methodologies of X-ray imaging are taught as well. This lecture is for the graduate students oriented in materials science, nano-technology or biotechnology.

**IBIO667/CHEB645 Protein Biosynthesis**

This is an intensive course to study protein synthesis mechanism as well as regulation network in the biological system.
IBIO699 Master Thesis Research

Students conduct research under the supervision of their academic advisors.

IBIO711/PHYS712A Advanced Bio-imaging

The course helps students to understand the principles of microscopy, one of the most important research techniques in modern physics, chemistry and biology. Further the latest research methods utilizing it as well as its biological application will be explored.

IBIO712/PHYS712B Current Issues in Biological Physics

We aim to get some sense of current issues in biological physics.

IBIO801A-Z Special Topics in Systems Biology

Selected topics reflecting the latest trend in systems biological research will be dealt with in depth.

IBIO811A-Z Graduate Seminar

Seminars for graduate students, which are related to all areas of interdisciplinary Bioscience and Bioengineering are delivered by invited speakers.

IBIO899 Doctoral Dissertation Research

Students conduct research under the supervision of their academic advisors.
Division of Integrative Biosciences & Biotechnology

1. Programs Overview

The Division of Integrative Biosciences and Biotechnology (IBB) offers a multidisciplinary graduate program that conducts R&D and produces world-class talents equipped with quantitative, systemic, integrative thinking abilities through basic understanding, analysis and application of various biological phenomena, and a coursework that integrates basic science with engineering. The graduate program offers the curriculum in two tracks: Bioscience Track and Biotechnology Track.

1) Integrative Bioscience Track: The Bioscience Track provides comprehensive education and research curriculum regarding biological phenomena from the single molecular level to the system level through theories, logic systems, technologies and quantitative methodologies developed in various areas including life sciences, chemistry, physics and computer engineering.

2) Integrative Biotechnology Track: The Biotechnology Track focuses on education and research for understanding biological phenomena and their applications by combining engineering methodologies such as bioengineering and mechanical engineering, knowledge and technologies. To this end, engineering analysis methods, tools as well as biological knowledge for engineering purposes are introduced.

2. Requirements for the Awarding of Degrees

- Integrative Program: Course Credits 27, Research Credits 33 (Overall 60 Credits)
- Doctoral Program: Course Credits 18, Research Credits 14 (Overall 32 Credits)

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<th>Type</th>
<th>M.S-Ph.D Integrated Program</th>
<th>Doctoral Program</th>
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<tbody>
<tr>
<td>Track</td>
<td>Bioscience</td>
<td>Biotechnology</td>
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<tr>
<td>Research</td>
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<td>Credits</td>
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</table>

- Considering the nature of the multidisciplinary program and the diversity and speed of advancement in study areas and the principle of personalized coursework designed for individual preference, 60 credits are required for Integrative (27 course credits and 33 research credits). 32 credits are required for Doctoral program integrative program (18 course credits and 14 research credits)
3. Course Description

**IBBT501/MECH534 Integrative Bio-Imaging Technology**............................ (3-0-3)

The course is designed to present the state-of-the-art technology for high resolution imaging of the micro structure of living organisms. The course also offers in-vivo dynamic research of the micro structure of cells and living organisms.

**IBBT502 Integrative Membrane Biology**............................ (3-0-3)

This course covers both basic and advanced level topics related to biological membrane systems and their components, lipids and membrane proteins. Topics include lipid metabolism and transport, lipid signaling, membrane trafficking, membrane domains, membrane proteins, membrane-cytoskeleton interactions, membrane-protein interactions, cell-cell communication, and methodologies to study biological membranes.

**IBBT504/LIFE502 Advanced Biochemistry**............................ (3-0-3)

This course explores the structures and regulation of receptors and ionic channels, and the molecular regulatory mechanisms of factors in signal pathways that emanate from them. In addition, the principles of enzyme chemical structures, functions, and application and related metabolic pathways and their significance as well as contemporary research techniques are addressed. In particular, emphasis is placed on enzyme kinetics, reaction mechanisms, and active sites, labeling and determination techniques, structural relationships among active inhibitors and active sites, and the modification of enzymes using genetic engineering and gene expression.

**IBBT505/LIFE505 Neurobiology**............................ (3-0-3)

This course explores the basic principles of the organization and reactions of the nervous systems of various life forms. In particular, emphasis is placed on neurocytology, the structure of the nervous system, the development of nerves, and the biochemical mechanisms of action potential and transmission and of sensory transduction.

**IBBT506/LIFE511 Cellular Signaling**............................ (3-0-3)

This course comprehensively explore the basic principles of regulating hormones, neuro-transmitters, growth factors, and cells’ reactions to changes in the external environment, components of receptors, switches, amplification systems, and molecular networks on a molecular level, various forms of signal transduction, as well as the growth, development, differentiation, and death of cells.

**IBBT507 Current Topics in IBB**............................ (3-0-3)

For a good understanding of overall research programs and integration in the division, in this class each faculty member will introduce graduate students, in particular freshman, his/her current research topics and their efforts for integrative studies with other faculty members.

**IBBT513/LIFE518 Proteins and Proteomics**............................ (3-0-3)

This course covers advanced-level topics on proteins and proteomics. Topics include protein structure, stability, regulation, folding, interactions, dynamics, modification and degradation.
IBBT514/LIFE515 Biology of Aging

The goals of this course are to provide a broad overview of the principles and applications of optical technologies that are being widely used or newly emerging in various scientific fields. It also introduces students cutting-edge imaging and research tools to allow unprecedented biological research performed with cells in living subjects and to develop new ways to diagnose diseases. Accordingly, the course is open to under and graduate students with diverse backgrounds, such as material science, and mechanical engineering and physics, as well as biological sciences, who wish to learn one of fastest-developing techniques for biological research and medical intervention.

IBBT515/LIFE509/IBIO518 Advanced Cell Biology

This course explores the structures of cells in relation to their functions, analysis of observations using optical and electron microscopes, and techniques for verifying the distribution of target proteins in cells using marked antibodies.

IBBT516/MECH532 Tissue Engineering for Mechanical Engineers

Tissue engineering is the use of a combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to improve or replace biological functions. This course teaches fundamentals that span several academic areas related to tissue engineering to students who have a mechanical engineering background, and introduces various approaches to research. Topics include basic cell biology, chemistry, bio-materials, anatomy, computer-aided design/computer-aided machining (CAD/ CAM), and manufacturing technology. Various mathematical and mechanical tools for simulating cell behavior are introduced. In addition, basic experimental laboratory instruction covers cell culture and scaffold fabrication.

IBBT517 Signal Transduction and Metabolism

Cell signalings are basic concepts for the understanding of energy homeostasis and control mechanism in living organisms. Especially, the relationships between the principles of signal transduction and the metabolic diseases such as diabetes and obesity will be focused to learn current trends and future subject of research in this area.

1) The components and principles of signaling for major receptors, switches, 2nd messengers, protein kinases and scaffolds.
2) The machineries and mechanisms for the control of energy homeostasis in living organisms.
3) Current trends in the researches on the disorders in metabolism and diseases such as diabetes and obesity.

IBBT518/LIFE570 Translational Research in Plant Science

Knowledge obtained from Plant science can be applied to improve the quality and quantity of food, energy, and to protect environment, and thus is becoming more and more important for our everyday life and world economy in 21st century. This course explores the current translational researches which attempt to connect the knowledge from basic plant science to application fields such as agriculture, industry, and environment. The course will consist of lectures from professors and student presentations. Occasionally invited speakers will give a lecture to the students in the class.

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IBBT519 Integrative Immunology
The course is designed to focus on basic and integrative Immunology for students who do not have immunology background (Beginner’s Immunology for engineering background).

IBBT520 Translational Immunology
In this course, students will learn how basic immunology research is translated and applied in the biomedical field for prevention and treatment of various diseases. The topics include monoclonal antibody therapy, cancer immunology, vaccination, immuno-suppressive drugs, transplantation, etc.

IBBT521 Integrative Bioscience Methodology
To understand diverse biological events, it is required to approach the scientific problems through integration of different disciplines. In this course, the recent published papers covering the interaction among nucleic acids, proteins, and lipids by state-of-art technologies will be introduced and discussed.

IBBT522 Cancer Immunology
From an immunologic perspective, cancer cells can be viewed as altered self cells that have escaped normal growth-regulating mechanisms. Cancer cells are comprised of a heterogeneous cell population including cancer stem cells which are less differentiated and dividing slowly, accounting for drug resistance and thus the recurrence of many cancers. Tumor cells display tumor-specific antigens and the more common tumor associated antigens, which could be recognized by T cells and antibody. The tumor-specific immunity includes not only soluble cytotoxic factors such as TNF but also CTL-mediated lysis, NK-cell activity, and ADCC. However, cancer cells have developed several strategies to evade our immune system. Cancer immuno-therapy includes cell-based cancer vaccines and monoclonal antibodies directed against tumor antigens. Currently, key challenges in designing effective strategies for cancer immuno-therapies are the identification of tumor-specific antigens, the development of efficient way for presenting tumor antigens, and generation of strong humoral and cellular immunity.

IBBT523 Introductory Integrative Bioscience
This course is intended to provide engineering graduate students with basic knowledge of biology and covers an introductory topics on biochemistry, molecular biology, and cell biology.

IBBT524 Introduction to Bio-Mechanical Engineering
This course is to provide introduction of bio-engineering related researches conducted by professors in mechanical engineering. This course will cover individual research topics such bio-dynamics, tissue engineering, bio-sensor technology, optical imaging technology with basic engineering principles of solid mechanics, dynamics, fluid mechanics.

IBBT525/CHEM532 Advanced Inorganic Chemistry II
This course focuses on transition metal based organometallic compounds. The concept of ligands and the rules of their coordinations to transition metals are introduced, which further provides concrete understandings about their optical, electrical, magnetic properties. The synthesis, chemical reactivity, characterization methods are also covered. In the last part, currently rising hot topics in materials chemistry are introduced.
IBBT526/LIFE516 Plant Molecular Cell Biology ................................................................. (3-0-3)

In this subject, students will learn the organization of the eukaryotic cell, physiological roles of organelles, operating principles of eukaryotic cells, and the theory/hypothesis on the cellular evolution. Furthermore, students will learn the mechanism of protein translation, protein targeting to the ER, chloroplasts and mitochondria, protein trafficking between endo-membrane compartments, and proteins and lipid molecules involved in the protein trafficking. This class will consist of lectures, presentation and group discussion.

IBBT527 Integrative Plant Physiology ................................................................. (3-0-3)

This course will introduce students to current findings and thinking in plant physiology, with a focus on development. The role of the basic plant hormones and light in controlling morphogenesis and physiology will be covered at the advanced level, with an emphasis on the most recent findings. Oral presentations from the primary literature will be a required part of student participation, with all activities in English. Students will present orally, and with appropriate visual aids, a paper that they will first outline and then critique in class. This will include analysis of what the primary questions are that were addressed in the paper and how far the authors went in obtaining the answers, what techniques were used and their appropriateness, and what follow-up work might be. This will be led primarily by the presenter(s), with contributions from the class, and moderated and guided by the instructor.

IBBT529 Plant Physiology ........................................................................................................... (3-0-3)

This course explores photosynthesis, metabolism, growth, reactions to the environment, plant-microbe interrelations, genesis, control and regulation, and hormonal reactions.

IBBT530 Principles in Oncology ........................................................................................................... (3-0-3)

This course introduces principles in Oncology covering from the cellular and molecular levels to tissue levels including those in cancer patients. Particularly, students will learn how tumor microenvironment impacts cancer therapy and how chemotherapy and radiotherapy exert their anticancer actions at the tissue, cellular, and molecular levels. Students will also be exposed to some of the newest trends in Oncology including metastasis and cancer stem cells.

IBBT601/LIFE503/IBIO658 Advanced Immunology ....................................................................... (3-0-3)

This course explores the principles of and techniques for conducting research on immunity and application for the resolution of major biological problems. In particular, emphasis is placed on the reactions of antigens and antibodies, immuno assay, structures and reactions of immuno-globulins, genes governing the immune system, processes through which antibodies are formed, principles of cell-mediated immunity, complements, tolerance, and transplantation, and techniques for producing and applying monoclonal antibodies.

IBBT602/IBIO613/MECH598 Bio Dynamics .................................................................................. (3-0-3)

Bio-dynamics deals with the living bodies in a view point of principles of mechanics. Especially treat the human body as biological and physiological object together with an applied engineering area. This course will cover related theories and analysis, and introduce up-to-date research trends. It also introduce in the areas of medical science, life-science, chemistry, mechanical engineering and chemical engineering, and the relationship between these areas.
IBBT603 Meso-Biology

This course introduces the structures and function of cellular meso (the size in tens and hundreds of nano-meters) architecture (cell organelles, vesicles, membrane signaling stations etc.) and explores the methodology for study of their biological functions.

IBBT604/IBIO616/MECH624 Biofl Mechanics

Fluid flow in animals and plants including the circulatory motion in cardio-vascular system are studied. Rheological behavior of blood and blood cells are analyzed based on fluid dynamic principles, and then applied to the understanding of the causes and possible treatments for diseases with heart and circulatory system.

IBBT605/LIFE601/IBIO652 Advanced Molecular Biology I

This course explores in depth DNA replication in lower cells, genetic recombination, DNA repair, structures and functions of genes, transposable elements, and gene expression regulation through the latest research and literature.

IBBT608/IBIO614 Interdisciplinary Biosciences

This course introduces life science related adjacent academic areas for cooperative research and helps students choose research topics.

IBBT609 Advanced Biotechnology

The course analyses the emerging biotech industry, its prospects and research directions. In addition, the course introduces basic and novel technologies in biotech industry.

IBBT610 Experimental Biophysical Chemistry

This course is to covers experimental insights and techniques to understand the phenomenon of life. Specifically, this course provides the basic biochemical and biophysical concepts, relation between structure, chemistry and property of bio-macromolecules (DNA, Protein, Carbohydrate, Bio-mimetic polymer).

IBBT615/LIFE606 Advanced Plant Cell Biology

This course explores in depth unique structures and functions of plant cells and examines the latest accomplishments, trends, and developments in research in this field. Recommended prerequisite: LIFE 506 Plant Physiology.

IBBT616/LIFE607 Plant Functional Genomics

This course explores techniques for conducting research on plant genome. In particular, emphasis is placed on rapidly developing areas of study including gene isolation, mutation induction, genome mapping, proteomics, and bio-informatics through an examination of the latest literature. Prerequisite: LIFE 510 Plant Molecular Biology.

IBBT618/LIFE619/IBIO638 생물정보학 (Bioinformatics)

This course addresses ways of searching for and analyzing DNA and protein information, as well as providing insight into biological literature and the latest trends in and the future of bioinformatics.
IBBT622A-Z Special Topics in Integrative Biosciences and Technology\hspace{0.5cm}(3-0-3)
This course explores special topics in integrative biosciences and biotechnology as the professor’s discretion.

IBBT623/IBIO611 Advanced Systems Biology\hspace{0.5cm}(3-0-3)
A novel feature of the graduate level course is an integrative analysis of complex biological systems. The course aims to develop fundamental principles for systems approaches: 1) formulation of key biological problems, 2) technologies for global data-sets and 3) computation for modeling and analysis via mining of such global data-sets and 4) integration of such data-sets with other relevant data. In the first half of the course, the course takes a rigorous mathematical approach with emphasis on the development of application of modern mathematical and computational methods. In the second half of the course, the course takes to develop basic principles to study spatio-temporal behaviors of biological systems via data integration at the system level.

IBBT624/IBIO617/MECH646 Nanobiotechnology\hspace{0.5cm}(3-0-3)
This course is designed to explore the conversion and material transport of fine energy, related devices and behaviors through the mechanical, material, physical, chemical, and biological analysis of fine bio-materials and reactions. This course further discusses cases of Bio-MEMS devices and Micro/Nano Electro Mechanical Systems development for the high throughput analysis and treatment of fine bio-materials and related scientific and technological issues.

IBBT625/CHEM624 Organic Synthesis Chemistry\hspace{0.5cm}(3-0-3)
This course deals with design and synthesis of organic compounds such as natural products, various application of organic reactions, and synthetic application of stereochemistry.

IBBT699 Master Thesis Research\hspace{0.5cm}(1-9)
As a partial fulfillment of a master degree, an independent research for a master thesis is conducted under the guidance of a designated thesis advisor.

IBBT702/LIFE701 Methods in Plant Molecular Genetics\hspace{0.5cm}(1-4-3)
In this course, students explores various techniques in plant molecular genetics through lectures, discussions, and experiments.

IBBT703/LIFE616 Biocommunications\hspace{0.5cm}(3-0-3)
This course explores the molecular principles and diversity of cell–molecule interactions in multicellular life forms. Particular emphasis is placed on receptor ligands, which are the key molecular mechanisms that form the basis of intermolecular recognition for the regulation of cellular functions and signal transduction, the functional modules and motifs of signal proteins, and unique molecular interaction through lectures and presentations. In order to enhance students’ mathematical and bio-informational understanding of communication in bio-systems consisting of such components, experts will give tutorial lectures.

IBBT704/LIFE703 Regulation of Gene Expression\hspace{0.5cm}(3-0-3)
This course explores DNA replication, chromosome stability, gene applicability, and regulation both before and after replication and before and after transcription.
IBBT718 Recent Topics in Immunology

This course explores the latest trends and hypothesis in immunology and students present their suggestion and discussion.

IBBT719 Current Advances in Immunology

The immune system provides protection from infectious agents and cancer. The immune system can be divided into innate and adaptive immunity, which are mediated by various types of cells, including T and B lymphocytes, antigen presenting cells, natural killer cells, neutrophils and basophils. The goal of this class is to highlight the recent advances in key topics in immunology, with emphasis in T cell biology. The topics will include T cell homeostasis, activation, differentiation and memory generation. Signals that regulate T cell biology, including from antigen presenting cells and innate immunity will also be discussed.

IBBT801A-Z Graduate Seminar

Seminars for graduate students, which are related to all areas of interdisciplinary Bioscience and Bioengineering are delivered by invited speakers.

IBBT899 Doctoral Dissertation Research

Graduate students working toward the Ph. D. degree are required to carry out Ph. D. dissertation research under the supervision of their thesis advisor.
Division of IT Convergence Engineering

1. Education Aim

The Division of IT Convergence Engineering (ITCE) is a multidisciplinary program focusing on the study of Autonomics, Communications & Networks, Nano Sensors & Systems, Biotechnology with an aim of increasing diversity in research and producing world-class researchers who are on the cutting edge of new research fields.

2. Program Overview

The Division of ITCE provides its researchers and students with an environment that encourages convergence studies and unprecedented collaboration of 4 different research areas, motivating them to engage in creating new research methods, technologies, and applications. Students will gain the latest knowledge of convergence engineering and receive hands-on training in research from distinguished professors home and abroad through a variety of academic activities such as international conferences. The Division of ITCE aspires to strengthen its researchers and students’ research capacity and international competitiveness through interdisciplinary research and collaboration with top research institutions in Korea and the world, ultimately contributing to the advancement of Korea’s science and technologies.

The Division of IT Convergence and Engineering applies a systematic management approach and offers its students an individually customized curriculum. All students are to choose and focus on one out of 4 given tracks, but they may take a wide range of courses from other tracks without being limited to the chosen track. Students are co-advised by a pair of academic advisors consisting of one POSTECH professor and one overseas professor on their research interests and academic courses: this will enable students to have a broader and more balanced knowledge of IT Convergence Engineering. With this firm educational foundation, students will become top-notch talents capable of dealing with convergence topics in the area of IT-NT-BT, developing interdisciplinary research methods, and dealing with international research management.

A. Track-focused Course Management

The Division of IT Convergence Engineering offers 4 tracks in order to maximize the impact of its interdisciplinary education: 1) Autonomics; 2) Communications & Networks; 3) Nano Sensors & Systems; and 4) Biotechnology. To effectively accommodate various academic needs and interests of students from diverse backgrounds, all students are required to take “Introduction to IT Convergence Engineering” and “Applications of IT Convergence” to gain a basic understanding of 4 different tracks: then, the electives may be taken from other tracks as well. To understand the convergence of IT-NT-BT, students in the MS/Ph.D integrated program and doctoral program must take more than 1 elective course from the other 3 tracks besides their own.
- **Track 1. Autonomics**
  Courses in this track introduce theories and technologies in computer networks, software engineering and machine learning to equip the students with the knowledge and skills necessary to design and realize an autonomous system with the least human participation. Education and research activities in the Autonomics track will allow students to acquire an in-depth understanding of areas including but not limited to knowledge representation, sensor network communications, analysis using nano sensors, bio-informatics based data, system security, and design of architecture.

- **Track 2. Communications & Networks**
  The goal of the Communications and Networks track is to train students to understand the basic concepts and advanced theories in Communications and Networks area and to aptly employ them for various applications. Main topics include novel modulation/encoding/decoding/demodulation schemes for high-speed multi-antenna systems, the analysis of networking protocols for secure data transport over wireless and wired networks, and the optimization of network control algorithms.

- **Track 3. Nano Sensors & Systems**
  The Nano Sensors & Systems track aims to employ the research and technology development in nano-science, nano-technology and nano-engineering to create innovative sensing, electronic, mechanical and fluidic components for low-cost, integrated and miniaturized systems for the existing as well as future needs in U-Health and U-Environment. The track offers courses for education and research in information technology, nano and bio-nano areas and related fields such as ultra-low power wireless transceivers, “intelligent” signal processing hardware and software, novel memory architectures and bio-sensing systems that will be incorporated into prototypical autonomic systems for U-Health and U-Environment.

- **Track 4. Biotechnology**
  This track aims to broaden the understanding of structures and systems, such as signal transduction, in a cell, cell division, and genetic expression that would be the sources used in the ubiquitous healthcare system. Particularly, this track aims to help students explore and understand various phenomena for biochemical process from a molecular level to system level, such as map forming and memory, and develop and use mathematical methods to interpret and examine them.
### B. Guidelines for Degree Requirements

<table>
<thead>
<tr>
<th>Degree Program</th>
<th>Credits</th>
<th>Remark</th>
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<tbody>
<tr>
<td></td>
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<td>- Research credits may be fulfilled by Master’s thesis/Doctoral dissertation research courses and Seminar courses.</td>
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<td></td>
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<td>- “Seminars in IT Convergence Engineering” is a mandatory course that must be taken for 2 semesters by all ITCE students who entered the program in or after the academic year of 2012. The requirement for “ITCE800A Seminars in IT Convergence,” however, may be substituted by other seminar courses offered by the ITCE-related departments such as the department of computer science, electrical engineering, and/or life sciences.</td>
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<tr>
<td></td>
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<td>- Course credits may be fulfilled by:</td>
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<td></td>
<td></td>
<td>1) ITCE courses</td>
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<td>2) Graduate-level courses from other departments at POSTECH</td>
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<td></td>
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<td>3) 400-level undergraduate courses at POSTECH (up to a total of 6 credits to be counted toward a graduate degree).</td>
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<thead>
<tr>
<th>Degree Program</th>
<th>Course</th>
<th>Research</th>
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<tr>
<td>Master’s program</td>
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<td>Doctoral program</td>
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<tr>
<td>MS/PhD Integrated program</td>
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### C. Credit Requirements for Degree

<table>
<thead>
<tr>
<th>Degree</th>
<th>Major requirement</th>
<th>Electives in one’s own track</th>
<th>Electives in other tracks</th>
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<td>Master’s</td>
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<tr>
<td>Doctoral</td>
<td>6*</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>M.S-Ph.D Integrated</td>
<td>6*</td>
<td>12</td>
<td>6</td>
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</tbody>
</table>

- For students who entered in the year of 2009 and 2010, the minimum requirement is 3 credits instead of 6 credits.
- Students must complete the respective minimum number of credits to fulfill the credit requirements for a degree.
- Students may be exempted from completed the ITCE major required courses only if they have taken the courses as part of their previous degree requirements.
### 3. Course Description

#### A. Course List

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<th>Classification</th>
<th>Course No.</th>
<th>Title</th>
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<td>Introduction to IT Convergence Engineering</td>
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<td>ITCE600</td>
<td>Applications of IT Convergence</td>
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<td>ITCE501/EECE700L</td>
<td>Autonomic Systems</td>
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<td>ITCE502</td>
<td>Ontologies and Semantic Reasoning</td>
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<td>ITCE503/EECE700M</td>
<td>Information and Data Modeling</td>
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<td>ITCE504/EECE515</td>
<td>Machine Learning</td>
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<td>ITCE505/EECE524</td>
<td>Probabilistic Graphical Models</td>
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<td>Elective</td>
<td>ITCE601/EECE600</td>
<td>Distributed Processing</td>
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<td>ITCE602/EECE702R</td>
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<tr>
<td>Autonomics)</td>
<td>ITCE603/EECE702R</td>
<td>Self-Protection System</td>
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<tr>
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<td>ITCE604/EECE607</td>
<td>Network and Service Management</td>
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<td>ITCE606</td>
<td>Knowledge Representation, Reasoning and Inferencing</td>
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<td>ITCE607</td>
<td>Advanced Semantic Reasoning and Applications</td>
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<td></td>
<td>ITCE710A/Z</td>
<td>Special Topics in Autonomics</td>
<td>Variable</td>
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<td>Elective</td>
<td>ITCE520/EECE609</td>
<td>Introduction to Random Variable and Process</td>
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<td>(Track2,</td>
<td>ITCE21/EECE576</td>
<td>Statistical Communication Theory</td>
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<td>Comm.&amp;</td>
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<td>Human Body Communication and Networking for Convergence Engineering</td>
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<td>Networks)</td>
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<td>Mobile Networks</td>
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<td>ITCE622/EECE626</td>
<td>Multimedia Networking</td>
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<td>ITCE623/EECE663</td>
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<td>ITCE624/EECE668</td>
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<td>ITCE720A/Z</td>
<td>Special Topics in Communications &amp; Networks</td>
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<td>Systems)</td>
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<td>RFIC Design</td>
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<td>ITCE545/EECE570</td>
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<td>Semiconductor Electronics II</td>
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<td>ITCE640</td>
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<td>ITCE642/EECE598</td>
<td>Advanced Nano Devices</td>
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<td>ITCE643</td>
<td>CMOS Circuits for Sensor Interface</td>
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<td>ITCE644</td>
<td>Nano Bio Sensor Engineering</td>
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<td>Sensor Technology for Convergence Engineering</td>
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<td>ITCE740A/Z</td>
<td>Special Topics in Nano Sensors &amp; Systems</td>
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2017 Division of IT Convergence Engineering

4. Course Description

**ITCE500 Introduction to IT Convergence Engineering** ................................................................. (3-0-3)

This course generally introduces Autonomics, Communications & Networks, Nano Sensors & Systems, Biotechnology and other related studies and focuses on possible creative research areas so that students can choose their research themes.

**ITCE501/EECE 700L Autonomic Systems** .................................................................................. (3-0-3)

This course is intended for the students who are interested in understanding autonomic systems. First, the need and motivation for autonomic systems will be described. Next, we will review different autonomic architectures from the US, Europe and Asia, emphasizing core mechanisms such as control loops, management abstractions, and how sensors and effectors interface the autonomic manager to the entity being managed. We will then examine the salient features of representative autonomic systems, and augment this with practical examples based on our WCU ITCE program, and discuss potential research topics for automics graduate students. The course will conclude with examples that explain how to manage different types of systems, how to enable business needs to drive the management of systems and services, and how to orchestrate behavior.

**ITCE502 Ontologies and Semantic Reasoning** ......................................................................... (3-0-3)

This course is intended for researchers and practitioners who are interested in designing ontologies to support knowledge engineering and management for use in semantic reasoning. This course emphasizes an understanding of the fundamentals required to build robust conceptual models using ontologies.

**ITCE503/EECE700M Information and Data Modeling** ............................................................ (3-0-3)

This course provides a detailed understanding of object-oriented information and data modeling, and how to use models to represent, analyze, and act on knowledge. This course gives a deeper
insight into the foundations of modeling, and emphasizes the use of modern software engineering practices, such as patterns, to represent and process information for common modeling problems. A detailed review of object-oriented information modeling fundamentals will be conducted, followed by hands-on experience in building different types of models for various applications ranging from well structured use cases to ad hoc design. Elements from our WCU ITCE program will be used as examples for students to build, analyze, and optimize models throughout the course to reinforce the theory learned.

**ITCE504/EECE515 Machine Learning**

Machine learning is the study of computer algorithms that allow computers to "learn". It is a method of creating computer algorithms such that computers are able to perform pattern recognition, prediction, decision, and so on. This introductory course on machine learning will address mathematical and statistical methods involving current statistical machine learning as well as various applications. Topics to be covered include density estimation, Bayes decision theory, latent variable models, mixture models, discriminant analysis, clustering, classification, dimensionality reduction, regression, kernel methods, VC-dimension, HMM, MLP, RBF, etc. Main focus will be given to statistical and probabilistic methods for machine learning, involving supervised, unsupervised, and semi-supervised learning.

**ITCE505/EECE524 Probabilistic Graphical Models**

Probabilistic graphical models are a happy marriage between probability theory and graph theory, providing a flexible and powerful tool for the design and analysis of machine learning algorithms when uncertainty and complexity are involved. This course offers an introduction to graphical models, emphasizing both theories and applications. Trees, factor graphs, undirected/directed graphs are considered, where nodes are associated with random variables. Probabilistic inference (belief propagation) and statistical estimation methods are introduced for graphical models.

**ITCE520/EECE576 Statistical Communication Theory**

Prerequisite: Undergraduate level Probability theory, Signal and systems, Linear algebra
- Review the basic principles of linear analysis, probability, statistics, and random processes
- Learn the analysis of linear and nonlinear systems with random inputs.
- Learn the design of systems that satisfy some statistical conditions for signal detection and waveform estimation
- Learn about how the information theory is applied to communication systems
- Learn the properties of noise in the communication systems

**ITCE521/EECE700O Human Body Communication and Networking for Convergence Engineering**

In this course, students will learn short-range wireless network solutions for personal and body area networks. Topics include network topologies, protocols, and industry standards for these networks such as Bluetooth, ZigBee, 802.15.3, and 802.15.4. They also include ultra low-power...
signal processing, RF communication near or in body networks, security provisions, and data fusion techniques. Personal and body area network scenarios and applications are also discussed.

**ITCE540 Introduction to Nano Technology**

This course provides in depth understanding of nano-technologies including nano-electronics, functionalized carbon nano-tubes or nano-wires, and MEMS. The biomedical application like Biological field effects transistors (BioFETs) is covered in the course as well.

**ITCE541/EECE560 Nano Electronics**

This course covers analysis of semiconductor surface, quantum state, conduction mechanism at surface, optical properties and elastic properties, surface processing technique and device application.

**ITCE542/EECE593 Microwave Active Circuits**

This course covers the basic concept of microwave active circuit designs such as s-parameter, two port network, matching circuit and gain/stability of transistor based amplifier. Then, the circuit design methodology for the important functional blocks of microwave transceivers such as broadband amplifiers, LNA, power amplifier, microwave mixer and power oscillator is studied.

**ITCE543/EECE596 RFIC Design**

The important RFIC chip design methods for the transceiver of the wireless communication system are studied. First, the transceiver architecture of the system is described. Then, the important functional blocks of the transceiver are covered. They include passive component design, LNA, mixer, oscillator and phase noise, and frequency synthesizer.

**ITCE544/EECE569 Analog Integrated Circuits**

Covers CMOS analog integrated circuit design techniques using hand analysis and SPICE simulation, reviews the operation of single transistor amplifiers such as CS/CG/CD amplifiers, frequency response and stability, noise analysis, band-gap voltage source and current source bias circuits, single-ended and fully-differential CMOS OP amp circuits, switched capacitor filter, phase locked loop and delay locked loop.

**ITCE545/EECE570 Digital Integrated Circuits**

Covers CMOS digital integrated circuit design techniques using hand analysis and SPICE simulation. Operation of CMOS inverter circuit, static logic circuit, dynamic logic circuits such as domino NORA and TSPC, pass transistor and differential logic circuits, VLSI building block circuits such as adder multiplier and data path, low power circuit technique, memory circuit such as ROM Fash memory SRAm and DRAM.

**ITCE546/EECE401 Semiconductor Electronics II**

Based on the Semiconductor Electronics course 1, students will learn a more detailed knowledge of Semiconductor technology. This course will cover P/N Junction, Hetero-junction, Bipolar transistor, MOSFET, nano-scaled CMOS HBT and HEMT.
ITCE560/MOLS619 Bioinformatics ................................................................. (3-0-3)
This course addresses ways of searching for and analyzing DNA and protein information, as well as providing insight into biological literature and the latest trends in and the future of bio-informatics.

ITCE561/MOLS502 Advanced Biochemistry .................................................. (3-0-3)
This course explores the structures and regulation of receptors and ionic channels, and the molecular regulatory mechanisms of factors in signal pathways that emanate from them. In addition, the principles of enzyme chemical structures, functions, and application and related metabolic pathways and their significance as well as contemporary research techniques are addressed. In particular, emphasis is placed on enzyme kinetics, reaction mechanisms, and active sites, labeling and determination techniques, structural relationships among active inhibitors and active sites, and the modification of enzymes using genetic engineering and gene expression.

ITCE562/MOLS515/IBIO655 Biology of Aging ....................................................... (3-0-3)
The focus of this course is on current understanding of aging process at an organismic level. Emphasis is placed on genetic control mechanisms that regulate aging and age-related diseases. Moreover, students will discuss key molecular signaling pathways that regulate aging processes, which are conserved across phyla.

ITCE563/IBIO614 Frontiers of Interdisciplinary Biosciences ..................................... (3-0-3)
The course helps students choose research topics.

ITCE564/IBIO615 Advanced Bioengineering .................................................... (3-0-3)
The course analyses the emerging biotech industry, its prospects and research directions. In addition, the course introduces basic and novel technologies in biotech industry.

ITCE565/MOLS508 Advanced Developmental Biology ......................................... (3-0-3)
This course explores the mechanisms through which the fertilized egg develops into an entity composed of various cells, tissues, and organs.

ITCE566/MOLS517/IBIO528 Advanced Molecular Genetics ............................... (3-0-3)
This course is designed to help students learn recent exiting advances in the molecular genetics. The topics include functional genetics, model organisms, molecular genomics. In addition, students will discuss breakthrough findings in the molecular genetics field.

ITCE600 Applications of IT Convergence .......................................................... (3-0-3)
In this course, students will learn how to perform research to support their projects which were defined and specified in ITCE500 Introduction to IT Convergence Engineering. The project will culminate in a submission of a conference or journal paper submission. The course will provide a set of 4 soft skills lecture on scientific databases, scientific publishing, project management.

ITCE601/EECE600 Distributed Processing ....................................................... (3-0-3)
This course will study the fundamental aspects of modern distributed systems. Issues concerned with distributed systems such as transparency, communication, resource sharing, fault tolerance,
scalability, consistency, and security as well as those concerned with designing, developing, and managing distributed applications and services will be covered in this course. Special emphasis will lie on emerging Peer-to-Peer computing.

**ITCE602/EECE702R Wireless Network Security** .................................................. (3-0-3)

Students will learn security principle and types of security adaption of wireless networks such as WWAN, WLAN, WPAN, MANET. The security issues are handled in the respect of prevention and protection. The aim of the subject is to focus on fundamental issues regarding wireless network security and to make the students’ own researches possible.

**ITCE603/EECE702E Self-Protection System** .................................................. (3-0-3)

The course deals with the principles and methods of self protection system to the unknown security intrusion from inner/outer system. The course studies detection of attack and intrusion, automatic detection of weakness, complementation of weakness, automatic learning about intrusion, and automatic backup etc. and the methods for reducing weaknesses.

**ITCE605/EECE607 Network and Service Management** .................................. (3-0-3)

The course will start with the fundamental concepts in network and service management, illustrated through a number of prominent frameworks. It will discuss key challenges in network and service management today and show how these problems are tackled with example techniques from both theoretical and system design perspectives. This course will also show autonomic networking as a principle design objective in dealing with the current network and service management complexity.

**ITCE606 Knowledge Representation, Reasoning and Inferencing** ....................... (3-0-3)

This course focuses on approaches relating to representing different data in a common way, which is crucial for reasoning and planning for solving problems in autonomic systems. The course illustrates the importance of (1) defining a common form for relating different information from different sources to derive a combined understanding of a managed entity, (2) transforming the common representation of knowledge to a form amenable to efficient reasoning, and (3) adding constraints for performing intelligent search and planning.

**ITCE607 Advanced Semantic Reasoning and Applications** .......................... (3-0-3)

This course explains how to apply semantic reasoning provided by autonomic systems to build systems for current and Future Internet applications. This course starts by reviewing finite state machines, and then using finite state machines to model formal as well as natural languages.

**ITCE620/EECE608 Advanced Computer Networks** ....................................... (3-0-3)

The main goal of this course is to study advanced topics on network technologies. The course begins with the basic concepts and techniques on computer networks, and then covers technical details in advanced topics on computer networks. This course also covers the state of the art protocols in networking technology.

**ITCE621/EECE620 Mobile Networks** ............................................................... (3-0-3)

Recently diverse wireless mobile networks are deployed. This course provides an in-depth
understanding of the fundamental problems in the area of mobile networks and studies the state of the art solutions to solve the problems. This course also covers many important issues in the area of wireless mobile networks.

**ITCE622/EECE626 Multimedia Networking** ................................................................. (3-0-3)

This course deals with the basic concepts that multimedia data can be effectively transferred through wire and wireless network. The course specifies media control technology considering networks and network control technology regarding media, introducing the best suitable technology which can connect those technologies.

**ITCE623/EECE663 Estimation Theory** ............................................................................. (3-0-3)

This course introduces the conventional linear estimators in frequency and time domains. In the algorithm point of view, two issues associated with the number of computations and the numerical stability are addressed and the modified estimators are provided. Furthermore, modern estimators, mainly designed with linear programming, are tackled under mixed criteria.

**ITCE624/EECE668 Robust Control** .................................................................................. (3-0-3)

This course summarizes modern techniques, based on linear system theories, for analyzing and synthesizing linear and even nonlinear systems. Especially, so-called LMI (linear matrix inequality), belonging to convex conditions, are used to design robust controllers against non-linearities or uncertainties under various criteria.

**ITCE640 Low Power Integrated Circuits** ........................................................................ (3-0-3)

The low power design of CMOS Integrated circuits is essential to implement the low power sensor networks. The class starts with the review of the CMOS device physics with the emphasis on the sub-threshold operation. It covers the low power analog circuits such as OP amps, switched capacitor circuits, continuous time filters, analog-to-digital converters and RF circuits. It also covers the low power design technique of digital circuits including low power logic circuits and SRAMs.

**ITCE641 Semiconductor Theory** ..................................................................................... (3-0-3)

This course provides a fundamental and in-depth knowledge of the theory of operation, modeling, parameter extraction, scaling issues, and higher order effects of active semiconductor devices that are used in mainstream semiconductor technology and emerging devices of practical interest. There will be a comprehensive review of the theories and latest models for the devices that are valid out to very high frequencies and the use of physical device modeling. A review of the latest device technologies and architectures will be presented. The course will be a prerequisite to the other applied courses in nano-technology, nano-electronics and photonics.

**ITCE642/EECE598 Advanced Nano Devices** ............................................................... (3-0-3)

This course covers recent developments of nano-devices. Lectures focus on basic device fundamentals, second order effects, fabrication processes, characteristics, and reliability of novel devices. Through term project assignments, students are expected to gain an understanding of advanced electron devices.
ITCE643 CMOS Circuits for Sensor Interface ................................................................. (3-0-3)

The operation principles of the sensors for monitoring the human body or the environment will be introduced. The low power circuit techniques will be studied by using the CMOS technology. The front-end analog amplifier, filter, analog-to-digital converter, microprocessor, memory and RF circuits will be covered.

ITCE644 Nano Bio Sensor Engineering ................................................................. (3-0-3)

The operation principles of the nano-semiconductor devices and the bio-medical sensors are covered. The application examples of the nano-devices to bio-medical applications will be studied.

ITCE645 Sensor Technology for Convergence Engineering ........................................... (3-0-3)

Sensors are small devices, in a sense, designed to replace bulky analytical instruments to meet various needs in chemical, environmental, biomedical, agricultural, and several other industries. This course will discuss how micro and nano-technologies have been shaping the sensor design and development. Development of sensors that are small, consume little power and inexpensive is key to realize the goals of U-health and U-Environment initiatives which are becoming common across the world.

ITCE699 Master Thesis Research ............................................................................. (1~9)

A research course for Master’s thesis.

ITCE710A/Z Special Topics in Autonomics ................................................................. (Credits can vary)

This course covers the new theory and topics of the Autonomics area.

ITCE720A/Z Special Topics in Communications & Networks ........................................ (Credits can vary)

This course covers the new theory and topics of the Communications & Networks area.

ITCE740A/Z Special Topics in Nano Sensors and Systems .......................................... (Credits can vary)

This course covers the new theory and topics of the Nano Sensors and Systems area.

ITCE760A/Z Special Topics in Biotechnology ............................................................. (Credits can vary)

This course covers the new theory and topics of the Biotechnology area.

ITCE800A/Z Seminars in IT Convergence Engineering ................................................ (Credits can vary)

This course consists of seminars on recent developments in various topics.

ITCE899 Doctoral Dissertation Research .................................................................... (1~9)

A research course for Ph.D. thesis
Division of Advanced Materials Science

1. Education Aim

The program of the Division of Advanced Materials Science aims to educate students to be world-class scientists with research capabilities in the development of new functional materials and device platforms through interdisciplinary research and study. To fulfill the mission, the division provides students with an environment for competitive research and a track-based educational curriculum designed to maximize exposure to key areas of technology across a complementary set of subject areas: physics, chemistry and materials science.

2. Program Overview

The program consists of three tracks: Materials Chemistry, Materials Physics, and Device Materials. Each student chooses one of the tracks based on his or her research interests.

- Materials Chemistry: The track provides education for the syntheses of novel nano-materials by self-assembly and self-organization, and their characterization, based on basic pivotal knowledge in chemistry.

- Materials Physics: The track provides education for understanding physical properties of new functional materials at atomic scales and fundamental characteristics of materials.

- Device Materials: The main objective in this track is to provide students with education for development of emerging device platforms for novel electronic/optical/magnetic/energy applications and their large-scale self-assembly within the framework of disruptive technology.

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<tr>
<th>Course</th>
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</table>

In the cases of Ph.D. program and M.S-Ph.D. integrated program, not only two core courses (6 credits) of a relevant track should be taken, but also 3 credits in courses of two other tracks should be obtained.

Each student will be co-advised by 2 professors (a major advisor/a minor advisor). Under the supervision of the major advisor, students will take courses and write a thesis. All of them are required to participate in the minor advisor’s research and obtain research credits for at least one semester before graduation.
If a POSTECH undergraduate student has completed some undergraduate courses that are part of our mandatory courses (or cross-listed courses as such) and enrolls in our division, the previously taken courses will be accredited. In addition, some mandatory electives should be taken to satisfy the total number of courses/credits for graduation requirements.

[Master’s program]
For a student to be qualified for submitting his/her thesis, in addition to taking credits required to complete a graduate curriculum, a proposal for thesis research should be submitted to and approved by the thesis reading committee one semester before filing the thesis. Students in this program must take a literature seminar and colloquium more than 2 times, respectively.

[Ph.D. program and M.S-Ph.D. integrated program]
For a student to be qualified for submitting his/her dissertation, in addition to submitting a proposal for dissertation research, he/she is to pass the qualifying examinations. The dissertation should be completed and approved by the dissertation reading committee. Students must pass the comprehensive examination (Ph.D. qualifying examination and an oral examination related to student’s major and their thesis or dissertation performed in English).

They are also required to publish at least 2 papers in an international academic journal approved by the division. At least one of the papers should be published in the first author (requisite).

Students in a Ph.D. program must take AMS literature seminar and colloquium more than 3 times, and those in an integrative program must take each course more than 4 times, respectively.

AMS offers degrees of Doctor of Philosophy (Ph.D.) in either science or engineering, which will be declared by students under the guidance of a major advisor during the oral presentation of their research plan.

3. Course Table

<table>
<thead>
<tr>
<th>Category</th>
<th>Area</th>
<th>Course No.</th>
<th>Title</th>
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<td>Quantum Mechanics I</td>
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<td>Device Materials</td>
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### 4. Course Description

**ADMS501 Nanoscience** ................................................................. (3-0-3)

This course aims to give a general introduction to contemporary subjects in nano-science and nano-technology.

**ADMS502/CHEM531 Inorganic Materials Chemistry** ........................................ (3-0-3)

Most inorganic materials are crystalline solids, therefore this course will start from the basic concepts of the solid state chemistry. Later on the structural features of the most important inorganic materials, common synthetic approaches for the material engineering as well as their properties and applications will be reviewed. Some recent trends and developments in inorganic materials will also be presented.

**ADMS503/CHEM552 Organic Materials Chemistry** ........................................ (3-0-3)

This course deals with the structure and property relationship of polymeric materials. Polymerization reaction, polymer kinetics and thermodynamics, characterization methods will be given.

**ADMS504/PHYS505 Quantum Mechanics** .................................................. (3-0-3)

An intermediate level quantum mechanics. The course will cover the basic principles of quantum mechanics, problems of various potentials, symmetry and conservation laws, scattering theory, perturbation theory, atoms and molecules, radiation, identical particle systems, and introductory relativistic quantum mechanics.
ADMS505/PHYS503 Electrodynamics ................................................................. (3-0-3)
Treated is an advanced level classical electromagnetism such as the statics of electromagnetism, Maxwell equations, special relativity, electromagnetic waves, motions of charged particles, and electromagnetic radiation.

ADMS506/PHYS401 Solid State Physics .......................................................... (3-0-3)
This course aims at basic understanding of physical phenomena in solids. Main topics covered in this course include crystal structures, lattice vibrations, electron dynamics in metals, thermal properties, and electronic band theory.

ADMS507/AMSE501 Advanced Thermodynamics of Materials .........................(3-0-3)
This course reviews the fundamental principles of thermodynamics and instructs the students their applications to real materials processing problems. The concepts of basic thermodynamic law, equilibrium, solutions, statistical thermodynamics, defects, surfaces and electrochemistry will be used to illustrate the role of thermodynamics in materials science.

ADMS510/CHEM510 Quantum Chemistry ....................................................... (3-0-3)
Fundamentals of quantum mechanics and its application to atoms and molecules. Topics include Schrödinger equation, matrix mechanics, uncertainty principle, molecular rotation and vibration, angular momentum, electronic structure of atoms and molecules, wave packets, and perturbation theory.

ADMS511/CHEM632 Supramolecular Chemistry ............................................. (3-0-3)
Synthesis and properties of supra-molecules composed of organic, inorganic molecules as well as bio-molecules are introduced in this course. The concepts of self-assembly and specific molecular recognition which are critical chemical routes for the formation of supramolecular structures are covered combined with the potential applications of supra-molecules towards energy storage, efficient catalysis, bottom-up generation of nano-scale electronic devices, etc.

ADMS513 Materials Chemistry ................................................................. (3-0-3)
The general aim of this course is to review the broad field of materials chemistry, starting from synthetic problems, methods of characterization and applications. The course will deal with chemical studies in modern materials emphasizing physical chemistry fundamentals, the interface between molecules and materials, the understanding of the interplay between molecular-level structure and functions of bulk materials.

ADMS514 Spectrometric Identification of Materials ....................................... (3-0-3)
This course provides guidance about how to identify materials, mainly organic compounds, from the synergistic information afforded by the combination of mass, infrared, nuclear magnetic resonance, and ultraviolet spectra. The features of this class are to learn not only the principles but also to provide plenty of practical quizzes to obtain deeper understanding.

ADMS515/CHEM551 Synthesis and Characterization of Macromolecules ..........(3-0-3)
An introductory course on polymer chemistry mainly dealing with various polymerization reactions and molecular characterization methods of polymers.
Nanochemistry deals with syntheses of various nano-materials and nano-structures and the characterizations thereof. This class intends to address syntheses and applications of recently developed nano-sized structures that include organics, semiconductors and metals. Students in this class shall understand recent nano-science and nano-technology, and thus develop capabilities leading principal researches at future careers in academia and industries.

This course provides a thorough background on chemical equilibria and related materials that are particularly important to analytical chemistry. These include: treatment of errors, chemical equilibria, classical methods of analysis, electrochemistry, spectrometry, kinetics, and separations.

This course is to provide 1 characterization methods that provide specific chemical bonding and geometrical structures of inorganic compounds and organometallic complexes. The topics include powder and single crystal X-ray diffraction, nuclear magnetic resonance, electron spin resonance, vibrational spectroscopy, and various surface characterization methods.

Introductory course of Polymer Science dealing with (1) polymerization reaction mechanism, kinetics and molecular weight distribution (2) molecular characterization methods mainly based on dilute polymer solution behaviors.

This course deals with syntheses of various functional nano-materials, nano-structures, and the characterizations thereof. This class intends to address syntheses and applications of recently developed ion and/or electron conducting nano-sized structures that include organics, semiconductors and metals, and thus develop capabilities leading principal researches at future careers in academia and industries.

This course provides a thorough treatment of the instrumental principles, terminology, methodology, and instrumentation 1 to analytical spectro-chemical methods. It also discusses specific spectro-chemical analysis techniques in terms of their implementation and characteristics, where appropriate, representative examples of practical applications of the techniques are given.

Topics include the Lagrangian and Hamiltonian formalism and its modern applications to nonlinear dynamics. The Lagrangian-Hamiltonian mechanics, the dynamics of the rigid body, the mechanics in the non-inertial coordinate systems and the theory of the special relativity are treated.
ADMS532/PHYS504 Electrodynamics II ................................................................. (3-0-3)
Treated is an advanced level classical electromagnetism such as the statics of electromagnetism, Maxwell equations, special relativity, electromagnetic waves, motions of charged particles, and electromagnetic radiation.

ADMS533/PHYS506 Quantum Mechanics II ............................................................ (3-0-3)
An intermediate level quantum mechanics. The course will cover the basic principles of quantum mechanics, problems of various potentials, symmetry and conservation laws, scattering theory, perturbation theory, atoms and molecules, radiation, identical particle systems, and introductory relativistic quantum mechanics.

ADMS534/PHYS601 Quantum Mechanics III ............................................................. (3-0-3)
required prerequisite: PHYS505, PHYS506
An advanced level quantum mechanics course. Topics include the Klein–Gordon equation, the Dirac equation, second quantization, the Feynman diagram and its applications, and introductory quantum field theory.

ADMS535/PHYS513 Advanced Statistical Mechanics .................................................. (3-0-3)
This course deals with equilibrium and nonequilibrium statistical mechanics with an emphasis on the latter. Linear response theory, temporal correlation functions, Boltzmann equation, transport phenomena, and the fluctuation-dissipation theorem are covered.

ADMS536, 537/PHYS521, 522 Solid State Physics I, II .................................................. (3-0-3)
This course discusses at advanced level experimental and theoretical problems in solid state physics. Topics include electromagnetic, optical, thermal and transport properties of solids, energy band theory and Fermi surface, magnetism, and superconductivity.

ADMS538/PHYS652 Vacuum Physics & Technology .................................................. (3-0-3)
Emphasizing the underlying physics, this course provides all the information required by new users of vacuum systems. Its coverage is wide-ranging - from the behavior of gases at low pressures, through methods of vacuum production and measurement, to system design and testing.

ADMS555/PHYS648 Structure of Thin Films ............................................................. (3-0-3)
In the first part of thin film processes, we study on vacuum, plasma, physical vapor deposition, and chemical vapor deposition. In the second part of thin film structures, we study on surface and interfaces, growth mechanism, transition, preferred orientation, and defects of thin films, mostly using synchrotron x-rays. Very recent research results are introduced on thin films structures.

ADMS556/AMSE650 Piezoelectric/Ferroelectric Materials ........................................ (3-0-3)
This course introduces various interesting modern topics in ferroelectric systems. These include crystal structure, statistical thermodynamic and Landau’s phenomenological descriptions of ferroelectric phase transitions, lattice dynamics and Raman scattering, domain structure, relaxor ferroelectricity, and magneto-ferroelectric couplings.
ADMS557/AMSE681 Physical Properties of Opto-Electronic Materials ..................................... (3-0-3)

The goal of this course is to bring together the fundamental physics of the semiconductor material and the semiconductor device physics. In this course, optical and electrical properties of semiconductor films are studied.

ADMS558/AMSE645 Optical Properties of Materials ................................................................. (3-0-3)

This course will present an intermediate treatment of the optical properties of semiconductors and insulators. Topics to be discussed include: basic electromagnetic theory, electronic band theory, absorption and dispersion, radiative transitions, stimulated emission, non-linear optical properties, and so on.

ADMS561/AMSE684 Nanoscale Semiconductor Devices ......................................................... (3-0-3)

The topics related to the fabrication of nano-scale devices are provided. Main topics include basic semiconductor device processing including thin films deposition and lithographic techniques as well as contemporary processing issues including ALD, gate stack, contact, interconnect. Also nano-technology based processing including nano-patterning and nano-material synthesis will be covered.

ADMS562/AMSE686 Electrical Properties of Low Dimensional Materials ................................. (3-0-3)

This course specifically aims to provide experimentalists with a phenomenological introduction to electron transport in low-dimensional materials, defined rather broadly. The lecture overviews the basic principles of electron transport particularly through confined potentials, and their typical manifestations in experimental observations. The goal of the course is also to develop the skill of critical reading of the experimental literature. This includes how to read an experimental paper, how to read forward and backward in the literature (including web-searched materials) without getting overwhelmed, and how to present and discuss your ideas effectively in a group setting.

ADMS563/AMSE682 Surface Analysis and Nano-scale Characterizations ................................. (3-0-3)

This course will present an intermediate treatment of the surface and interface analysis of solid materials and nano-scale characterizations of nano-materials and nano-structures. Topics to be discussed are basic theories and experimental techniques for characterizations of surfaces and interfaces.

ADMS566/AMSE683 Light Emitting Diodes ............................................................................ (3-0-3)

The goal of this course is to bring together the fundamental physics of light emitting diodes (LED) including electrical properties and optical properties. In this course, the recent trend of LED research and development is studied.

ADMS567 Advanced Materials in Nanotechnology ................................................................. (3-0-3)

This class aims to give a general introduction to contemporary subjects in nano-science and nano-technology, with a particular emphasis on solid-state electronics. The lecture is designed for the class (1) to get familiar to modern materials science in nano-technology, (2) to understand the basic physical principles operating at the nanometer scale, and (3) to develop the skill of effective and critical reading of experimental literature.
ADMS568/AMSE669 Nano-Biomaterials ................................................................. (3–0–3)
The convergence of recent advances in nano-biotechnology and medicine has created the new research domain of nano-medicine. This course will provide students with an in-depth understanding of nano-biomaterials for nano-medicine in terms of life science, chemistry, physics, and materials science.

ADMS570/AMSE649 Photonics Glasses ......................................................... (3–0–3)
Discussion of basic principles, optical characteristics and future trend of photonic glasses for lasers, fiber-optics and display technologies. Tailoring of their optical properties through nano-structuring of glasses will also be discussed.

ADMS590/TIMP685 Patent & Information Analysis ..................................... (2–0–2)
This course aims to provide education for understanding of patents and how to prepare patents.

ADMS599 Current Trends in Materials Science ........................................ (3–0–3)
This course explores the latest trends and the future of various disciplines in rapidly developing materials sciences and technologies of today.

ADMS601/AMSE606 Statistical Mechanics of Materials ................................ (3–0–3)
This course emphasizes fundamental theoretical principles of statistical mechanics and their applications to the understanding of various types of functional materials. The topics include ensembles and ergodicity, principles of classical and quantum statistics, molecular partition functions, linear response theory, time-correlation function formalism, molecular spectroscopy and dielectric relaxation, cooperative magnetic transitions and various solid solutions.

ADMS621 Condensed Matter Field Theory ................................................ (3–0–3)
This course emphasizes the development of modern methods of classical and quantum field theory with applications oriented around condensed matter physics. Methods covered include second quantization, path and functional field integration, mean-field theory, Ginzburg-Landau Theory of critical phenomena, the renormalization group method, and topological field theories.

ADMS699 Master Thesis Research ................................................................. (1–9)
Graduate students working toward the Master’s degree are required to carry out master’s thesis research under the supervision of their advisor.

ADMS710 Special Topics in Materials Chemistry ....................................... (3–0–3)
Selected topics in advanced researches on materials chemistry and their applications are covered through this special course.

ADMS712/CHEM736 Homogeneous Catalysis ............................................. (3–0–3)
Catalytic reactions of organic compounds using organometallic compounds are introduced. The theoretical and experimental backgrounds for the developments of active organometallic complexes to specific catalysis as well as mechanism studies of various catalytic reactions in solution phase are mainly covered.

ADMS713/CHEM741 Applied Electrochemistry ............................................ (3–0–3)
This course covers applied electrochemistry and related aspects relevant to graduate research. These include various experimental techniques important to student’s thesis research and interpretations thereof.
ADMS714/CHEM754 Physical Properties of Macromolecular Solutions ........................................ (3-0-3)
An advanced course learning thermodynamics of polymer solution related with the static and
dynamic properties of single polymer chains and their ensembles.

ADMS715/CHEM755 Speciality Macromolecules ................................................................. (3-0-3)
Specialty polymers are introduced in the aspect of novelties in applications, and their pros and
cons in the polymerization, structure, properties, and applications are discussed. In addition, for
some selected specialty polymers there are discussed potential solutions to solve their
disadvantageous characteristics.

ADMS720 Special Topics in Materials Physics ................................................................. (3-0-3)
Selected topics in advanced researches on materials physics and their applications are covered
through this special course.

ADMS721,722,723/PHYS701,702,703 Special Topics in Condensed Matter I, II, III .............. (3-0-3)
Advanced courses on the topics of condensed matter physics. Topics will include semiconductors,
surface physics, low temperature physics, polymers, magnetism, and superconductivity. The topics
and prerequisites will depend on the instructor.

ADMS724,725/PHYS705,706 Special Topics in Modern Physics I, II................................. (3-0-3)
Advanced courses on the topics of modern physics besides condensed matter and statistical
physics. The topics include particle, nuclear, atomic, and molecular physics and quantum optics.
The topics and prerequisites will depend on the instructor.

ADMS740 Special Topics in Device Materials ................................................................. (3-0-3)
Selected topics in advanced researches on device materials and their applications are covered
through this special course.

ADMS741/AMSE742 Special Topics in Electronic Materials .............................................. (3-0-3)
Printed plastic electronics and displays are currently one of the most researched topics within the
flat panel display community. The field of flexible or flat panel displays is truly unique in the sense
that it is interdisciplinary to the display community, combining basic principles from nearly all
engineering and science disciplines. Energy conversion devices also attracted many interests in the
organic electronics fields. In this course, the organic materials and devices for information displays
and energy conversion devices will be covered. Basically, organic light-emitting diodes,
liquid-crystal displays, organic photovoltaic cells, organic thin-film transistor, and organic memory
based on organic materials will be studied in this course. Finally the applications of the component
devices to flexible displays will be covered.

ADMS743/AMSE741 Special Topics in Ceramics ............................................................... (3-0-3)
Selected topics in advanced ceramic materials are lectured in this special course.

ADMS744A–D Special Topics in Polymer Physics................................................................. (1–3)
Selected topics in advanced polymer physics are lectured in this special course.

ADMS 800 AMS Literature Seminar ..................................................................................... (1-0-1)
In this course students present seminar talks on their own reviews of literature on current topics
in advanced materials science.
ADMS 801 Colloquium ................................................................................................................ (1-0-1)
Students are encouraged to attend the colloquium lectures on current topics presented by
departmental or invited speakers.

ADMS 899 Doctoral Dissertation Research ................................................................................. (1-9)
Graduate students working toward the Ph.D. degree are required to carry out Ph.D. dissertation
research under the supervision of their advisor.
Division of Advanced Nuclear Engineering

1. Education Aim

DANE aims to be the leader in the further development of safe and sustainable nuclear energy by preparing leading specialists with integrity, creativity and innovative quality in nuclear engineering through providing high-quality education and training in the platform of education and research. DANE also aims to collaborate with national and global experts and research and education institutes to perform top-notch research through the combination of fundamental science such as physics, chemistry, material and geological science and applying technologies such as nuclear, mechanical, chemical, bio, and environmental engineering.

As nuclear engineering is a multidisciplinary field engaged in science, technology and engineering, it incorporates diverse research areas with vanguard technologies to achieve both efficiency and safety of nuclear power plants (NPPs). With the goal to be the leader in the further development of safe and sustainable nuclear energy, DANE offers the education and research programs in (a) nuclear safety and energy conversion, (b) nuclear physics and plasma, and (c) radioactive waste management. The comprehensive graduate program covering the three broad areas requires multi-disciplinary collaborations including nuclear and plasma physics, mechanical, chemical and environmental engineering, and materials and geological science.

2. Graduation Requirements and Procedures

[Course Requirements]

A. Courses Curriculum (Applies to students enrolled since the spring semester of 2017)

<table>
<thead>
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<th>Category</th>
<th>Course No.</th>
<th>Course Title</th>
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<td>Common Courses</td>
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<td>Nuclear Engineering</td>
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<td>NUCE502</td>
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<td></td>
<td>NUCE718Q</td>
<td>Advances of Nuclear Reactor Physics and Engineering</td>
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<td>NUCE702</td>
<td>Nuclear Reactor Experiment</td>
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<td>Mandatory Courses</td>
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<td>Nuclear Power Plant Engineering</td>
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<td>NUCE89901-09</td>
<td>Doctoral Dissertation Research</td>
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</table>
B. Mandatory Courses

- Students enrolled prior to 2014
  Students are required to take two mandatory subjects: (1) Fundamentals of Nuclear Engineering (NUCE501) and (2) Nuclear Reactor Physics (NUCE601)

- Students enrolled from 2014
  Students are required to take three mandatory subjects out of the three subjects: (1) Fundamentals of Nuclear Engineering (NUCE501) and (2) Nuclear Reactor Physics (NUCE601) and (3) Radioactive Waste Management (NUCE602)

- The students who have been enrolled since the spring semester of 2017
  Students are required to take 2 of the 3 mandatory Courses.
  Students are required to take Nuclear Engineering (NUCE501) and Nuclear Reactor Physics (NUCE502).

For students with a bachelor’s degree in Nuclear Engineering, the requirement to take Nuclear Engineering (NUCE501) and Nuclear Reactor Physics (NUCE502) shall be waived if the students pass the Q.E. for NUCE501 and NUCE502. However, the students must take Advances of Nuclear Reactor Physics and Engineering (NUCE718Q).

For students continuing their studies for a doctoral degree after receiving a master’s degree from POSTECH’s Division of Advanced Nuclear Engineering, major required courses shall be waived if they were all taken during the master’s program.

C. Elective Courses

Students must complete minimum two NUCE elective courses for the completion of the degree.

D. Graduate Student Seminar

Master Program students should take minimum two semesters of the DANE seminar courses.
M.S.-Ph.D. Integrated Program students should take minimum six semesters of the DANE seminar courses are required.
Ph.D. Program students should take minimum four semesters of the DANE seminar courses are required.

[Credit Requirements]

- Students enrolled prior to 2014

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<th>Program</th>
<th>Course Credits</th>
<th>Research Credits</th>
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- Students enrolled from 2014

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<tr>
<td>Ph.D Program</td>
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<tr>
<td>M.S.-Ph.D. Integrated Program</td>
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<td>30</td>
<td>60</td>
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</table>

- Acceptance of credits from other department
Up to six credits for students taken among the 400 level courses are approved as course credits.
Master Program : Up to six credits are accepted.
Ph.D. and M.S.-Ph.D. Integrated Program : Up to 12 credits are accepted.

[Thesis Requirements and procedure]

A. Dissertation Proposal
M.S.-Ph.D. Integrated Program students should submit a dissertation proposal within four semesters. Students can extend one semester to submit the dissertation proposal by receiving his/her advisor’s approval.

B. Qualifying Examination, QE
Qualifying Examination held twice a year. QE must be held on the last week of December or the first week of January and the last week of June or the first week of July to approve it by the university graduate committee.
Ph.D. and M.S.-Ph.D. Integrated Program students should pass qualifying Examination within four semesters after entrance.
Master Program who passes QE within four semesters after the entrance can apply for M.S.-Ph.D. Integrated Program.
Students obtained 60 points or above out of 100 points for each subject in the exam are considered to be passed.
For those who earned grade A- or higher in mandatory and elective subjects are exempt from QE.

<Exam subjects>
- From Student number 2011 to 2016
  In principle, the Q.E. will be a written examination. Students must take and pass the exams for 2 mandatory courses and 1 elective course.
- Applies to students enrolled since the spring semester of 2017
  In principle, the Q.E. will be a written examination. Students must pass the Q.E. for 2 out of 3 mandatory courses (NUCE510, NUCE520, NUCE530), NUCE501, and NUCE502 (4 courses in total).

C. Paper Publication in an International Academic Journal
Ph.D. and M.S.-Ph.D. Integrated Program students should publish minimum one article out of dissertation as the first author to International Journal recognized by the division.
### D. Thesis Defense

Master Program students are required to organize the thesis defense committee that consists of minimum three persons including his/her advisor.

Ph.D. and M.S.-Ph.D. Integrated Program students are required to have a review committee of minimum five persons including an advising professor (minimum one person should be outside the department and the present university professors should be more than half.)

#### 3. Course Description

<table>
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<th>Classification</th>
<th>Course No.</th>
<th>Course Title</th>
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<td>Advances of Nuclear Reactor Physics and Engineering</td>
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<td>Nuclear Thermal-Hydraulics-2</td>
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<td>NUCE711</td>
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<td>NUCE718M</td>
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<td>Synchrotron Radiation Science and Applications</td>
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<td>Radiation Shielding and Monte Carlo Simulation</td>
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<td>Radioactive Contaminants in the Environment</td>
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<td>NUCE731</td>
<td>Advances of Radioactive Waste Management</td>
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<td>NUCE732</td>
<td>Radiochemistry</td>
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<td>NUCE800A</td>
<td>Seminar A</td>
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4. Course Description

NUCE501 Nuclear Engineering

This course will cover an introduction to nuclear power plants, interaction of radiation with matter, neutron cross sections, diffusion theory, criticality calculations, reactor kinetics, neutron slowing down theory, heat transport and temperature distribution in reactor core, and reactivity feedback. The objective of this course is to learn the fundamental concepts and tools for the analysis of nuclear fission reactors.

NUCE502 Nuclear Reactor Physics

This course is an introduction to the theory of nuclear fission reactors including neutron transport theory, the P1 approximation, and diffusion theory. In addition, it lectures on criticality calculations, which are crucial for reactor interpretation, as well as reactor kinetics, neutron slowing down theory, and numerical solution of the diffusion equation.

NUCE718Q Advances of Nuclear Reactor Physics and Engineering

The course covers the theory of nuclear fission reactors including multiplication factor, scalar flux and net current, reaction rates, diffusion theory, criticality calculations, reactor kinetics, neutron slowing down theory, and numerical solution of the diffusion equation. An introduction to heat transport in reactor core is also provided.

NUCE702 Nuclear Reactor Experiment

This course consists of the introduction lecture of reactor experiment, and the practical experiments using KUCA (Kyoto University Critical Assembly) in Japan. The KUCA is a multi-core-type critical assembly. Students visit the facility and participate in three major experiment: approach to criticality, control rod calibration, and measurement of reaction rate. The subjects cover overall topics of nuclear reactor and help students to understand the essence of nuclear reactor physics and radiation detection.

NUCE510 Nuclear Power Plant Engineering

The overall objective for this course is to have the students understand fundamentals behind the nuclear power plant design and analysis. To achieve the objective, the course provides some basic concepts essential to practical engineering which will be frequently met in the nuclear power plant areas. To this end, the key theories for the analysis of components constructing the plant will be addressed based on the thermodynamic cycles as well as fundamentals. Characteristics of the major components are also learned throughout the lecture.

As a practical application point of view, theoretical backgrounds of a thermal-hydraulic analysis computer code, MARS, will be introduced for familiarity, because it is most widely applied to the analyses of the nuclear power plant as well as experimental facilities in the nuclear thermal-hydraulic research areas.

NUCE520 Radiation Detection

In this course, students learn these 1. Fundamental principle of radiation detection like particle characteristics and an interaction, 2. Operating Principle of radiation detector for different particles, 3. Measurement technique like data statistics and handling, and spectroscopy.
NUCE530 Radioactive Waste Management

This course is designed for the senior undergraduate and the graduate students of nuclear science, nuclear engineering, environmental science and engineering, biology, geology, and chemistry to provide an overview of fundamentals of radioactive waste management. This course includes nuclear fuel cycle (front and backend), radioactive wastes generation and types, radiation source/measurement/effects/nuclear waste incineration, actinide chemistry, mechanisms of microbiological effects on radionuclide immobilization in the environment, treatment technology of radioactive wastes, waste form development and testing methods, geological storage and disposal of wastes, modeling of radionuclide transport, decontamination/decommissioning methods, and risk assessment/safe analysis of repository. The primary goal of this course is to provide the students for understanding of radioactive wastes, immobilization of different waste forms and its management practices so that student will be able to work effectively with nuclear and environmental engineers in industry or academic institutions.

NUCE511 Heat Transfer Physics

This is a graduate course describing atomic-level kinetics (mechanisms and rates) of thermal energy storage, transport (conduction, convection, and radiation), and transformation (various energy conversions) by principal energy carriers. These carriers are: phonon (lattice vibration wave also treated as quasi-particle), electron (as classical or quantum entity), fluid particle (classical particle with quantum features), and photon (classical electromagnetic wave also as quantum particle).

NUCE518 Nuclear Thermal-Hydraulics-1

NUCE519 Nuclear Thermal-Hydraulics-2

NUCE611 Two Phase Flow

This course will discuss pressure drop in two phase flow, heat transfer phenomena and phase change such as condensation and boiling phenomena. Based on these, applied design technology and malfunction in normal operation of steam generator, condenser and nuclear reactor will be analyzed. Also, flow boiling crisis and instability in two phase flow will be examined.

NUCE711 Probabilistic Safety Analysis


NUCE523 Plasma Physics

This course is intended for the fundamentals for the use of E&M (electricity and magnetism), charged particles or e-beam, and plasmas for biomedicine and some basics of molecular biology and thermodynamics included.
NUCE524 Radiation Safety.................................................................................................................. (3-0-3)

The knowledge of radiation expected when radioactive isotopes, radiation generators, and nuclear power plants are used, is introduced. The principle and practical methods to minimize the radiation exposure are given. Students will understand the radiation and study the detection techniques, the radiation effects to human body, the protection principle to prevent the radiation exposure, and etc. Safety-related issues in different applications of various radiations are given to students.

NUCE718M Particle Accelerator Technologies..................................................................................... (3-0-3)

This course covers subjects related with the principles and technology in the Light source accelerators. The key words covered in this course are: Introduction to accelerator physics (Storage ring and XFEL) and technology, Magnet technology, Vacuum system, Diagnostics technology, laser system.

NUCE526 Synchrotron Radiation Science and Applications................................................................. (3-0-3)

The first applications of synchrotron radiation were in the field of solid-state physics. But, its use now is ubiquitous in all the physical and natural sciences, with also significant medical applications. ‘Samples’ studied at beamlines range from man-made inorganic materials and devices, natural minerals and rocks, environmentally significant specimens, cultural heritage materials, biologically relevant molecules. The class covers the properties of the important beamline experimental techniques and their principles, and also, introduce to free electron lasers and an overview of the most common experimental techniques and applications.

NUCE721 Radiation Shielding and Monte Carlo Simulation................................................................. (2-2-3)

The radiation produced in utilizing radioactive isotope, radiation generator, and nuclear power plant is introduced. This course consists of how to protect the radiation to minimize the radiation exposure and how to use well-known Monte Carlo codes. Safety-related issues in different applications of various radiations are given to students. This helps students to understand the principle of shielding analysis using Monte Carlo codes (FLUKA, PHITS, MCNP) with fundamental knowledge of Monte Carlo calculation. The practice course of each codes will be given to students.

NUCE533 Radioactive Contaminants in the Environment....................................................................... (3-0-3)

This course provides the graduate students for an overview of fundamental radiochemistry and hydrogeochemistry associated with environmental nuclear wastes on soils and groundwater. Because the environmental concerns of the fate and transport of radioactive contaminants in subsurface environments are significantly increasing and the nuclear waste management is also depending on the interaction of the radioactive contaminants on mineral surfaces in soils and aquifers, an increasing understanding of fundamental radiochemistry and hydrogeochemistry in contaminant transport and remediation processes is strongly needed.

NUCE534 Noncrystalline Ceramics...................................................................................................... (3-0-3)

This course teaches basic theories and the most up-to-date research trend on principles and generation of Photonics glasses which are applied to the movement and generation of photon, laser, optical communication, display, etc.
NUCE731 Advances of Radioactive Waste Management.......................................................... (3-0-3)
This course provides the graduate (or senior) students for advanced understanding of radiochemistry, radionuclide speciation, aqueous geochemistry and modeling, mineralogy, groundwater hydrology, low-temperature solid waste form development, geomicrobiology, mechanisms of microbial transformations of actinides, fission and activation products, the impacts of microbial activity on disposal of low-level wastes in shallow land burial grounds, intermediate-level waste in engineered facilities, and high-level waste in deep geological formations, microbial gas generation from radioactive wastes, environmental contamination and remediation methods, bioremediation of contaminated sites, vitrification of radioactive wastes, and decontamination methods and technology development.

NUCE732 Radiochemistry ........................................................................................................ (3-0-3)
This radiochemistry course is designed for graduate students in the nuclear engineering or other engineering departments, and the chemistry department, who are beginning their careers in radiochemistry. The objective of this course is to introduce the theories and fundamental understanding of radiochemistry. Topics to be covered the nuclear stability, including the fundamental principle of radioactive(alpha-, beta-, and gamma-) decay, the interaction of radiation with the matters, and their measurements through alpha/gamma spectrometry, and gross alpha/gross beta counting. In addition to the protection from the exposure of radioactivity dealing in the laboratory. furthermore, the usage of radioactive tracers in chemical kinetics, the separation chemistry, and the environmental chemistry will be also covered in the course. Each student from this course will be able to work effectively with nuclear engineers and the environmental radio-chemist in the nuclear industry or the academic institutes.

NUCE733 Chemical Process for Waste Management and Decontamination ....................... (3-0-3)

NUCE699 Master Thesis Research ....................................................................................... (credits varies)
Students will conduct Master Thesis Research under the guidance of advisors.

NUCE899 Doctoral Dissertation Research ............................................................................ (credits varies)
Students will conduct Doctoral Dissertation Research under the guidance of advisors. Students will conduct Master Thesis Research under the guidance of advisors.

NUCE800A Seminar A ....................................................................................................... (1-0-1)
Weekly seminars are organized throughout a semester. Prominent speakers whose work related with various fields of nuclear engineering and physics are invited for the seminar.
Department of Creative IT Engineering

1. Education Aim

The graduate program of Creative IT Engineering (CiTE) aims at nurturing students to have self-initiated problem-solving capabilities and social entrepreneurship based on creative imagination, integrative investigation, and transformative innovation.

2. Program Overview

POSTECH’s CiTE strategically focuses on high-risk and high-impact of information and communication technology (ICT) innovations in four major areas: Smart Computing, Smart Devices and Systems, IT-based Future Healthcare. CiTE pursues high-impact innovations through interdisciplinary education and research collaborations in the areas of natural sciences, ICT, arts/humanities, social sciences, and leadership/entrepreneurship. The whole curriculum has been designed to significantly enhance students’ innovative dispositions, competencies, and potentials through student-centered learning pedagogues, which encompass student-initiated, hands-on, and career-enhancing experiences through a learning by doing approach on real-world problems. The curriculum also aims to promote a broad range of problem-solving skills, such as modeling, analysis, scientific computation, and critical assessment of feasible solutions.

[Degree requirements]

<table>
<thead>
<tr>
<th>Degree Program</th>
<th>Course Credits</th>
<th>Research Credits</th>
<th>Total Credits</th>
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<td>Doctoral program</td>
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<tr>
<td>MS/PhD integrated program</td>
<td>27</td>
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</tbody>
</table>

[Guidelines for Coursework]

1) Course credit requirements for a graduate degree may be fulfilled by:
   A. CiTE Graduate courses
   B. Graduate courses from other departments at POSTECH
   C. 400-level undergraduate courses from CiTE and/or other departments at POSTECH (up to a total of 6 credits to be counted toward course credits)
   - Note 1: Credits from Master’s Thesis/Doctoral Dissertation Research courses and Seminar courses may not be counted toward course credits.
   - Note 2: It is recommended for students who did not receive an undergraduate degree from CiTE to take undergraduate Creative Studio courses. (these courses may not be counted toward graduation credits.)

1)
3. Course List

Newly made courses are first opened in 'Special Topics in Creative IT' and are later changed into regular courses.

<table>
<thead>
<tr>
<th>Category</th>
<th>Course Number</th>
<th>Course Title</th>
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<tbody>
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<td>Course</td>
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<tr>
<td>Electives</td>
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<td>Linguistics Basis for Natural Language Processing</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>CITE522/CSED518</td>
<td>Fuzzy and Intelligent System</td>
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<td>CITE524/CSED526</td>
<td>Introduction to Data Mining</td>
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<td>CITE531/EECE553</td>
<td>Introduction to Neural Networks</td>
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<td>CITE532/EECE558</td>
<td>Advanced Materials for Nano Semiconductor</td>
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<td>CITE533/EECE564</td>
<td>Linear System Theory</td>
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<td>CITE534/EECE571</td>
<td>VLSI System Design</td>
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<td>CITE535/EECE579</td>
<td>Information and Communication Security</td>
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<td>CITE536/EECE560</td>
<td>Nano Electronics and Quantum Mechanics</td>
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<td>CITE511/TIMP503</td>
<td>Technology and Innovation Management</td>
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<td>CITE512</td>
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<tr>
<td></td>
<td>CITE537/EECE557</td>
<td>Compound Semi. Devices</td>
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<td>CITE601/CSED605</td>
<td>Real-time Systems</td>
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<td>CITE602/CSED610</td>
<td>Information Retrieval</td>
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<td>CITE623/CSED611</td>
<td>Machine Translation</td>
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<td>CITE631/EECE651</td>
<td>Computational Intelligence</td>
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<td>CITE632/EECE653</td>
<td>Semiconductor Fabrication Processing</td>
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<td>CITE633/EECE659</td>
<td>Nonlinear System Theory</td>
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<td>CITE634/EECE664</td>
<td>System Identification Theory</td>
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<td></td>
<td>CITE635/EECE667</td>
<td>Circuit Analysis Algorithms and Software</td>
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<td>CITE636/EECE672</td>
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<td>CITE611/TIMP603</td>
<td>Strategic Management of Innovation</td>
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<td>CITE700A-Z</td>
<td>Special Topics in Creative IT</td>
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<td>CITE899</td>
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</table>
4. Course Description

CITE521/CSED504 Advanced Operating System……………………………………………. (3-0-3)

Through this course, students will gain in-depth knowledge on how modern operating system works through Linux. Topics about resource management algorithms and data structures used in Linux will be discussed in detail. In addition, evaluation of micro-kernel and module-based monolithic kernel structures will help students understand full spectrum of operating system structure alternatives.

CITE522/CSED518 Linguistics Basis for Natural Language Processing………………………. (3-0-3)

The course provides a basis of linguistic concepts and issues from the viewpoint of language engineering, focusing on various grammar models which are powerful enough to capture a lot of linguistic reality and where implementations are readily available. We also cover their applications to machine translation and information retrieval.

CITE523/CSED521 Fuzzy and Intelligent Systems………………………………………………. (3-0-3)

This course introduces two folds. One is to understand its operational principle of soft computing techniques, such as fuzzy systems, neural networks, and evolutionary systems and to learn how to implement them. Another is to learn how to integrate these constituent techniques into an hybrid intelligent system that provides a more powerful and robust system performance and how to apply it for a variety of optimization problems, such as time series prediction, protein structure prediction, optimal trajectory determination, optimal classifier design, location based services, human robot interaction, and ubiquitous and pervasive computing.

CITE524/CSED526 Introduction to Data Mining…………………………………………………. (3-0-3)

Data Mining is the study of computer algorithms for effectively analyzing and extracting information or knowledge from data This introductory course will address fundamental concepts and techniques of data mining. Topics to be covered are data preprocessing, data warehousing and OLAP, frequent pattern and association analysis, prediction, classification, clustering, and ranking. Students are required to have some backgrounds in probability and statistics. This course is designed for junior, senior undergraduate students or first year graduate students. It is recommended to take this course concurrently with a database course.

CITE531/EECE553 Introduction to Neural Networks…………………………………………. (3-0-3)

This course and its sequel, EECE651 (Computational Intelligence) together comprise the series of the Soft Computing courses. It covers the neural network architecture, its learning algorithms, and its applications to pattern recognition, robotics, and control. The architecture consists of a great variety of paradigms including the Multi-layer Perceptron along with Back Propagation learning, Support Vector Machines, Kohonen’s Clustering Network and the Associative Memory Network.

CITE506/EECE558 Advanced Materials for Nano Semiconductor……………………………. (3-0-3)

This course covers crystal growth theory, bulk crystal growth, liquid phase epitaxy (LPE), vapor phase epitaxy(VPE), metal organic vapor phase epitaxy(MOVPE), and molecular beam epitaxy(MBE). It also deals with computer simulation and evaluation method of crystal growth.
CITE533/EECE564 Linear System Theory.................................................................(3-0-3)
Review of Linear Algebra, Modeling of Physical System in the State space, Solution of State equations, controllability and observability, Kalman canonical forms, Phase plane portraits, PBH test, Discrete-time system, observer and pole placement, some nonlinear system examples

CITE534/EECE571 VLSI System Design.................................................................(3-0-3)
The design techniques of VLSI systems are discussed with emphasis on the low design levels, such as gate-level/circuit-level and physical-level layout. The top-down and bottom-up design methodology and layout design rules are also discussed. The design styles, such as gate array and cell-based design, and various CAD software are discussed. In addition, the cocking schemes for synchronous systems are discussed. The design trends in the UDSM and SoC era are discussed. Then, the impacts of UDSM and low power design techniques are discussed. The class design project will provide chances to get the hands-on design experiences with extensive use of CAD software.

CITE535/EECE579 Information and Communication Security...............................(3-0-3)
This course covers Cryptographic algorithm and protocol, and also explores the adaptation for these privacy protection, message authentication, identity verification digital signature.

CITE536/EECE560 Nano Electronics and Quantum Mechanics.................................(3-0-3)
This course covers analysis of semiconductor surface, quantum state, conduction mechanism at surface, optical properties and elastic properties, surface processing technique and device application.

CITE511 Technology & Innovation Management....................................................(3-0-3)
The course introduces strategic management of technology. Fundamental knowledge and skills for technology management are the main topics of this course. The course consists of three major sections:
1) understanding the dynamics of technological innovation, 2) formulating technological innovation strategy, and 3) implementing technological innovation strategy. Class discussions will include group work, individual projects, and case studies

CITE511 Creative Convergence Studio.................................................................(3-0-3)
This course enables students to broaden their knowledge of and gain an insight into the fields of humanities and social sciences, arts, and engineering by selecting various topics and areas of interests in the fields.
To this end, students will be given opportunities to learn from faculty a broad range of approaches and methodologies in the subject fields and get hands-on experience of designing and manufacturing test-products and services accordingly. This course will mainly focus on 1) the methods in sociology of science, 2) the concept of sustainable development, and 3) learning through games and plays, and will allocate five weeks per topic.
CITE537/EECE557 Compound Semiconductor Devices ......................................................... (3-0-3)

In this course, students learn basic property of compound semiconductor and new compound processor technology, etc. They study very high speed device (i.e. HEMT, MISFET) and a branch of compound semiconductor circuit, etc.

CITE621/CSED605 Real-time Systems ......................................................................................... (3-0-3)

This course teaches the fundamental aspects of real-time operating systems, such as scheduling, concurrency, and distributed real-time communication. In addition to class lectures on theoretical results, each student of this course will be required to give presentations on the related papers and conduct a term project in order to understand how the practical real-time system works.

CITE622/CSED610 Information Retrieval ..................................................................................... (3-0-3)

The objective of the course is to introduce students to the theoretical underpinnings of information retrieval (IR). This course will examine the design, usage, and evaluation of retrieval systems. We will focus on the underlying retrieval models, databases and system implementations. Retrieval technology both on and off the WWW will be examined.

CITE623/CSED611 Machine Translation ....................................................................................... (3-0-3)

This course covers Machine Translation (MT), i.e. the use of computers to translate (or help humans to translate) between natural languages. It provides a theoretical overview, and considers the essential linguistic and practical problems of MT in general. And then we look in detail at a number of paradigm systems and the work of various research centers. We also touch on evaluation issues.

CITE631/EECE651 Computational Intelligence .......................................................................... (3-0-3)

This course covers the remaining topics of Computational Intelligence encompassing Evolutionary Computation, Fuzzy Logic, and their hybrid systems. Computational Intelligence attempts to computationally model the process of the human’s amazing capability of inferencing and learning amidst all kinds of uncertainties and imprecision of the environment. First, as simple and efficient optimization techniques, Evolutionary Algorithm as inspired by natural evolution, Particle Swarm Optimization and Ant Colony Systems are dealt with. Then, Fuzzy Logic and Systems are introduced that models the rule-based human reasoning process. Then, the biologically-inspired optimization is used to optimize the design of the fuzzy systems. Next, its applications to robotics and automation will be given as examples. Finally, the fusion of fuzzy system and the neural network in the Neuro-Fuzzy framework is introduced where self-learning of the necessary rules are possible.

CITE632/EECE653 Semiconductor Fabrication Processing ........................................................ (3-0-3)

This course covers the unit processes for semiconductor device fabrication. After an overview of process requirements for a state-of-art device, the principle and process details of wafer fabrication, wafer cleaning, epitaxial film growth, thermal oxidation, ion implantation, chemical vapor deposition, wet and dry etching, metalization, and lithography are introduced and discussed.

CITE633/EECE659 Nonlinear System Theory ............................................................................. (3-0-3)

Describing function, Popov criterion, Lyapunov stability are studied. Existence and uniqueness of the solution of nonlinear differential equation are covered. Utilizing the methodology based on differential geometry, system equivalence and feedback linearizability are studied.
CITE634/EECE664 System Identification Theory .......................................................... (3-0-3)

In this course, students get the basic concepts and major results of system identification theory. Then students learn how to obtain plant model from real data and study real time identification algorithms. Students will improve their ability in solving real identification on problems via term projects.

CITE635/EECE 667 Circuit Analysis Algorithms and Software ........................................ (3-0-3)

Various computer algorithms, graph theory, and numerical analysis methods that are associated with the computer-aided software for the analysis and design of VLSI systems are discussed. Major application areas include circuit-level simulation, logic simulation, placement and routing, high-level synthesis, logic synthesis, physical synthesis, timing verification, testing, and layout. Both theory and applications are discussed, and class projects provide chances to have hands-on experiences for software development.

CITE636/EECE 672 Linear Optimal Control ..................................................................... (3-0-3)

In this course, we derive linear optimal controllers including the standard regulator systems and tracking systems for linear system. We study various properties of regulator systems and design parameter selection. We also study LQG regulator based on the Kalman-Bucy Filter and the loop transfer recovery. Finally we study real application cases via term projects.

CITE611 Strategic Management of Innovation .............................................................. (3-0-3)

This course discusses theory and case studies with a focus on three innovations that bring about sustained growth of an enterprise: innovation of products and services, process innovation, and business model innovation.
1. What factors make an enterprise succeed and fail, why?
2. What is the dynamics of innovation that creates sustained growth?
3. For “high-return innovation,” what kinds of strategies and process should an enterprise choose?

CITE700A-Z Special Topics in Creative IT ..................................................................... (2-0-2)

In this course, students will be given lectures about up-to-date topics in interested fields by department professors or visiting professors. The department’s own IT-related courses can also be created with the purpose of consilience education in different areas of studies.

CITE599 Creative IT Colloquium ................................................................................... (1-0-1)

CITE699 Master Thesis Research .................................................................................. (variable credit)

Graduate students working toward the M.S. degree are required to carry out Ph. D. dissertation research under the supervision of their thesis advisor.

CITE799A-D Creative IT Individual Study ..................................................................... (0-3-1)

Students can receive credit for this course through lab rotation. Through lab rotation, students perform and experience various research activities and actively choose their research area in accordance with their aptitude and talents.
CITE801/EECE802 IT Scientific Writing

This is a course in writing scientific papers in English. It is a 12-week, credit course for graduate students. Each student will be required to produce a scientific manuscript. Topics will include strategies for producing the components of a manuscript, for writing a first draft, for designing effective figures and tables, and for revising the draft. The course will include exercises designed to help in this process. There will be no formal examinations; all marks will be based on exercises, assignments, and the final manuscript.

CITE802/EECE803 IT Research Paper Presentation Skill

This is a course in giving scientific presentations in English. It is a 12-week, credit course for graduate students. Students will learn how to effectively organize a presentation visually and verbally: how to produce effective graphics, and how to express their ideas in good English. Students will also improve their English grammar, vocabulary, and diction.

CITE899 Doctoral Dissertation Research

Graduate students working toward the Ph. D degree are required to carry out Ph. D. dissertation research under the supervision of their thesis advisor.
1. Education Aim

The Graduate Institute of Ferrous Technology was established with a mission to grow into a world leader in education and research specializing in advanced iron and steel technology. GIFT aims to educate future leaders in iron and steel technology, and lead the field in innovation, creativity, and foresight. GIFT intend to contribute to national and international economic development through a close cooperation with industries associated with iron and steel production, and the application of ferrous alloys.

2. Program Overview

Graduate study at GIFT is designed to provide students with a comprehensive instruction in the fundamental engineering principles that govern the production, properties and application of iron and steel. First-year graduate students at GIFT typically have undergraduate and sometimes graduate degrees in a wide range of science and engineering disciplines. The individual Programs of study is planned in consultation with the faculty members. The programs may be directed toward fundamental science, engineering or a combination of both depending on the preference, capabilities and professional career goals of the student.

- Engineering courses are offered in metallurgy, steel processing mechanics, and control and automation as applied to the steel industry. These courses focus on operations, processing, and design technology applications for the steel industry.
- In the course of their study Students will develop problem-solving capabilities as these apply to plant operations.
- For their dissertations, students are will focus on research projects which are closely related to technological challenges, advanced product development and fundamental expects of ferrous alloy systems.
- Student research-and-technology-development competence is augmented by lectures, seminars, conference attendance and the use of state-of-the-art equipment for material research.
- Recommended courses may include those offered by other departments within POSTECH.

2.1 Credit Requirements for Degree

<table>
<thead>
<tr>
<th>Degree Program</th>
<th>Course credits</th>
<th>Research credits</th>
<th>Total credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master’s program</td>
<td>18</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>Doctoral program</td>
<td>12</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>MS/PhD integrated program</td>
<td>30</td>
<td>30</td>
<td>60</td>
</tr>
</tbody>
</table>
- Guidelines for Course credits
  Credit requirements for coursework may be fulfilled by:
  a) GIFT courses
  b) Additional academic courses from other departments at POSTECH as necessary up to 6 credits per semester in consultation with, and approved by, the student’s academic advisor
  c) 400-level undergraduate courses up to a total of 6 credits

- Guidelines for Research credits
  Research credit requirements may be fulfilled by:
  a) Master’s Thesis /Doctoral Dissertation Research courses
  b) Seminars in Ferrous Metallurgy (Students in M.S. program must take a seminar course for 4 or more semesters)
  c) Technical English courses

2.2 Degree Requirements

- Master’s Program
  A. Students must complete a minimum of 18 credits of coursework and 10 credits of research.
  B. Master’s Thesis Defense: A Master’s candidate is required to orally present and defend his/her thesis before the Thesis Review Committee. The committee should consist of 3 members including the student’s thesis advisor.

- Doctoral and MS/PhD Integrated Program
  A. To complete the coursework, students must complete a minimum of 12 course credits and 20 research credits.
  B. Qualifying Examinations*: Students must pass their qualifying examinations in accordance with GIFT guidelines.
  C. Journal Publication: Students must publish one or more papers in international academic journals (SCI) approved by GIFT.
  D. Doctoral Dissertation: A Doctoral candidate is required to orally present and defend his/her dissertation before the Dissertation Review Committee. The committee should consist of 5 members including the candidate’s dissertation advisor. At least 1 member of the committee must be selected from other departments or institutions. However, the majority of the committee members must be from GIFT.
### Guidelines for Qualifying Examinations

<table>
<thead>
<tr>
<th>Eligibility Criteria for Application</th>
<th>Enrollment for a minimum of 3 semesters in the program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- 12 course credits completed before taking the Q.E</td>
</tr>
<tr>
<td></td>
<td>(Students are highly recommended to complete their course requirements within 2 semesters of beginning the program)</td>
</tr>
<tr>
<td></td>
<td>- Cumulative GPA of 3.0/4.3 or above</td>
</tr>
<tr>
<td>Timeline</td>
<td>During 3rd of 4th semester of study</td>
</tr>
<tr>
<td>Duration</td>
<td>About 2 hours</td>
</tr>
<tr>
<td>Qualifying Examination Review Committee</td>
<td>Ph.D. course: The review committee should consist of the same members as those who serve on dissertation review committee.</td>
</tr>
<tr>
<td></td>
<td>Integrative course: The committee should consist of 3 member including the dissertation advisor of the Ph.D. candidate. And the majority of the committee members must be GIFT tenured-track faculty member.</td>
</tr>
<tr>
<td>Examination Results</td>
<td>Pass or Fail</td>
</tr>
<tr>
<td>Re-examination</td>
<td>If a student fails the exam, he/she may have an opportunity to retake the exam. The second attempt must occur within 4semesters of beginning the program.</td>
</tr>
</tbody>
</table>

*Note: Please refer to ‘Academic Calendar Related to Degree Requirements’, POSTECH Catalog for thesis writing.*
3. Course Description

[Course Specialization]

GIFT courses emphasize subjects relevant to iron and steel research and technological applications of ferrous alloy system. The courses are highly specialized in comparison to general material science education at most other universities. Materials Sciences or Chemical Engineering curricular in most departments may typically offer Thermodynamics courses but GIFT offers a graduate Thermodynamics course specifically applied to iron and steel research applications. In addition, two or more lecturers teach most courses, whereby, theory and fundamentals may be covered by GIFT faculty member and the practical applications are presented by expert from POSCO and RIST. GIFT students are also free to take other courses for credit if their advisor feels it enhances their research. This opportunity provides GIFT students with a high degree of academic freedom.

[Course List]

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIFT501</td>
<td>Seminars in Ferrous Metallurgy I</td>
<td>1-0-1</td>
</tr>
<tr>
<td>GIFT502</td>
<td>Seminars in Ferrous Metallurgy II</td>
<td>1-0-1</td>
</tr>
<tr>
<td>GIFT503</td>
<td>Seminars in Ferrous Metallurgy III</td>
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</tr>
<tr>
<td>GIFT504</td>
<td>Seminars in Ferrous Metallurgy IV</td>
<td>1-0-1</td>
</tr>
<tr>
<td>GIFT50201</td>
<td>Masters Thesis Research</td>
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<tr>
<td>GIFT50203</td>
<td>Masters Thesis Research</td>
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</tr>
<tr>
<td>GIFT50206</td>
<td>Masters Thesis Research</td>
<td>6-0-6</td>
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<tr>
<td>GIFT50301</td>
<td>Doctoral Dissertation Research</td>
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<td>GIFT50303</td>
<td>Doctoral Dissertation Research</td>
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</tr>
<tr>
<td>GIFT50305</td>
<td>Doctoral Dissertation Research</td>
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<tr>
<td>GIFT508</td>
<td>Technical Writing</td>
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<tr>
<td>GIFT50801</td>
<td>English Composition-Intermediate</td>
<td>3-0-1</td>
</tr>
<tr>
<td>GIFT50802</td>
<td>English Composition-Advanced</td>
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<tr>
<td>GIFT50803</td>
<td>Presentation Skill</td>
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<tr>
<td>GIFT50804</td>
<td>Audio-Visual English</td>
<td>3-0-1</td>
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<tr>
<td>GIFT50805</td>
<td>Topic Discussion - Intermediate</td>
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<tr>
<td>GIFT50806</td>
<td>Topic Discussion - Advanced</td>
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</tr>
<tr>
<td>GIFT50807</td>
<td>Clinic</td>
<td>3-0-1</td>
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<tr>
<td>GIFT509</td>
<td>Technical Korean</td>
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<tr>
<td>GIFT600</td>
<td>Metallurgical Thermodynamics</td>
<td>3-0-3</td>
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<tr>
<td>GIFT601</td>
<td>Metallurgical Reaction kinetics &amp; mech.</td>
<td>3-0-3</td>
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<tr>
<td>GIFT602</td>
<td>Principles of Steelmaking Process</td>
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<tr>
<td>GIFT603</td>
<td>Principles of Ironmaking Process</td>
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<tr>
<td>GIFT604</td>
<td>Convective Heat and Mass Transfer</td>
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<tr>
<td>GIFT605</td>
<td>Texture and Related Phenomena</td>
<td>3-0-3</td>
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<tr>
<td>GIFT606</td>
<td>Computational Thermodynamics</td>
<td>3-0-3</td>
</tr>
<tr>
<td>GIFT610</td>
<td>Solid State Physics for Ferrous Technology</td>
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</tr>
<tr>
<td>Course No.</td>
<td>Course Title</td>
<td>Credit</td>
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<td>GIFT611</td>
<td>Transmission Electron Microscopy</td>
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<tr>
<td>GIFT6111</td>
<td>TEM Laboratory</td>
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<tr>
<td>GIFT612</td>
<td>Understanding of Modern Steel Products</td>
<td>3-0-3</td>
</tr>
<tr>
<td>GIFT613</td>
<td>Theory of Dislocations</td>
<td>3-0-3</td>
</tr>
<tr>
<td>GIFT618</td>
<td>Magnetic Materials and Application</td>
<td>3-0-3</td>
</tr>
<tr>
<td>GIFT619</td>
<td>Special Topics on Physical Metallurgy</td>
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<tr>
<td>GIFT620</td>
<td>Phase Transformation in Steels</td>
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<tr>
<td>GIFT621</td>
<td>Modeling of Phase Transformations in Steels</td>
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<tr>
<td>GIFT624</td>
<td>Crystallography</td>
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<tr>
<td>GIFT629</td>
<td>Special Topics on Computational Metallurgy</td>
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<tr>
<td>GIFT630</td>
<td>Mechanical Properties of Ferrous Technology</td>
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<tr>
<td>GIFT631</td>
<td>Special Topics for Ferrous Technology</td>
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<tr>
<td>GIFT632</td>
<td>Advanced X-ray Diffraction Analysis</td>
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<tr>
<td>GIFT634</td>
<td>Welding and Joining</td>
<td>3-0-3</td>
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<tr>
<td>GIFT640</td>
<td>Thermal and Fluid Engineering</td>
<td>3-0-3</td>
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<tr>
<td>GIFT642</td>
<td>Special Steels</td>
<td>3-0-3</td>
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<tr>
<td>GIFT651</td>
<td>Special Topics on Mechanical Metallurgy</td>
<td>1-0-1</td>
</tr>
<tr>
<td>GIFT653</td>
<td>Plasticity and Forming</td>
<td>3-0-3</td>
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<tr>
<td>GIFT654</td>
<td>Brittle and Ductile Fracture</td>
<td>3-0-3</td>
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<tr>
<td>GIFT655</td>
<td>FEM for Crystalline Solid</td>
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<tr>
<td>GIFT657</td>
<td>Continuum Mechanics</td>
<td>3-0-3</td>
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<tr>
<td>GIFT658</td>
<td>Experimental Mechanics</td>
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<tr>
<td>GIFT659</td>
<td>Metal Failure and Its Prevention</td>
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<tr>
<td>GIFT660</td>
<td>Structure &amp; Properties of Metallic alloys</td>
<td>3-0-3</td>
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<tr>
<td>GIFT661</td>
<td>Electrical Steels</td>
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<tr>
<td>GIFT669</td>
<td>Selected Topics on the Mechanical Properties of Steel</td>
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<tr>
<td>GIFT671</td>
<td>Corrosion Science and Engineering</td>
<td>3-0-3</td>
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<tr>
<td>GIFT672</td>
<td>Stainless Steels</td>
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<tr>
<td>GIFT673</td>
<td>High Temperature Oxidation and Coatings</td>
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<tr>
<td>GIFT674</td>
<td>Introduction to Organic Coatings</td>
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<tr>
<td>GIFT675</td>
<td>Protective Coatings for Steel Corrosion</td>
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<tr>
<td>GIFT678</td>
<td>Special Topics on Chemical Metallurgy</td>
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<tr>
<td>GIFT680</td>
<td>Advanced Control Theory and Applications</td>
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<tr>
<td>GIFT681</td>
<td>Robotics</td>
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<tr>
<td>GIFT689</td>
<td>Special Topics in Control and Automation</td>
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<tr>
<td>GIFT694</td>
<td>Structure and Properties of Slags</td>
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<td>GIFT700</td>
<td>Introduction to Metallurgical Engineering</td>
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<td>GIFT701</td>
<td>Characterization and Microanalysis</td>
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<tr>
<td>GIFT702</td>
<td>Solidification</td>
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<tr>
<td>GIFT703</td>
<td>Steel Production Technology</td>
<td>3-0-3</td>
</tr>
</tbody>
</table>
[Course Description]

GIFT501, 502, 503, 504 Seminars in Ferrous Metallurgy

The purpose of this course is to give students the opportunity to obtain information about important issues and recent progress in the steel industry from invited specialists in each field. This course is required of all full-time PhD candidates in each semester for which they are registered.

GIFT50201~50203 Masters Thesis Research

These courses are required to perform research projects for the M.S. degree under the supervision of a faculty advisor.

GIFT50301~50305 Doctoral Dissertation Research

These courses are required to perform PhD research projects under the supervision of a faculty advisor.

GIFT508~50807 Technical English Courses

Technical English courses are designed for student’s writings or prepared to write major research paper, a thesis or a dissertation. The English courses will highlight characteristics of effective writing in the various section of research paper and also will help students create dynamic presentations with the emphasis their unscripted oral skills while presenting and when responding to questions.

GIFT509 Technical Korean

Improvement of overall Korean ability with a focus on productive skills of enhancement.

GIFT600 Metallurgical Thermodynamics

The objective of the course is to understand basic principles of thermodynamics, and to apply the principles in various phenomena relevant to ferrous metallurgy. The laws of thermodynamics will be applied to gas, liquid, solid systems with special emphasis on Iron & Steelmaking systems (gas, metal, slag, inclusions, refractory, etc.). Basic solution theory, energy requirements, relations between Gibbs energy and phase equilibrium & phase stability will be examined. Thermodynamics of surfaces and interfaces and the bases of electrochemistry will also be introduced. The students are to be prepared for a meaningful use of computational thermodynamics software in real Iron & Steelmaking situations after the course.

GIFT601 Metallurgical Reaction Kinetics & mech.

This course deals with reaction mechanisms and kinetics of metallurgical systems and discussion on reaction processes. In particular, this course addresses the important rate controlling processes in high-temperature reactions, including gas phase mass transfer, free vaporization, liquid phase mass transfer and heat transfer. On completion of this course, students are expected to be confident of dealing with heterogeneous reactions occurring in steelmaking, refining, casting, reheating and hot rolling.
GIFT602 Principles of Steelmaking Process
Understand the causes and countermeasures for defects in continuously cast slabs/blooms during steelmaking and continuous casting process, and the effects of defects on final products.

GIFT603 Principles of Ironmaking Process
The course will be directed towards systematically understanding the underlying principles of ironmaking by focusing on the basic interactions between various components and phases. The class will also drive the students to adapt themselves to the real ironmaking processes by making them understanding the ways and means of increasing blast furnace productivity, which depends upon the fuel efficiency and flow of materials and gases through the dry and wet zones of the furnace. The course is also required to be aware of the important treatment of raw iron ores and coals, which is one of the hot issues in the field of ironmaking since the efficient pretreatment of raw materials dominantly occupies the competitiveness of the entire steel production process.

GIFT604 Convective Heat and Mass Transfer
This course is intended to provide students with the fundamentals and tools needed to model, analyze and solve the various kinds of problems involving “flow induced transport” phenomena in Iron & Steel making process. Starts from discussions about basic concepts and equations in convection, this course will cover analytic solution methods, boundary layer theory, empirical solutions and numerical simulations. On completion of this course, students are expected to be confident of how to solve the transport and fluids problems analytically and numerically.

GIFT605 Texture and Related Phenomena
Texture, or preferred orientation, is a fundamental phenomenon resulting from the microstructure evolution that takes place during various processes including casting, thin film fabrication, and thermo mechanical processing of materials. A strong texture developed in material results in anisotropy in properties of the material. Therefore, ‘texture and related phenomena’ has been a subject of teaching and research because of its technological importance and scientific interest. The object of this course is to teach texture and related phenomena focusing on steels and related materials.

GIFT606 Computational Thermodynamics
This course will provide 1) an introduction on recent advances on computational thermodynamics, 2) solid back ground on the principles lying behind the computational thermodynamics. Students are expected to use such computations in their own researches after the course is completed. Among various possible applications using the computational thermodynamics, topics related to metallurgy will be discussed.

GIFT610 Solid State Physics for Ferrous Technology
The objective of this course is modern understanding of materials relies upon atomic-scale description of material properties. This course will provide fundamental Concepts in solid state physics from quantum mechanical point of view. Starting with chemical bonding in solids, crystallography, electronic theory, lattice dynamics, and phase transition are covered.
GIFT611 Transmission Electron Microscopy

The purpose of this course is to introduce students the basic principles of transmission electron microscopy. The first part of lecture will cover the basics of electron optics, structure of TEM, and principles of electron diffraction. Geometry of electron diffraction and its application to the structure analysis will be emphasized. In the second part, theory of image contrast in TEM will be presented. Kinematical and dynamical theory of diffraction contrast will be discussed with examples of crystalline defects such as dislocations, stacking faults and inclusions. The principles of other commonly used methods will also be presented. These include Convergent beam electron diffraction (CBED), High Resolution TEM (HRTEM), Energy Dispersive Spectroscopy (EDS), Electron Energy Loss Spectroscopy (EELS). This course offers only the basic principles of TEM.

GIFT6111 TEM Laboratory

Transmission electron microscope (TEM) is a powerful tool for the analysis on the sub-micron or nanometer scale microstructure. However, actual operation of TEM is so complicated that beginner needs to understand the structure of TEM and the analytical technique. In this course, the actual skill for TEM operation and the explanation of TEM structure will be treated for the beginner of TEM operation.

GIFT612 Understanding of Modern Steel Products

The course "Understanding Modern Steel Products" gives the students an in depth introduction to the physical metallurgy of steels. The approach is application-oriented, emphasizing engineering properties of steels and the requirements specific to the use of steel in the transport, energy, consumer products, and constructional industries. In The introductory lectures, essential concepts of strengthening mechanisms in crystal plasticity are reviewed. In the first part of the course, the following topics are covered: Formable Low Carbon Steels, High Strength Low Alloy Steels, Multiphase Steels, Conventional CMn Steels, Specialty Steels, Stainless Steels and Engineering Steels. In the second part of the course, the making, shaping and processing of steel in state-of-the-art production facilities is discussed in detail. The course also introduces the main SAE/ASTM/AISI, EN, JIS and ISO standardization schemes for steel grades.

GIFT613 Theory of Dislocations

This course will cover the basic theory of dislocation including fundamental concept of dislocation, basic linear elasticity, stress-strain fields and associated self-energies of dislocation. Dislocation in various crystal structures and its interactions with other defect structures will also be given. The essential object of this course is to provide the students with the relationship between strengthening mechanism and dislocation motion in the crystalline structures in a comprehensive way.

GIFT618 Magnetic Materials and Application

This course introduces basic concepts of electromagnetism related to magnetic materials, and a variety of other topics, including Kinds of Magnetism, Magnetic Phenomena, and Commercial Magnetic Materials. The process of producing electrical steels is also reviewed.
GIFT620 Phase Transformation in Steels

This course will give an overview on the principles of phase transformation of steels and related issues, which is very essential to understand the diverse and versatile properties of modern steel products. The objective of this course is to provide the students with the fundamentals on equilibrium and non-equilibrium phase transformation in ferrous alloy, which contains basic solution thermodynamics, diffusion, and reconstructive and displacive transformation behavior in steel. Strengthening mechanism available for ferrous alloys and the concept of microstructure control by heat treatment and thermo-mechanical treatment will also be given.

GIFT621 Modeling of Phase Transformations in Steels

The objective of the course is to provide principal concepts of phase transformations and related phenomena through theoretical models and numerical practice. Several numerical practices working with simple codes will be assigned after introduction to the fundamental ideas of models.

GIFT624 Crystallography

The course is intended for candidates who have a zero knowledge of crystallography, who by the end of the course should be able to deal both with the elements of modern crystallography and mathematical aspects dealing with diffraction, interfaces, texture, phase transformations and deformations.

GIFT630 Mechanical Properties of Ferrous Alloys

The objective of this course is to introduce students to the in-depth concept of mechanics of materials. The introductory part of the course includes the review of continuum mechanics such as vector and tensor analysis, stress, strain and general principles. In addition, advanced topics on modern constitutive theory such as mathematical description of elasticity and plasticity, their application to finite element method, crystal-based plasticity will be introduced.

GIFT632 Advanced X-ray Diffraction Analysis

This course explores quantitative X-ray analysis using kinematic X-ray diffraction theory, including thermal-diffuse scattering, distortion and mosaic size, stacking disorder, local ordering and clustering, small angle scattering, liquid and amorphous solids. The course also covers EXAFS and X-ray topography using dynamic X-ray diffraction theory.

GIFT634 Welding and Joining

To provide principal understanding of various welding and joining technologies commonly applied for steel products. Both conventional and new joining processes including their applications are to be introduced. Weld ability of C-Mn steels and stainless steels are also to be discussed with various issues in welds.

GIFT640 Thermal and Fluid Engineering

This is an interdisciplinary course that examines thermal processes and fluid flow. The course considers the thermal behavior of gas, liquid, and solid phases from the mechanical point of view, including statistical mechanics. Topics include basic concepts of thermodynamics and analysis of fluid flow phenomena using vector-tensor calculus. Some boundary value problems of heat conduction are examined. Convection transport phenomena in both the laminar and turbulent
regimes are presented. This course emphasizes the significances of the equations and their application to real systems, and presents quick methods to estimate key indices to choose paths of detailed analysis.

**GIFT642 Special Steels**

This course presents alloy design and physical metallurgy, processing technology, and characterization of corrosion-resistant stainless steels, heat-resistant high-temperature steels, die steels, and various specialty steels.

**GIFT653 Plasticity and Forming**

This course is an introduction to plasticity and its application to metal forming. The course will emphasize the continuum description of plasticity, which is more suitable for the analysis of forming processes compared to micro-scale descriptions. The course will start with an introduction of mathematical tools, vectors and tensors, necessary to understand the continuum concepts of stress and strain. The relationship between stress and strain, or constitutive behavior, will be established first for a linear elastic solid. The non linear relationship between these quantities for a plastic solid will be covered in detail through the classical flow theory of plasticity. The Concepts of isotropic and anisotropic behavior will be introduced. Material properties relevant to forming analyzes will be described together with relevant micro-structural features and deformation conditions. The notion of formability will be discussed in connection with plastic instability and fracture phenomena. The flow theory of plasticity will be applied to the analysis of bulk and sheet forming operations through the upper bound and other methods.

A few specific processes will be studied in more details: Rolling, extrusion and forging for bulk forming; Drawing, stretching and stamping for sheet forming.

**GIFT654 Brittle and Ductile Fracture**

This course is an introduction to the fracture analysis of brittle and ductile solids. Metals deformed at low temperature are usually fragile and remain essentially elastic even when a crack propagates. Ductile materials, such as many metals deformed at room temperature or most metals deformed at high temperatures are ductile. In steels, there is a transition temperature under which the material is brittle and above which it is ductile. In brittle metals, cracks propagate as a result of the separation of inter-atomic planes, or cleavage, while in a ductile materials, the mechanism of fracture occurs by an increasing degradation of the material, damage, during plastic deformation. Ductile fracture is a sequence of three distinct phenomena: 1) Nucleation of micro-voids by decohesion from the matrix of in-homogeneity such as second phases and inclusions, or by cracking of these particles; 2) Growth of micro-voids due to plastic flow in the matrix and; 3) Coalescence of voids through the processes of micro-localization of ligaments linking neighboring voids. Fracture occurs in a part either during forming or during service. During forming, fracture is ductile and occurs after damage accumulation while, in service, it can be either brittle or ductile. In service, fracture occurs by cracks nucleation, due to material cycling fatigue, and crack propagation through the structure. In this class, the different types and mechanisms of fracture will be described. Fracture occurring in forming will be analyzed based on theories of void nucleation, growth and coalescence, and using constitutive descriptions of plasticity for materials containing small amounts of porosity. Fracture in service will be discussed after an introduction to fracture mechanics where stress and strain fields around a crack tip are analyzed. Stress, strain
and energy criteria for crack propagation will be introduced and concepts such as fracture
toughness and fatigue crack growth will be discussed.

**GIFT655 FEM for Crystalline Solid**

This course provides fundamentals of finite element methods for solids. The class covers the
finite element formulations of linear static analysis, displacement-based finite element procedures,
formulation of nonlinear static finite element methods, and elementary theory of single and
polycrystalline solids. Especially, this course will discuss how to implement the constitutive material
models into the finite element methods. Every student is required to be involved in a term project
by which he or she can obtain hands-on experience in solving problems by using a commercial FE
software (through the user material subroutines).

**GIFT657 Continuum Mechanics**

The purpose of the course is to study the equations that describe material deformation and the
forces required to achieve it. Continuum mechanics does not assume that materials are linearly
elastic or that their geometry is simple and their internal deformations are known. Continuum
mechanics allows deformations to be arbitrarily large and material responses to be nonlinear and
dissipative. This introductory continuum mechanics course does not cover specific material models
in much depth; instead, it covers general principles, thermodynamics that apply to all material
models, and simpler linear and nonlinear constitutive models.

**GIFT658 Experimental Mechanics**

This course is an introduction to methods to characterize the mechanical behavior of solids.
Concepts include principles of materials science and engineering relevant to the interpretation of
structure-property relationships, contact and non-contact methods in experimental solid mechanics.
For contact methods, presentation will begin with traditional strain gauges and extensometer, then
proceed to nano-indentation and atomic force microscopy. For non-contact methods, the
background knowledge in optics and wave phenomena will be introduced to describe a number of
techniques. In particular, the principles of digital image correlations, photo-acoustics and X-ray
diffraction will be established. Specific applications of the different techniques to the
characterization of the behavior of metallic materials will be introduced. This will include high rate
and impact property determination, and residual stress analysis.

**GIFT659 Metal Failure and its Prevention**

This course will give an overview of fracture, fatigue and creep processes of metallic alloys,
which take most part of failure in structural parts. Lecture will focus on the detailed mechanisms
responsible for the failure, mechanical and microstructural factors and its prevention methods.
Recent hot topics related with such failure will also be discussed.

**GIFT660 Structure & Properties of Metallic Alloys**

This course examines application of science and engineering principles to the design, selection,
and performance of engineering alloys (including steel, Al, Mg, Ti, Ni alloys). Topics include alloy
classes, design, effect of alloying elements, relation to processing variables, and structure-property
relationships.
GIFT661 Electrical Steels

This course introduces fundamental theory of electric and magnetic fields applied to materials. It discusses microstructure and electrical/magnetic properties of grain-oriented silicon steels. This course explains the effect of hot rolling on microstructure and properties of silicon steels. It addresses the effect of cold rolling on secondary re-crystallization in silicon steels and high temperature deformation of silicon steels. The course covers the structure and texture of electrical steels. Examples of various kinds of electrical steels will be cited together with current and future electrical steel technology.

GIFT669 Selected Topics on the Mechanical Properties of Steel

This course reviews the state of knowledge of the mechanical properties of ferritic and austenitic steel grades and their implications for the automotive, constructional and engineering industries, which are the most important areas of engineering in which steels are used. The course also introduces students to the most recent insights into strengthening processes in standard steels and advanced high-strength steels. The course emphasizes practical applications of the available theories to steels.

GIFT671 Corrosion Science and Engineering

The basic theory of electrochemistry will be studied since it controls the main reaction mechanism of aqueous corrosion. Various forms of corrosion will be discussed in terms of reaction between the material and environment. Corrosion prevention methods will be introduced depending on the specific corrosion system, including alloy design, organic painting, and cathodic protection.

GIFT672 Stainless Steels

This course begins with an overview of general features of stainless steels. It briefly introduces students to the melting and refining processes of stainless steel production together with alloy design concepts. The class will be directed towards understanding important surface treatment, microstructure- and corrosion control of stainless steels, integrating process-controlling factors and micro-structural features and mechanical properties of stainless steels. Examples of several grades of stainless steels will be discussed together with current and future technology of stainless steel production.

GIFT673 High Temperature Oxidation and Coatings

In this class, the principle of high temperature oxidation mechanism is discussed for various engineering materials including steels. The basic concepts of alloy design for high temperature applications are introduced. Various engineering practices for protective coating technologies are reviewed.

GIFT674 Introduction to Organic Coatings

This course is intended to provide current scientific understanding in the field of organic coatings with a summary of the applied technology of the field. The objective of this course is to introduce coatings chemistry in a way that would fulfill the purpose of providing the beginner, involved in and having interest in organic coatings, with an easy-to-understand primer that might broaden his understanding of the subject later. This course introduces general science from a paint point of view, colloidal aspects of the subject, flow and dispersion of coatings, basics about paint
compositions including organic film former, solvents, pigments and additives. Introduction to corrosion and corrosion protection by coatings will also be addressed during this course. In addition, surface treatment and some special coatings for metallic substrates will be touched in this course.

GIFT675 Protective Coatings for Steel Corrosion
This class teaches the basic principle of various protective coating technologies commonly applied for steel products. Both organic and metallic coating technologies are discussed with various process parameters which determine the property of the coatings. The corrosion resistance of the coated steel products is studied in various corrosive environments. This course will also introduce general science from a paint point of view, colloidal aspects of the subject, flow and dispersion of coatings, basics about paint compositions including organic film former, solvents, pigments and additives. Introduction to corrosion and corrosion protection by organic coatings which are currently employed in industries will also be addressed during this course.

GIFT680 Advanced Control Theory and Applications
This class provides students with advanced control theory as well as general industrial applications. Characteristics of various systems are analyzed and synthesized for efficient controller design based on state space representation. Topics include fuzzy sets and systems, optimal control systems, nonlinear control and adaptive control systems, and their industrial.

GIFT681 Robotics
To provide an understanding of all the basic principles and techniques of robotic manipulator, including kinematics, inverse kinematics, Jacobian matrix, trajectory planning and various control technique. Also a comprehensive and up-to-date account of fundamentals of design, analysis and synthesis of robotic systems.

GIFT689 Special Topics in Control & Automation
Introducing fundamentals and approaches to intelligent systems and their applications in industrial control. Providing system modeling and intelligent controller design techniques through various industrial case studies.

GIFT694 Structure and Properties of Slags
To understand the basic of polymerized silicate-based glass structure, which will govern the various thermo-physical properties of ferrous slag system such as viscosity, thermal conductivity, electric conductivity, and refining capacities. Other glass systems based on CaO-Al2O3 will also be dealt with.

GIFT700 Introduction to Metallurgical Engineering
This course is offered to those students who have not taken any course related to the materials science and engineering during their undergraduate studies. The course is designed to provide the basic understanding of the metallurgy of irons and steels, including their structure, property and performance. Practical applications of ferrous materials are discussed with respect to the control of composition and microstructure by various thermal, mechanical and surface treatments.
GIFT701 Characterizations and Microanalysis

This course begins with an overview of fundamental physical and electronic theories underlying chemical and instrumental analysis for the determination of composition and structure of materials. The class will be directed towards systematically understanding the approximate principles of each instrument operation by combining the results of practical analysis, measurement, and testing and their application methods. Each student in the course is required to submit a modular report on a special experiment closely related to metallurgical processes and research with a special emphasis on how to interpret and utilize experimental results.

GIFT702 Solidification

The goal of this course is to enable the student to solve practical solidification processing problems through the application of solidification theory. The objectives of this course are to: (1) Develop solidification theory so that the student can understand solidification structure; (2) Develop a strong understanding of the role of heat transfer in castings; (3) Develop an appreciation for the strengths and weaknesses of a variety of casting processes. The first half of the course will be theoretical, covering nucleation, growth, instability, and solidification microstructure: cells, dendrite, eutectic and peritectic structures, solute redistribution, inclusion formation and separation, and defects and heat transfer problems. The second part of the course will be process oriented and will include conventional and near-net-shape casting, rapid solidification and spray casting with emphasis on process design to avoid defects.

GIFT703 Steel Production Technology

This course begins with an overview of process routes of an integrated steel works such as POSCO. The class will be directed towards systematically understanding the underlying principles of each process by positively using the e-learning web site of steel-university-org. The class will also drive the students to adapt themselves to the real processes by making them exercising the simulation programs of specific processes. Each student in the course is required to submit a modular report on a special topic closely related to metallurgical processes and research with a special emphasis on how to interpret and apply simulation results.
Chapter 1 General Provisions

Article 1 (Purpose) The Graduate Institute of Ferrous Technology of Pohang University of Science and Technology (hereinafter referred to as “GIFT”) aims to nurture science and engineering talents with creativity and expertise by teaching and researching in-depth theories and a wide range of applications in ferrous science and technology and to contribute to the ferrous industry, the nation, and humanity by advancing science and technology.

Article 2 (Programs) GIFT offers master’s degree programs (hereinafter referred to as “Master’s Program”), doctoral degree programs (hereinafter referred to as “Doctoral Program”), and programs combining Master’s and Doctoral Programs (hereinafter referred to as “MS/PhD Integrated Program”).

Article 3 (Degree Conferment) ① Details concerning the conferment of master’s and doctoral degrees shall be stipulated separately. However, a master’s degree may be awarded to a student in an MS/PhD Integrated Program if he/she satisfies all the requirements for a master’s degree. ② The degrees specified in Clause 1 may be further categorized into a professional degree and an academic degree. Details shall be stipulated separately.

Article 4 (Department and Admission Capacity) ① GIFT shall establish the Department of Ferrous Technology to operate each degree program. ② The admission capacity of each degree program shall be determined by the Ministry of Education, Science and Technology.

Chapter 2 Admissions, Transfers and Readmissions

Article 5 (Time of Matriculation) Matriculation to GIFT shall take place within 30 days from the first day of a semester.

Article 6 (Eligibility) ① An applicant for a Master’s or MS/PhD Integrated Program at GIFT must have a bachelor’s degree or its equivalent. ② An applicant for a Doctoral Program at GIFT must have a master’s degree or its equivalent.

Article 7 (Application Process) ① An applicant for each degree program at GIFT shall submit the following documents and follow the prescribed admission review process.
1. Master’s or MS/PhD Integrated Programs
   - Application form, certificate of graduation or certificate of expected graduation (undergraduate), official academic transcript(s) for all undergraduate years, list of research achievements, and research plans
2. Doctoral Programs
   - Application form, certificate of master’s degree or certificate of expected master’s degree, official academic transcripts (both undergraduate and graduate), and a copy of master’s thesis

② If a student currently enrolled in the Master’s Program at GIFT wishes to apply for an MS/PhD Integrated Program, he/she must submit a prescribed application form to the Dean of GIFT.

Article 8 (Admission Review Process)
① Admissions to GIFT shall be based on the following criteria. However, the President of the University may waive part of the process or use a different method.
   1. Review of documents on the academic background and achievements of an applicant
   2. English proficiency test (for applicants from non-English speaking countries)
   3. Oral examination on an applicant’s major field of study (For an international student, this may be replaced by two or more letters of recommendation from professors of the university from which he/she graduated.)

② Details concerning the admission of a current Master’s Program student at GIFT to an MS/PhD Integrated Program shall be stipulated separately.

Article 9 (Enrollment Process) Admitted students must submit all required documents within a designated period.

Article 10 (Inter-University Transfer)
① A student who wishes to transfer to GIFT because his/her advisor is moving from another university to GIFT may do so subject to approval by the President of the University following deliberations by the GIFT Committee. The transfer shall be subject to the admission capacity of the given year.

② The provisions in Article 13, Clause 2 shall apply mutatis mutandis to academic affairs regarding an interuniversity transfer student, including the credits earned at previous schools by the student, minimum time required to graduate, and enrollment time limit.

③ (Deleted)

Article 11 (Readmissions)
① If a person who has voluntarily withdrawn or has been dismissed from the University applies for readmission, the President of the University may grant readmission to the applicant within the admission capacity of the year, following deliberations by the Graduate Institute of Ferrous Technology Committee (hereinafter referred to as “GIFT Committee”). However, the following persons shall not be readmitted to GIFT:
   1. A person who has exceeded the enrollment time limit as specified in Article 15, Clause 3 of these Statutes.
   2. A person who has been dismissed from the University for disciplinary reasons as provided for in Article 15, Clause 4 of these Statutes.

② If an applicant is granted readmission, credits he/she earned in the past shall be reappraised.

Chapter 3 Enrollment and Change of Academic Status

Article 12 (Enrollment) Students must enroll and complete the course registration within the
designated period of each semester.

**Article 13 (Intra-University Transfer)**

① A student who wishes to change his/her affiliation to GIFT because his/her academic advisor is moving from another department of the University to GIFT may do so subject to approval by the President of the University following deliberations by the GIFT Committee.

② Notwithstanding these Statutes, academic affairs regarding an intra-university transfer student, including credits earned by the student from his/her graduate study in another department, minimum time required to graduate, and enrollment time limit, shall be determined and implemented with the approval of the President of the University following reassessment by the GIFT Committee.

③ (Deleted)

④ When a student in an MS/PhD Integrated Program of the General Graduate School transfers to GIFT, he/she may transfer to the Doctoral Program of GIFT if he/she has met all of the following requirements (Established November 16, 2012):

1. The student has been enrolled for three semesters or more
2. The student has met course credit requirements for the completion of Master’s Program
3. The student has maintained a cumulative GPA of 3.0 or higher
4. The student has passed the doctoral qualifying examination.

⑤ The result of the doctoral qualifying examination taken by a student while enrolled in an MS/PhD Integrated Program shall be recognized subject to deliberations by the GIFT Committee. (Established November 16, 2012)

**Article 14 (Leave of Absence)**

① A student who will be absent from classes for one-fourth or more of the total days of instruction in a semester due to illness or other unavoidable circumstances may submit an application for leave of absence and take a leave of absence upon approval by the President of the University.

② Each leave of absence shall not exceed two consecutive semesters. The combined length of leaves a student may take during his/her course of study shall not exceed three semesters for a Master’s Program and four semesters for a Doctoral Program. However, the period of leave for the compulsory military service shall not be counted when calculating the combined length of leaves.

**Article 15 (Returning from a Leave of Absence)**

① If a student’s leave of absence has expired or the reason for the leave has become no longer valid, the student shall submit a Request to Return from Leave of Absence during the enrollment period of the returning semester and obtain approval from the President of the University.

② Return from military leave shall only be allowed within one year from a student’s discharge: if the date of discharge falls within the first one-fourth of the total days of instruction, the student may be allowed to enroll for the semester, notwithstanding Clause 1.

**Article 16 (Voluntary Withdrawal)** Any student wishing to voluntarily withdraw from the University shall submit an application for withdrawal co-signed by his/her guarantor and obtain approval from the President of the University.

**Article 17 (Dismissal from the University)** A student in any of the following categories shall be dismissed from the University by the President of the University following deliberations by the GIFT Committee, and the student and his/her parent(s) shall be notified accordingly:

1. A person who fails to return to school in the semester following the end of his/her leave of absence
2. A person who fails to enroll within the designated enrollment period for each semester
3. A person who fails to earn his/her degree within the enrollment time limit for degree completion
4. A person who has been dismissed from the University as a result of a disciplinary decision by the GIFT Committee

Article 18 (Appeals) A student who has been notified of his/her dismissal in accordance with Article 15 may appeal the dismissal to the President of the University within two weeks of receiving the notice.

Chapter 4 Classes and Credits

Article 19 (Days of Instruction) The total days of instruction in an academic year shall be a minimum of 30 weeks (a minimum of 15 weeks for each semester).

Article 20 (Curriculum) Matters concerning the planning and operation of the academic curriculum to be followed by students shall be determined separately by the President of the University.

Article 21 (Minimum Time Required to Graduate and Enrollment Time Limit)
① The minimum time required to complete the Master’s or Doctoral Program at GIFT shall be two years each. The minimum time required to complete the MS/PhD Integrated Program shall be four years. However, for a student who satisfies the degree requirements early with accelerated coursework, credit carry-over from another degree program, recognition of credits earned at Pohang University of Science and Technology (hereinafter referred to as “University”) and other graduate institutions, and/or an outstanding thesis, the required time may be reduced by one year for the MS/PhD Integrated Program and by six months for the Master’s or Doctoral Program.
② The enrollment time limit in GIFT shall be three years for the Master’s Program, six years for the Doctoral Program, and seven years for the MS/PhD Integrated Program.
③ If a student enrolled in the Master’s Program at GIFT is admitted to the MS/PhD Integrated Program, the time he/she spent in the Master’s Program shall count towards the minimum time required to graduate and the enrollment time limit for the MS/PhD Integrated Program.
④ The period of leave of absence in each program shall not count towards the enrollment time limit.
⑤ If the enrollment time limit needs to be extended for unavoidable reasons, the President of the University may grant an extension of one year up to two times following deliberations by the GIFT Committee.

Article 22 (Full-time Enrollment) A Master’s Program student must enroll full-time for a minimum of two semesters. A Doctoral Program student must enroll full-time for a minimum of four semesters. However, exceptions may be allowed subject to approval by the Dean of GIFT.

Article 23 (Completion of Coursework)
① A student may be granted the Completion of Coursework status in special cases provided that the student has earned the credits required for the Completion of Coursework as provided for in Article 22 of these Statutes, maintained a GPA of B0 (3.0) or higher, and was enrolled in the Doctoral Program for a minimum of four semesters.
② A research student who has been granted the Completion of Coursework status as provided for in Clause 1 and engages in research required for a degree may be granted the same rights and obligations as a student.

Article 24 (Credits Required for the Completion of Coursework)
① The minimum credits required for the Completion of Coursework shall be 28 for the Master’s
Program, 32 for the Doctoral Program, and 60 for the MS/PhD Integrated Program.
② The minimum course credits required shall be 18 for the Master’s Program, 12 for the Doctoral Program, and 30 for the MS/PhD Integrated Program.

**Article 25 (Course Credits and Research Credits)**
① Course credits refer to the credits earned by taking courses in the curriculum separately established by GIFT. The number of undergraduate course credits that could be recognized shall be limited to six credits from 400-level courses.
② Research credits refer to the credits earned through research activities such as thesis research, seminars, and experiments.

**Article 26 (Credits per Semester)** A graduate student at GIFT may earn 3 to 18 credits each semester including research credits.

**Article 27 (Credit Units)** For course credits, one credit unit shall represent a minimum of 15 class hours in one semester. However, a separately determined criterion shall be applied to research credits earned through activities such as thesis research, seminars, and experiments.

**Article 28 (Credits from Other Programs)**
① If an undergraduate student of the University earns credits from a course offered in GIFT, the credits may be recognized later as credits for the Master’s or MS/PhD Integrated Program.
② Credits earned by a Master’s Program student at GIFT by taking a course offered in the Doctoral Program may be recognized later as credits for the Doctoral Program.
③ For the application of Clauses 1 and 2, only the credits earned in excess of the requirements for graduation or the Completion of Coursework status shall be used: such credits shall be approved by the President of the University through a prescribed evaluation process. Details concerning the matter shall be stipulated separately.

**Article 29 (Credits Earned in a General Graduate School of the University)** A student of GIFT may earn up to six credits per semester by completing courses offered in a (General) Graduate School of the University (hereinafter referred to as “General Graduate School”) upon approval by his/her academic advisor and the Dean of GIFT.

**Article 30 (Grading)**
① Courses with coursework credits shall be evaluated based on examination results, assignments, attendance, etc. Letter grades and corresponding points are as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>A+</th>
<th>A0</th>
<th>A-</th>
<th>B+</th>
<th>B0</th>
<th>B-</th>
<th>C+</th>
<th>C0</th>
<th>C-</th>
<th>D+</th>
<th>D0</th>
<th>D-</th>
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<tr>
<td>Point</td>
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<td>4.0</td>
<td>3.7</td>
<td>3.3</td>
<td>3.0</td>
<td>2.7</td>
<td>2.3</td>
<td>2.0</td>
<td>1.7</td>
<td>1.3</td>
<td>1.0</td>
<td>0.7</td>
<td>0</td>
</tr>
</tbody>
</table>

② Courses with research credits shall be graded with “S” (Satisfactory) or “U” (Unsatisfactory).
③ If a student cannot submit all the work required for evaluation, a grade of “I”(incomplete) may be given provisionally.

**Article 31 (Credit Recognition and Grade Point Average Calculation)**
① Only the credits from courses with a grade of D- or higher or S shall be recognized as credits earned.
② The grade of S shall not be included in the calculation of a grade point average.

**Article 32 (Change in Course Registration)** A student may change his/her course registration during the designated period with approval from his/her academic advisor and the Dean of GIFT.

**Article 33 (Course Withdrawal)** A student may withdraw from a course between the fourth and the ninth week of instruction each semester, with approval from the course instructor, his/her academic adviser, and the Dean of GIFT. The student shall receive a grade of “W” for the course. Discontinuing a course within the first three weeks of instruction shall be regarded as a drop.
Article 34 (Make-up Examination)
① A student who is unable to take an examination due to illness or other unavoidable reasons must submit a request for make-up examination with approval from the course instructor and his/her academic adviser.
② A make-up examination must be taken before the next semester starts.

Article 35 (Attendance Requirements for Credit Recognition)
A student who has missed one-fourth or more of the total classes without justifiable reason shall not be given credits.

Article 36 (Repeating Courses)
A graduate student may not repeat a course unless approved by the Dean of GIFT.

Article 37 (Recognition of Credits Earned at Other Graduate Institutions)
① Credits earned from graduate study in other institutions may be recognized by the President of the University following deliberations by the GIFT Committee.
② A student may earn credits from other graduate institutions that have entered into a cross-registration agreement with the University or one that is recognized by the President of the University.
③ The credits earned under Clause 1 or 2 shall not exceed 50% of the credits required for graduation for each degree program.

Article 38 (Special Lecture) Special lectures may be offered for each degree program at GIFT during summer/winter breaks following deliberations by the GIFT Committee and approval of the President of the University. Credits may be awarded for these special lectures.

Chapter 5 Non-degree Programs

Article 39 (Public Lectures) GIFT may offer public lectures to those who wish to acquire knowledge and skills necessary for general education or academic research following deliberations by the GIFT Committee.

Article 40 (Research Students)
① A person who is eligible to enter GIFT and wishes to attend a class or participate in a research project may audit a class or take part in the research as a research student provided he/she passes the prescribed screening and review conducted by GIFT.
② GIFT shall not charge a research student any fees including tuition fees. If a research student participates in research, he/she may be paid compensation with the approval of the President of the University.
③ A research student who has shown satisfactory research performance may be given a Certificate of Research Performance as provided for in Form 1 (attached).

Chapter 6 Scholarships

Article 41 (Scholarships and Student Assistantships)
① Scholarships may be awarded to the students of GIFT, and details on this shall be stipulated separately.
② Details concerning the appointment and management of student assistants shall be determined separately by the Dean of GIFT.

Article 42 (Restriction on Multiple Scholarships) In principle, a student may not receive more than one scholarship at a point of time. However, exceptions may be made for a scholarship of special
nature subject to approval by the Dean of GIFT following deliberations by the GIFT Committee.

Chapter 7 Disciplinary Measures

Article 43 (Academic Warning)
① A student with a grade point average below B0 (3.0) for a semester shall be given an academic warning.
② A student who has received two academic warnings during his/her course of study may be dismissed by the President of the University following deliberations by the GIFT Committee.

Article 44 (Disciplinary Measures)
① The GIFT Committee shall decide on a disciplinary measure against a student who has committed an act in disregard of his/her duty as a student.
② Disciplinary measures shall include probation, suspension (for a definite or an indefinite period), and dismissal.
③ All disciplinary measures shall be lifted when their effective term expires. The Dean of GIFT may request the GIFT Committee to lift a disciplinary measure (including suspension for an indefinite period) prior to its expiration in consideration of the opinion of a student’s advisor.

Chapter 8 GIFT Committee

Article 45 (Organization) The GIFT Committee shall consist of 5 to 11 GIFT faculty members appointed by the President of the University, with the Dean of GIFT serving as the chair. If necessary, however, the President of the University may appoint to the committee a faculty member of the University who is in a department other than GIFT.

Article 46 (Terms of Office) The term of office of a committee member shall be two years. The term of a member appointed to fill a vacancy, however, shall be the remaining term of his/her predecessor.

Article 47 (Matters for Deliberation) The GIFT Committee shall deliberate on the following matters:
1. Matters concerning admissions, completion of coursework, and the conferment of degrees in GIFT
2. Matters concerning the establishment of basic plans for academic affairs in GIFT
3. Matters concerning the opening and closing of departments or majors in GIFT
4. Matters concerning the curricula in GIFT
5. Matters concerning the amendment and abolition of rules and regulations related to GIFT
6. Matters concerning public lectures and research students
7. Matters concerning awards for, and disciplinary measures against, graduate students
8. Matters concerning scholarships
9. Matters concerning the graduate student enrollment capacities
10. Other matters concerning the operation of GIFT as deemed necessary by the Dean of GIFT

Article 48 (Convening a Committee Meeting and Passing a Resolution) The GIFT Committee shall be convened by the Dean of GIFT when necessary: a resolution shall be passed on the majority vote of the current members.
Chapter 9 Conferment of Degrees

**Article 49 (Degree Conferment)** GIFT may award Master of Science and Doctor of Philosophy degrees. The Regulations on the Conferment of Graduate Degrees, which govern matters pertaining to the conferment of degrees in the General Graduate School of the University, shall apply mutatis mutandis to matters pertaining to the conferment of degrees in GIFT.

**Article 50 (Exception to Provisions on Thesis Committee Chair)** Notwithstanding the provisions of the foregoing Article, the Dean of GIFT may appoint a faculty member of the University who is not a student’s academic advisor as the chair of the student’s thesis committee.

Chapter 10 Amendment of Statutes

**Article 51 (Statutes Amendment Procedures)** Amendments to these Statutes shall take effect with the approval from the President of the University following advance notice and deliberations by the GIFT Committee.

Chapter 11 Mutatis Mutandis Application

**Article 52 (Mutatis Mutandis Application)** The Statutes of the Graduate School of Pohang University of Science and Technology shall apply mutatis mutandis to matters other than those specifically provided for in these Statutes.

**Addenda**

1. **(Effective Date)** These Statutes shall be established and take effect on September 1, 2005.

2. **(Interim Measures)** Matters executed before the effective date of these Statutes shall be deemed to have been executed by these Statutes.

**Addenda**

1. **(Effective Date)** These Statutes shall be established and take effect on March 1, 2009.

2. **(Interim Measures)** The interim measures in Article 1, Clause 3 of Article 2, and Clause 3 of Article 3 in the Addenda shall be deleted. Matters executed before the effective date of these Statutes shall be deemed to have been executed by these Statutes.

**Addendum**

These amended Statutes shall take effect on June 1, 2012.

**Addenda**

1. **(Effective Date)** These Statutes shall be established and take effect on November 16, 2012.

2. **(Interim Measures)** Matters concerning intra- and inter-university transfers shall be governed by Article 10 and Article 13 of these Statutes. Matters executed before the effective date of these Statutes shall be deemed to have been executed by these Statutes.
Graduate School of Engineering Mastership

1. Education Aim

As the global engineering industry has been rapidly growing and showing potential to reach a market worth of USD 3-4 trillion by 2020, it is not an overstatement to say that Korea’s future growth hinges on this fast-growing global “Blue Ocean” business. While Korean companies are steadily expanding into the global market, Korea’s advanced engineering professionals are yet to become highly competitive. Talented engineers in high added-value areas such as FEED (Front End Engineering Design) and PMC (Project Manager Consultant) are particularly in a seriously short supply. Therefore, the Graduate School of Engineering Mastership (GEM) aims to offer students with a world-class education program specializing in advanced engineering and foster them into global leaders in the field who are equipped with high-value added capabilities.

2. Program Overview

The goal of the GEM curriculum is to foster outstanding technology-oriented engineers with on-site experience who are highly in demand in various plant systems engineering fields. To this end, the curriculum is designed to emphasize high-value added technologies needed in future industrial sites and to nurture project leaders with firm engineering backgrounds through participation in domestic/overseas internship programs and engineering clinics. With this curriculum, the GEM cultivates interdisciplinary talents by requiring students to major in FEED and additionally study PMC as a minor.

2.1 Credit Requirements for Degree

<table>
<thead>
<tr>
<th>Degree Program</th>
<th>Credits</th>
<th>Details</th>
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3. Course Description

3.1 Overview
The GEM’s curriculum consists of 2 major course tracks, FEED and PMC. There are 4 sub-courses under FEED: Offshore Engineering, Chemical Process Engineering, Power Plants Engineering, and Iron and Steel Engineering. There are also 2 sub-courses under PMC: Systems Engineering (SE) and Project Management (PM).

3.2 Course List

<table>
<thead>
<tr>
<th>Category</th>
<th>Area</th>
<th>Course No.</th>
<th>Title</th>
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<td>GEMS501</td>
<td>Introduction to Plant Systems Engineering</td>
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<td>GEMS502</td>
<td>Introduction to Project Management</td>
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<td>GEMS611</td>
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<td>GEMS613</td>
<td>Subsea Production Pipelines</td>
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<td>GEMS657</td>
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<td>GEMS671</td>
<td>SE-PM based Integrated FEED</td>
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</table>
3.3 Course Description

GEMS501 Introduction to Plant Systems Engineering .................................................. (3-1-3)

Industrial plant is a very complex system requiring multi-disciplinary technologies. To cope with
the complexity and risk, together with optimization in terms of development time, life cycle cost,
and performance quality, System Engineering is a key technology that almost all the Korean
Industries are not familiar with. This course is designed to provide SE concepts including how to
analyze and develop plant systems for the engineers to carry out FEED/PMC effectively. Through
Lab and Term Project, hand-on experience will be provided.

GEMS502 Introduction to Project Management .......................................................... (3-1-3)

This subject covers the basic knowledge and skills for project management in accordance with
the end to end project life cycle. This subject will cover how to use the PM related SWs, including
Oracle Primavera and Risk.

GEMS503 Plant IT ..................................................................................................... (2-2-3)

A basic concept, theory and application method of IT based plant engineering over an entire life
cycle are covered in this course. Practice and team project activities about requirements analysis
and management, feasibility analysis and planning, FEED, detailed design, installation and a test will
be conducted in this course for the practice capability.

GEMS611 Ocean Engineering ....................................................................................... (3-0-3)

Basics of offshore engineering, theories of ocean waves, and classification of offshore platforms.
Calculation of wave, current, and wind forces on offshore structures based on theory and empirical
formulae. Design of reliable and safe offshore platforms from calculated results. Coastal engineering
Applications of the complex offshore structures.

GEMS612 Deepwater Petroleum Exploration and Production .................................... (3-0-3)

Ocean environments and their loads. Probabilistic design of fixed and floating offshore platforms.
Dynamics of offshore platforms and motion characteristics. Deepwater petroleum development
processes including exploration, drilling, system development, and production. Deepwater subsea
pipelines, flow-lines, and risers.

GEMS613 Subsea Production Pipelines ...................................................................... (3-1-3)

Design and installation of subsea flow-lines/pipelines. Subsea pipeline routing. Pipeline
manufacturing, corrosion resistant and weld-ability of subsea pipelines. Characteristics of flexible
pipelines and design to prevent internal and external corrosion of subsea pipelines. Case studies of
design and installation of subsea pipelines.
GEMS614 FEED for Offshore Plant I: Basic Design of Offshore Pipeline (2-2-3)

Analysis of subsea pipeline systems. Early stage of front end engineering design (pre-FEED) of subsea pipelines and flow-lines. Review of various design codes. Diameter and wall thickness of pipelines, thermal expansion analysis, static and dynamic free span analysis, on-bottom stability, routing design, cathodic protection, and shore approach design. Design drawings through case study. Project design reports.

GEMS615 FEED for Offshore Plant II: Advanced Design of Offshore Pipeline (2-2-3)

Subsea pipeline system design with DNV codes. FEED of subsea pipelines and flow-lines. Diameter and wall thickness of pipelines, on-bottom stability, dynamic free span analysis by vortex shedding, anode design for cathodic protection, and risk assessment from dropped objects. Case studies. Project design reports and presentation.

GEMS616 FEED for Offshore Plant III: Design and Installation of Offshore Riser (2-2-3)

Installation analysis of subsea pipeline systems. S-Lay and J-lay installation methods by using commercial software. Various installation scenarios of subsea pipeline such as normal lay, initiation & laydown, abandonment & recovery, and davit lift, etc. Subsea riser design. Structural analysis and fatigue, and installation analysis of risers.

GEMS617 Dynamics of Offshore Structures (3-0-3)

This course covers introduction of dynamic motions of offshore structures for oil and gas field development. The characteristics of each types of motion will be identified for the basic design. Characteristics of the floating structure motions and dimensional analysis are required for the engineering design. Environmental loads from wave and current and their contribution to the dynamic motions of the offshore structures will be deeply covered. Boundary value problems for floating body motion calculation will also be covered in this course.

GEMS618 Offshore Plant Engineering (3-0-3)

Deepwater petroleum exploration, drilling, production system development, and operation. Deepwater equipment subsea flow-line, and risers. Trends of deepwater technology development. Deepwater petroleum drilling and subsea production system design.

GEMS619 Ocean Wave Energy Engineering (3-0-3)

This course covers the characteristics of regular ocean waves and irregular ocean waves. Wave energies based on the basic features of ocean waves will be estimated for oil and gas field development. Potential theory, stream function, Bernoulli theorem regarding ocean wave will be covered. Linear wave theory of small amplitudes will be mainly covered. Two-dimensional ocean wave, propagation velocity, water particle velocity, distribution of wave and ocean wave energy will be covered. Statistics and spectrum analysis of ocean waves will be identified. Various nonlinear wave theories will also be covered in this course.

GEMS620 Subsea Engineering (3-0-3)

Subsea petroleum production systems. Subsea field developments, control distribution systems, subsea survey, subsea system installation and characteristics of lay vessels. Cost estimation of subsea systems. Subsea control system and power supply systems, design of optimized subsea production systems.
GEMS621 Chemical Process Synthesis ................................. (3-1-3)
This course teaches how to design the various chemical and biological processes. Students will be able to quickly and accurately design the optimum process based on recently developed design support software. To bridge the gap between theories and actual practices, students will participate in a number of projects performed for chemical process synthesis to improve the ability for practical application.

GEMS622 Chemical Process Engineering .............................................. (3-1-3)
Based on the understanding of the structure and function of the basic processes for chemical plants, students will comprehensively develop their knowledge for the overall design of chemical plants. In other words, they will understand the relationships between processes in chemical plants and cultivate the ability to design optimal chemical processes considering the characteristics of each process and their economic efficiency. To bridge the gap between theories and actual practices, students will participate in a number of chemical process engineering projects to improve their ability to deal with real-world applications.

GEMS623 Chemical Process Simulation .............................................. (3-1-3)
This course teaches how to simulate various chemical and biological processes using process simulation tools. Students will make process models and find an optimal solution to maximize profits and minimize risks using models built. To bridge the gap between theories and actual practices, students will participate in a number of chemical process simulation projects to improve their ability to deal with practical applications.

GEMS624 FEED for Chemical Plant I: Reaction Process Design .................... (2-2-3)
This course introduces the FEED of the reaction engineering area. Students will learn the foundational and element technology of reaction engineering for the FEED. They will also cultivate the ability to put theory into practice through a curriculum that reflects full-scale process development. In the main content, this course deals with mass and energy balance, phase equilibrium and chemical equilibrium, physical property modeling, steady state modeling and simulation, process optimization, economic analysis, project reporting and presentation.

GEMS625 FEED for Chemical Plant II: Separation Process Design .................. (2-2-3)
This course introduces separation engineering design which is a key part in the FEED of separation engineering area. Students will learn process synthesis and analysis technique. From the chemical product demand analysis, students will learn how to design separation engineering processes economically and safely for given raw materials, unit equipment, utilities, etc. After completing this course, they will be able to provide the results for economic analysis and Process Flow Diagram (PFD) for given demand. In the main content, the course deals with hierarchy process, heuristic methods for such as process design or synthesis of heat exchange networks. In order to effectively perform the project, students will use contemporary process design software.

GEMS626 FEED for Chemical Plant III: Utility Process Design ..................... (2-2-3)
This course introduces the utility engineering of the FEED chemical process engineering design. Students will learn process dynamics, control system design and instrumentation technique. They will also cultivate the ability to design the utility systems to allow economical and safe operation for
given process flow diagram (PFD). After completing this course, they will be able to provide utility design package. In the main the course deals with dynamic modeling and simulation, sensor and instrumentation system, control system design, and process safety and environmental analysis. In order to effectively perform the project, students will use contemporary process design software.

GEMS627 Chemical Equipment Design

This course teaches students how to understand the principles of the unit operations and design for reactors, distillation columns, absorption towers, separators, tanks, heat exchangers, pumps and compressors in the actual chemical process. It also investigates the phenomena occurring in each operation and deals with the problems of determining the optimal device at minimum cost. To bridge the gap between theories and actual practices, students will participate in a number of chemical equipment design software to improve the ability for real-world applications.

GEMS628 Chemical Process Optimization

This course teaches how to formulate optimization problems and how to solve them. It also deals with single and multiple variable optimizations under constraints. To bridge the gap between theories and actual practices, students will participate in a number of chemical process optimization projects to improve the ability for real world applications.

GEMS631 Power Generation Engineering

This course aims to introduce a comprehensive and fundamental knowledge about energy converting & power generation system of power generation plants. It consists of the following elements: kinds of energy sources, energy conversion concepts, thermodynamics & fluid mechanics of power conversion, basic principles of various power generation systems and energy storage systems, system configuration and characteristics. And students will learn more about the new thermal power plants technology being developed for the energy-saving, high efficiency, and environmental protection, etc.

GEMS632 Electric Systems Engineering

This course aims to provide a knowledge about the on/off-site electrical systems of power generation plants. The main contents are onsite electrical system(electrical systems design, electrical single line diagram, protective relay, logic diagram, safety equipments, lighting equipments, cable equipments), off-site electrical systems (transmission & substation, distribution system, transmission line) and associated apparatus. Students will also learn more about the new electrical systems technology being developed for power plants.

GEMS633 System Control Engineering

This course aims to introduce a comprehensive knowledge about measurement and control systems of power generation systems. It introduces a technology which is applied to the system and control theory which is applied to the current power generation facility process control. Major basic theories of linear, digital and main control systems, as well as the design requirements of thermal and nuclear power plants will be covered. Characteristics of digital control systems and the latest MMIS configuration and design practices are also introduced.
GEMS634 FEED for Power Plants I: Process and Power Conversion Systems Design

This course focuses on an innovative and comprehensive design engineering projects which use various process systems of power generation facilities. The main focus of the course are on the balance of a plant, including steam systems, water supply systems, cooling water systems, HVAC systems, as well as power generation and conversion systems, including power sources, turbine-generator systems, condenser, feedwater systems with its related equipments. Lectures focus on the methodology to creative design and improving for the related systems by the learning and experiences which based on the previously attended courses as well as other elementary engineering courses they may have been on.

GEMS635 FEED for Power Plants II: Electrical Systems Design

This course focuses on an innovative and comprehensive design engineering projects related to both on/off-site electrical systems. The main contents are onsite electrical systems(electrical systems design, electrical single line diagrams, protective relay, logic diagrams, safety equipments, lighting equipments, cable equipments), off-site electrical systems (transmission & substations, distribution systems, transmission lines) and associated apparatus. Lectures covers a methodology of systematic analysis, creative design and improvement on the related systems, based on preceding common required courses and elementary engineering courses.

GEMS636 FEED for Power Plants III(Instrumentation Control Systems Design)

This course covers an innovative and comprehensive design engineering projects about various power system, instrumentation and control systems of power generation facilities. The main contents are main power systems, auxiliary power systems, lighting systems, switch yards systems, corrosion prevention systems, process control systems, main control room systems (Man–Machine Interface), accident surveillance systems, CCTV and related equipment. Lectures cover a methodology for systematic analysis, creative design and improvement on the related systems by applying knowledge and experience gained from preceding courses.

GEMS637 Power Plants Structural Engineering

This course covers a various basic theories and application methods for structural analysis and design in structures of nuclear and thermal power generation facilities. The bulk of this course focuses on various topics such as major power generation facility structures, marine and coastal structures for seawater intake and drainage, the basements for vibrating equipments, ground design according to the site conditions and characteristics of various buildings, analysis of ground condition and construction materials, design method and design criteria. Especially, A current hot topics, as seismic analysis and design methods for structures will be introduced.

GEMS638 Power Plants Piping Engineering

This course aims to an introduce basic theories and application methods about the layout, analysis and design of thermal and nuclear power plants buildings, equipments and piping systems. Since building and equipment layout design affects protection of power generation facilities, construction, operation and maintenance of power plants. Piping systems are essential in power plant process systems and their careful layout design and stress analysis is required.
GEMS641 Introduction to Computer Aided Engineering (CAE) for Iron and Steel Process (3-1-3)

This course covers basic theories of thermodynamics and their numerical analyses including finite element method (FEM) for analysis and design of mechanical structures and computational fluid dynamics (CFD) for solving partial differential equations of viscous incompressible and compressible flows. The basic principles of thermodynamics and their applications in industrial fields are introduced.

GEMS642 Introduction to Iron and Steel Process (3-0-3)

To understand the main process of steelmaking, academic fundamentals of ironmaking, steelmaking, continuous casting, hot rolling, cold rolling and plating will be introduced.

GEMS643 CAE Practice I for Iron & Steel Process (3-1-3)

This course deals with basic knowledge of thermodynamics including conduction, convection and radiation. Heat and mass transportation will be analyzed in boundaries of laminar and turbulent flow through momentum, energy and mass conservation law.

GEMS644 FEED for Iron & Steel Plant I: Basic Design of Iron and Steel Plants (2-2-3)

These days, systems are is becoming various and complex as industries keep growing. We instruct how to analyze and improve the system creatively from knowledge of engineering and natural science.

GEMS645 FEED for Iron & Steel Plant II: Element Design of Iron and Steel Plants (2-2-3)

Students will learn how to suggest solutions and to materialize the solution for the analyzed system. Students will also learn how to design the system which will satisfy function, performance and expense for the solutions. Students will perform system analysis using CAE. They will also research optimum design of system by designing and analyzing system structure stability and based on authentic cases.

GEMS646 FEED for Iron & Steel Plant III: Creative Design Theory (2-2-3)

Students will learn how to resolve the occurred problems by applying the suggested solutions to real cases. Even the solutions are applied to the system by using integrated system, various problems which outbreaks in the industrial field makes unexpected problems. So, methodology to operate and manage for a better system by reflecting occurred problems or weak points to the solutions again.

GEMS647 CAE Practice II for Iron & Steel Process (3-1-3)

This course covers formation and analysis of boundary problems through basic concepts of linear elasticity and its application (transformation, balance equation, constitutive equation and energy law).

GEMS648 Iron & Steel Process Design (3-0-3)

To understand design theories in the main ironmaking process, methods of design in blast furnaces, converter, electric furnace, continuous casting machine, rolling mill and FINEX processes will be introduced. Furthermore, the design methodology of the main facilities and practice with process simulation tool will become familiar to students.
GEMS651 System Requirements, Design and Evaluation (3-0-3)

This course covers systems engineering (SE) from technological development perspective. The purpose of this course is to provide FEED capability for the industrial plant systems. Students will learn how to design system architecture from the system requirements of target system, how to evaluate architecture alternatives using diverse evaluation criteria, and how to decide for the best solution. Topics included are process, methods, and tools for developing requirements and architecture, and verification and validation.

GEMS652 System Integration, Test and Evaluation (3-0-3)

In this course, students will learn how to integrated systems and how to test/evaluate the integrated system. Specifically, it teaches requirements and considerations for integrating from component level to system level. It also teaches requirements, test methods, and tools for test, verification and validation of system.

GEMS653 System Analysis & Specialty Engineering Integration (3-0-3)

This course covers the procedures and methods for integration, verification and validation of system, along with their applications. Detailed contents are: 1) How to integrate low-level system elements to acquire high-level system elements satisfying the predefined requirements, 2) Definition objectives, roles, procedures, and methods for verification and validation, 3) Plans for performing verification and validation and its relationship with other activities in the systems engineering process, 4) Relationships of verification and validation with other activities, and 5) How to utilize international standards for planning of integration, verification and validation, securing appropriate data, and documentation.

GEMS654 PSE Practice I: SE Based Product Design (2-2-3)

The object of this course is to apply technology development theory of systems engineering learned from the SRDE (System Requirements, Design, and Evaluation) course (GEMS 651) to real products. This course selects products that the students can easily access as a target system and covers all technology development activities such as requirement development, making design alternative, evaluation of design alternatives and selection of final system design through life cycle of systems engineering. Through the extensive hands-on-experience, students will learn application concept and effectiveness of the Systems Engineering in practice.

GEMS655 PSE Practice II: SE Based Plant Design (2-2-3)

The object of this course is to apply technology development theory of systems engineering to plant systems or sub-systems of the plant. To carry out projects for plant system as the target system, this course require domain knowledge of the target plant system. This course is designed for team work composed of SE specialists and domain experts, such as chemical process engineering, power generation engineering, iron and steel engineering, and offshore engineering. Through this course, the students will catch the necessity and synergy effectiveness of the multi-disciplinary team work that SE is thrusting for.

GEMS656 PSE Practice III: SE Based Integrated Design (2-2-3)

The object of this course is to carry out research projects to exploit systems engineering effectively regardless of engineering domain based on the knowledge and experiences obtained from
the courses, such as SE based Product Design (GEMS654) and SE based Plant Design (GEMS655). This course enables students to explore research topics for disciplinary convergence and to realize their full potentials. This course will provide a good opportunity to increase and cultivate the innovative engineering capability with systems engineering from a more strategic and long-term perspective.

GEMS657 Modeling and Simulations (M&S) ......................................................... (3-0-3)

This course provides methodologies for logical, mathematical, and physical expression regarding system phenomena, entities or processes. Students will have capabilities to estimate lifecycle costs and risks through carrying out modeling and simulation under many diverse operating environmental conditions within a given period of time.

GEMS658 Systems Engineering Management ....................................................... (3-0-3)

This course provides how to manage large-scale complex engineering and/or technical projects from the perspective of system engineering. Students will gain detailed knowledge in systems engineering management planning (SEMP) which deals with system development and management plan, and in change management, configuration management, risk management and other various analysis and control methods for supporting system development process. Finally by applying system engineering concept into organization, methods for enhancing organization’s system engineering ability will be handled.

GEMS659 Model Based Systems Engineering(MBSE) ......................................... (3-0-3)

In the past, most system engineering activities were under Document Based System Engineering (DBSE) paradigm, and huge amount of documents were begun to be produced and handled as systems were getting more complex. Document based system model caused inconsistent understanding of target system between participating stakeholder. In order to overcome the limitation, Model Based System Engineering (MBSE) which can express the system more accurate and concise was developed and introduced. This course provides knowledge in how to model a system from the perspective of various system model view based on System Modeling Language (SysML). Student will study kinds of system model, modeling tool and method, and will understand the different objectives of each system models. Using MBSE supporting tools, MBSE will applied to specific system to cultivate a sense of actual system development.

GEMS661 Project Risk Management ................................................................. (3-0-3)

This Subject covers the capability to analyze the risk and risk mitigation through an effective decision making process. This subject will cover how to use SWs related with the decision making.

GEMS662 Contract Management and Negotiation .............................................. (3-0-3)

This subject covers the plant and construction contracts, claim management and negotiation skills for the purpose of the successful plant business management through relative risk identification and mitigation. This subject will cover the negotiation role play with the related cases.

GEMS663 Project Financing .............................................................. (3-0-3)

This subject covers financial analysis and financing structure for successful plant projects. This subject will cover the case studies related with the actual financing models.
GEMS664 PM Practice I ................................................................................................................. (2-2-3)
This subject covers the critical PM issues at the stage of pre-contract or pre-project. This subject will cover the case studies and practices with the probable plant projects. This subject shall be the first pre-requisite subject in which to take the PM practice & case study II and III.

GEMS665 PM Practice II ............................................................................................................... (2-2-3)
This subject covers the critical PM issues at the stage of construction and operation. This subject will cover the case studies and practices with the probable plant projects. It’s required to take the PM practice & case study I, as the pre-requisite subject. This subject shall be the pre-requisite subject to take the PM practice & case study III.

GEMS666 PM Practice III ............................................................................................................. (2-2-3)
This subject covers the integrated project management for the whole stage of project planning, construction and operation. This subject will cover the case studies and practices with the probable plant projects. It’s required to take the PM practice & case study I & II as pre-requisite subjects.

GEMS667 Feasibility Studies ........................................................................................................... (3-0-3)
This subject covers the diverse methods to appraise the technical and financial feasibility studies for successful plant business. This subject will cover the practices and case studies related with the actual plant business/projects.

GEMS668 Global Plant Project Leadership ...................................................................................... (3-0-3)
This subject covers the international leadership for the global plant business, including multi-national project management, off-shore plant management, international communication, global negotiation and global business leadership.

GEMS670 Reliability, Availability, Maintainability, and Safety (RAMS) ........................................ (3-1-3)
This course deals with overall system reliability addressing how well a system could provide functionalities and satisfy system requirements under pre-defined conditions. Student will study defining reliability of various systems and system functions, and also study establishing mathematical model to express quantitative reliability. By analyzing certain complex system, reliability model will be established for each consisting subsystems, and integrated reliability model will be developed and applied to whole complex system. Reliability test planning and procedure will be studied, as well as reliability program and standards.

GEMS671 SE-PM based Integrated FEED .................................................................................... (2-2-3)
With all theory / technology / tools from the courses of PSE-PM (PMC) and each FEED domain, an integrated design project will be undertaken. Students will pick up at least one project related to each FEED domain, and then develop their integrated designing capabilities with FEED and PMC.

GEMS681 Internship I .................................................................................................................... (0-2-1)
This course aims to help students accumulate experience via on the job training in the engineering industry, and to apply theories on an actual site.
GEMS682 Internship II .............................................................................................................. (0-2-1)

This course aims to help students accumulate experience via on-the-job training in the engineering industry and to apply theories on an actual site.

GEMS699 Master Research and Thesis ............................................................................... (Variable Credit)

This course is designed to support students’ research for their M.S. degree dissertation under the academic advisor’s instruction.

GEMS691 Engineering Seminar I ....................................................................................... (1-0-1)

GEMS692 Engineering Seminar II ....................................................................................... (1-0-1)

GEMS899 Doctoral Dissertation ......................................................................................... (Variable Credit)

This course is designed to support the student to perform research on a specific subject for a doctoral degree under the academic advisor’s instruction.