2020 Course Catalogue

POSTECH Graduate Program
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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]

This program is designed for students whose final goal is to earn a Doctor’s Degree in Mathematics.

A. To graduate with Ph. D degree

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
according 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.

[Master’s Program]

A student in Master’s program must meet the same requirement as [MS/Ph. D Integrated degree program] B to earn a master’s degree.

[Ph. D Program]

A student in the Ph. D program should earn 32 or more credits, including 18 or more coursework credits. Other requirements are the same as [MS/Ph. D Integrated degree program] A.

[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, 518, 519, 545, 612, 616, 617, 619, 647)

Stream3 : Topology, Geometry and related courses  
(520, 523, 524, 570, 621, 622, 623, 624, 625)

Stream4 : Numerical Analysis and Applied Mathematics  
(541, 542, 551, 640, 641, 643, 645, 647, 651, 652)

(530, 531, 532, 533, 537, 538)

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.

[To earn credits from graduate courses of the other departments or undergraduate courses of Department of Mathematics]

1) Graduate students are allowed to earn up to 6 credits from MATH400-level undergraduate courses of Department of Mathematics. In such a case, their evaluations for the courses must be given by letter grades.

2) Graduate students are allowed to earn up to 6 credits from graduate courses (from 500-level to 800-level) of the other departments. In such a case, their evaluations for the courses must be given by letter grades.

3) Rule 1) and 2) are applied to the graduate students of entrance year 2019 and the years thereafter.

3. Course Description

MATH501 Algebra I ............................................................. ............................................................. (3-0-3)

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)

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)
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)
Recommended 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, canoncail 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)
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)
    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: MATH313
    Cauchy Problem, Laplace Equation, Hilbert Space Method, Sobolev space, Potential Method, Heat
    Equation, Wave Equation.

MATH518 Ergodic Theory ............................................................................................................................. (3-0-3)
    Recommended Prerequisite: MATH514
    This course is designed to provide the basic concepts, important examples and techniques in
    ergodic theory, measure preserving transformations, recurrence, ergodicity, mixing, isomorphism,
    entropy

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 ............................................................................................................... (3-0-3)
    Recommended Prerequisite: MATH321, MATH422
    Differentiable manifolds and submanifolds, tangent bundles, vector fields, Frobenius theorem,
    tensors, differential forms, Lie derivatives, Lie groups and Lie algebras, exponential maps, matrix
    groups, adjoint representations, integration on manifolds

MATH523 Introduction to Differential Topology .......................................................................................... (3-0-3)
    Recommended Prerequisite: MATH321
    Immersion, Submersion, Transversality, Topological invariants

MATH524 Algebraic Topology I .................................................................................................................... (3-0-3)
    Recommended Prerequisite: MATH321
    Complexes, homology theory, Eilenberg–Steenrod axioms, cohomology, universal coefficient theorems,
    cohomology products, Poincaré duality

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, Bayesian 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

MATH532 Applications of Mathematics and Big Data ....................................................... (3-0-3)
Recommended Prerequisite: MATH230
We understand basic concepts of data analysis and machine learning using mathematical methodology. Based on this, we implement the machine learning algorithm directly and analyze the latest trends.

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)
Recommended Prerequisite: MATH230, 311

MATH538/EVSE579 Environmental Statistics .................................................................... (3-0-3)
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

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, WKW Method, Green’s functions

MATH542 Methods of Applied Mathematics II ............................................................... (3-0-3)
Recommended Prerequisite: MATH313
Integral Equations, Volterra Equation, Fredholm Equation, Hilbert-Schmidt Theory, Wiener-Hopt 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)
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: MATH203, 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
Voltage graph, Group actions on graphs, Cayley graph, Embedding of graphs, Map Colorings, Genus of groups, Graph and matrices, Algorithm

MATH562 Combinatorics II
Combinatorial Enumerations, Polya Theory, Interconnection network, Block design, Finite geometry, Algorithm

MATH565 Coding Theory
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
Recommended Prerequisite: MATH302
Public key crypto-algorithm, Cryptanalysis, Finite field Study public key cryptosystem based on various number theoretical theories. We will discuss such as elliptic curve crypto system and RSA systems

MATH570/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, 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
Recommended Prerequisite: MATH 503, 524, 612
Complex variety, Hilbert’s nullstellensatz, Riemann surfaces and algebraic curves, Residues, Quadric Line Complex

MATH604 Elliptic Curves
Recommended Prerequisite: MATH505
Algebraic varieties, Algebraic curves, Geometry on elliptic curves, Elliptic curves on local fields, Elliptic curves on global fields.

MATH606 Automorphic Forms
Modular Form, Siegel modular form, Jacobi form, Quadratic form, L-function
MATH608 Homological Algebra

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

Recommended Prerequisite: MATH510
Bergman Kernel & Integral Formula, Plurisubharmonic function, Pseudoconvexity, Domain of Holomorphy, problem, Levi Problem, Hardy Space

MATH616 Fourier Analysis

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

Recommended 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

Recommended Prerequisite: MATH519
Basic sequences, Classical Banach spaces, Devoretsky-Rogers Theorem, Groendick inequality, Choquet Integral Representation Theorem

MATH621 Riemannian Geometry

Recommended Prerequisite: MATH520
Connections, high dimensional Riemannian manifolds, curvature, Ricci curvature tensor, scalar curvature, Jacobi fields, geometric invariants, gauge transformations, curvature and topology

MATH622 Complex Manifolds

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 II

Recommended Prerequisite: MATH524
Homotopy groups, fibrations, cofibrations, Whitehead theorem, Hurewicz theorem, Frudenthal theorem, obstruction theory, spectral sequences
MATH625 Lie Groups and their Representation .......................................................... (3-0-3)
  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 ............................................... (3-0-3)
  Best uniform approximation, Condition numbers, Krylov method, Eigenvalue problems, Several Time Scale

MATH645 Mathematical Fluid Dynamics ..................................................................... (3-0-3)
  Recommended Prerequisite: MATH313
  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 ................................................. (3-0-3)
  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 ................................................................. (3-0-3)
  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 ........................................................................ (3-0-3)
  Recommended Prerequisite: MATH313, 651
  Finite difference methods, Finite element methods, Parabolic problems, Hyperbolic problems, Elliptic problems, Error analysis in Sobolev spaces, Singularity

MATH661 Algebraic Graph Theory ............................................................................. (3-0-3)
  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 ......................................................................... (3-0-3)
  Recommended Prerequisite: MATH301, 321
  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 ............................................................................ (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.

MATH709~789 Topics I, II, III ................................................................. (1-0-1, 2-0-2, 3-0-3)

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.
Department of Physics

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. Graduate students admitted in or before 2018 may take up to six credits from 400-level undergraduate courses. In order to have them acknowledged by his/her department and counted towards his/her graduate program, the student must choose to be evaluated on a letter-grade basis. If a graduate student takes a graduate-level course (500-level to 800-level graduate courses, excluding seminar courses) from another department, and wishes to have the credit acknowledged by his/her department, the student must choose to be evaluated on a letter-grade basis.

Graduate students admitted in or after 2019 may take up to six credits from 400-level undergraduate courses (his/her own department), and/or 200-level to 400-level undergraduate courses (another department). In order to have them acknowledged by his/her department and counted towards his/her graduate program, the student must choose to be evaluated on a letter-grade basis.
If a graduate student takes a graduate-level course (500-level to 800-level graduate courses, excluding seminar courses) from another department, and wishes to have the credit acknowledged by his/her 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 the coursework credits of their master’s degree from another university 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** ................................................................. (3–0–3)
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** ................................................................. (3–0–3)
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** ............................................................. (3–0–3)
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** .................................................... (3–0–3)
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** ................................................................. (3–0–3)
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**

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**

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**

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**

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**

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**

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**

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 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 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 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 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 Synchroton 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 ............................................................................................................ (3-0-3)
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 ................................................................................................ (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.

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.

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.

PHYS707 Special Topics in Statistical Physics ............................................................................. (3-0-3)
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 ........................................................................ (3-0-3)
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 ............................................................................................... (3-0-3)
This course covers various advanced topics in the classical and the modern optics.

PHYS712 Special Topics in Biological Physics .............................................................................. (3-0-3)
This course is intended to cover various advanced topics in biological physics.
PHYS715 Special Topics in Particle Accelerators ................................................................. (3-0-3)
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 ........................................................................ (3-0-3)
This course covers various advanced topics in the plasma physics.

PHYS720 Special Topics in Brain Science ......................................................................... (3-0-3)
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 ......................................................................................................... (1-0-1)
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 ................................... (1~3)
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 ........................................................................... (1~4)

PHYS899 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 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

[Undergraduate course credits]

<table>
<thead>
<tr>
<th>Division</th>
<th>Until 2018 students enrolled</th>
<th>Starting in 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate Courses</td>
<td>400 units (G or S/U)</td>
<td>200 ~ 400 units (G or S/U)</td>
</tr>
<tr>
<td>(Maximum 6 credits)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Based on credit recognition criteria for graduate school subjects in other departments]
If a graduate student takes a graduate course (500 to 800 units), he or she can take the course under the guidance of a professor, and the grade may be received as letter grade or S(pass) / U(failed).

[Credits Required for Graduation]

<table>
<thead>
<tr>
<th>Programs</th>
<th>Course Credit</th>
<th>Research Credit</th>
<th>Overall Credit</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S.</td>
<td>12(3) Credits</td>
<td>16 Credits</td>
<td>28(3) Credits</td>
<td></td>
</tr>
<tr>
<td>Ph.D</td>
<td>12(3) Credits</td>
<td>30 Credits</td>
<td>42(3) Credits</td>
<td></td>
</tr>
<tr>
<td>Ms-Ph.D Integrated</td>
<td>18(3) Credits</td>
<td>42 Credits</td>
<td>60(3) Credits</td>
<td>3 credits must be completed for each field</td>
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</tbody>
</table>
[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 other major 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.

[M.S.-Ph.D. integrated program]
Students in this program do not submit a Master’s thesis. A student must complete major and other major 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** .............................................................. (3-0-3)

This course is to provide 1 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** ......................................................................... (3-0-3)

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** ...................................................................................... (3-0-3)

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** .................................................................................................. (3-0-3)

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 multi-dimensional 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**
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**
This course aims to have students get critical view on research in various discipines of current chemical sciences and technologies.

**CHEM612 Advanced Quantum Chemistry**
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**
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**
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**

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**

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**

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

**CHEM619 Nanochemistry**

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................................................................. (3-0-3)
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............................ (3-0-3)
This practical course gives 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...................................................... (3-0-3)
Notable trend and special topics for organic chemistry are discussed.

CHEM631 Bioinorganic Chemistry...................................................................... (3-0-3)
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.................................................................. (3-0-3)
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........................................................................... (3-0-3)
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.......................................................................... (3-0-3)
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................................................................. (3-0-3)
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 ......................................................... (3-0-3)
Special topics in modern inorganic chemistry, materials chemistry, surface chemistry, solid state chemistry are introduced.

CHEM642 Chemical Instrumentation ................................................................. (3-0-3)
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 ......................................................... (3-0-3)
A select subset of current topics in analytical chemical sciences and technologies are reviewed and discussed.

CHEM651 Macromolecular Physical Chemistry ......................................................... (3-0-3)
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 ................................................................. (3-0-3)
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 ......................................................... (3-0-3)
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 ......................................................... (3-0-3)
Selected topics from bio-organic, biophysical, or biological chemistry will be discussed. The contents of this course will vary.

CHEM699 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.

CHEM711 Theoretical Background for Computer Simulations of Biological Systems ......................................................... (3-0-3)
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** .......................................................... (3-0-3)

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

**CHEM714 Dynamics of Elementary Gas Reactions** .......................................................... (3-0-3)

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** .......................................................... (3-0-3)

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 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.

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 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. Criteria of Credit Recognition for Undergraduate Level Courses/Graduate Level Courses of Non-major Department

- Students may register up to 6 credits from undergraduate level courses in the course number 200-400’s under their advisor’s guidance (with the exception of courses from the Division of Humanities and Social Sciences). In this case, students may choose the grading system between Letter Grade and S/U(Satisfactory/Unsatisfactory) Grades.

- Students may take graduate level courses from a non-major department under their advisor’s guidance (except for the Research courses) In this case, students may choose the grading system between Letter Grade and S/U(Satisfactory/Unsatisfactory) Grades.

4. Credits Required for Graduation

<table>
<thead>
<tr>
<th>Programs</th>
<th>Course Credit</th>
<th>Research Credit</th>
<th>Overall Credit</th>
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</thead>
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<tr>
<td>M.S</td>
<td>19 Credits</td>
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<td>Integrative</td>
<td>28 Credits</td>
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</table>

5. 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** ............................................................................. (3-0-3)

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** ............................................................................................... (3-0-3)

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** ............................................................................................ (3-0-3)

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** ..................................................................................................... (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.

**LIFE512 Metabolic Controls** .................................................................................................. (3-0-3)

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** ....................................................................................... (3-0-3)
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................................................................. (3-0-3)

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 undergraduate 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 the fastest-developing techniques for biological research and medical intervention.

LIFE515 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.

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.

LIFE571 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.
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 explores 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 ................................................................... (3-0-3)
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 ..................................................................... (3-0-3)
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 .................................................................. (3-0-3)
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 .................................................................................. (3-0-3)
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

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

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

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

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 .......................................................................................................................... (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 bioinformatics.

LIFE620 Advanced Biostatistics .............................................................................................................. (3-0-3)
This course explores advanced statistic processing techniques and analyses needed for the analysis and understanding of biodata.

LIFE621 Protein Biochemistry ................................................................................................................. (3-0-3)
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 .................................................................................. (3-0-3)
This course explores the latest trends in and the future of various disciplines in the rapidly developing life sciences of today.

LIFE623 Ionic Channels ............................................................................................................................ (3-0-3)
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 .......................................................................................................... (3-0-3)
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** ................................................................. (1-0-1)
In this course, students present their research results.

**LIFE699 Masters Thesis Research** ............................................................... (1~9)
In this course, students conduct research under the supervision of their respective academic advisors.

**LIFE701 Methods in Plant Molecular Genetics** ............................................ (1-4-3)
In this course, students explores various techniques in plant molecular genetics through lectures, discussions, and experiments.

**LIFE702A-D Methods and Logic in Molecular Biology A-D** ......................... (3-0-3)
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 explores 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-morphogenensis, 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 explore 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 view. 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.

LIFE721 Methods in Cell Physiology ............................................................................. (0-6-3)
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 ...................................................................................... (3-0-3)
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 ....................................................................................... (2-2-3)
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 ...................................................................................... (1-0-1)

LIFE806A-Z/IBIO801A-Z Special Topics in Systems Biology A-Z ................................. (3-0-3)
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 ....................................................................................... (1-0-1)
In this doctoral seminar, students will present their research.

LIFE899 Doctoral Dissertation Research ....................................................................... (1-9)
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 18 must be course credits and 10 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 300, 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 300, 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 15 must be
course credits and 17 research credits.
(Credits from courses taken to fulfill the requirements for a master’s degree will be excluded.)
- Take AMSE899 (Doctoral Dissertation Research) and 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 300, 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 300, 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 30 must be course credits and 30 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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<th>Master’s Program</th>
<th>Doctoral Program</th>
<th>MS/PhD Integrated Program</th>
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<td>Course Credits</td>
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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 role 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.

AMSE508 Research Method in Materials Science and Engineering .............................................(3-0-3)

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.

AMSE561 Nucleic Acid Biomaterials and Nanobiotechnologies

This course provides an introduction to nucleic acid biopolymers (e.g., DNA and RNA) and their connection with cutting-edge nanobiotechnologies. The course covers: discovery, basic chemistry, structure, synthesis, instrumental analysis and manipulation of nucleic acids. General topics include recent advances in nucleic acids for molecular diagnostics and therapeutics, genome engineering, and even nonbiological applications.

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

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………………………………………………………………………(3-0-3)

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……………………………………………………………………………………………(3-0-3)

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…………………………………………………..(3-0-3)

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……………………………………………………………………..(3-0-3)

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………………………………………………………………..(3-0-3)

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…………………………………………………………………………………………..(3-0-3)

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.

AMSE656 Oxide Thin Film Materials and Devices ............................................................... (3-0-3)

- Understand fundamental electronic structure and chemistry of oxide.
- Relate electronic structure to electronic properties.
- Describe the principle of the unique properties in oxide thin films and heterostructures.
- Understand the principles of growth and characterization of oxide thin films
- Apply what you have learned in the class to your research on oxides.

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

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 semesters.
   - Ph.D. Program students must take Graduate Seminar for three semesters.
   - Integrative Program students must take Graduate Seminar for five semesters.
   * Graduate Seminar of foreign students : not mandatory for foreign students.

2. Registering for courses MECH806(Technical Writing), MECH807(Scientific Writing), GEDU141(Technical Writing)
   - Graduation requirement : Requires MECH806 or MECH807 or GEDU141
   - 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 or GEDU141 during a master’s course, you do not need to register for this course.

3. Information about taking the MECH808, 809(Graduate Research Seminar A, B)

<table>
<thead>
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<th>Course</th>
<th>Graduate Research Seminar A</th>
<th>Graduate Research Seminar B</th>
</tr>
</thead>
<tbody>
<tr>
<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>
</tr>
</tbody>
</table>

- This course is mandatory for the new students starting from 2014 Fall semester.
- This course is mandatory for Master’s Program students.
4. The graduate school subject credit includes the following subjects:
   - Undergraduate subjects:
     1) After and including the 2019 academic year number
        Subjects of the department of mechanical engineering are accepted if 400-level are taken as
        grade. Subjects of the other departments are accepted if 300-level or 400-level unit are taken
        as grade. In this case, grade acceptance range is limited to a maximum of 6 credits.

     2) Before the 2018 academic year number
        The scope of acceptance for 400 unit subjects of mechanical engineering and other departments
        is limited to a maximum of 6 credits.

   - Other department graduate school subjects:
     Acceptance ranges in S/U courses are up to 9 credits for master and Ph.D. course, and up to 18
     credits for integration courses. (No acceptance limits for subjects taken as a grade)

2. Course Table

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<td>MECH505</td>
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<td>MECH507</td>
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<td>MECH534</td>
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### 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** ............................................................................. (3-0-3)
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 .......................................................... (3–0–3)
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 ........................................................................ (3–0–3)
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 ........................................................................... (3–0–3)
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 ............................................................ (3–1–3)
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.

MECH527 Advanced Artificial Intelligence for Mechanical Engineering .......................... (3–0–3)
This course is designed to exploit and understand Artificial Intelligence, especially Deep Learning from a perspective of mechanical engineering. Students are expected to learn theoretical backgrounds and their implementations of algorithms in Python. Starting from a basic machine learning, various kinds of neural networks will be intensively studied. Numerical Python coding is heavily required during lectures and homework assignments.

MECH531 Acoustics ............................................................................................................ (3–0–3)
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 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 ortho-tropic 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 these 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 .......................................................................................... (3-0-3)

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 ................................................................................................ (3-0-3)

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 ................................................................ (3-0-3)
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 ............................................................................................. (3-0-3)

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.

MECH574 Capillary and Wetting Phenomena ............................................................................... (3-0-3)

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 ............................................................................................................... (3-0-3)
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**....................................................................................................................... (3-0-3)

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**.................................................................................................... (3-0-3)

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**..................................................................................................................... (3-0-3)

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**..................................................................................... (3-0-3)

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**..................................................................................................... (3-0-3)

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-matching 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** ...................................................................................................... (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.

**MECHECH647 Bioengineering** ........................................................................................................ (3-1-3)

Prerequisites: 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.

**MECH650 Microscale Heat Transfer** ............................................................................................. (3-0-3)

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** ........................................................................................................ (3-0-3)

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** ........................................................................ (1-0-1)

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** ........................................................................................................ (3-0-3)

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

**MECH678 Flow Visualization** ........................................................................................................... (3-0-3)

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 ...................................................... (3-0-3)

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 ........................................................................... (3-0-3)

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 .............................................. (1-3-3)

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 .......................................................... (3-0-3)

MECH702 Special Topics in Mechanical Engineering A/Z .................................................. (Credits can vary)

MECH704 Special Topics in Applied Mechanics A/Z ............................................................ (3-0-3)

MECH707 Special Topics in Thermo Fluids A/Z ................................................................. (3-0-3)

MECH716 Energy Methods .................................................................................................. (3-0-3)

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 ............................................................................ (3-1-3)

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 ................................................................................................ (3-0-3)

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** ................................................................. (3-0-3)

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** ...................................................... (3-0-3)

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** ............................................................ (3-0-3)

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** .............................................. (3-0-3)

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** ......................................................... (3-0-3)

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** .................................................................................. (3-0-3)

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

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 mulit-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

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

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

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

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

MECH808 Graduate Research Seminar A

MECH809 Graduate Research Seminar A

MECH899 Doctoral Dissertation Research (Credits can vary)
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 semester.
- 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>
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<th>Overall Credit</th>
</tr>
</thead>
<tbody>
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<tr>
<td>Ph.D</td>
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<td>14 Credits</td>
<td>32 Credits</td>
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<tr>
<td>Integrative</td>
<td>42 Credits</td>
<td>18 Credits</td>
<td>60 Credits</td>
</tr>
</tbody>
</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 ........................................................................................................... (3-0-3)
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.

IMEN574 Programming for data science .................................................................................... (3-0-3)
Prerequisite: Statistics course (IMEN272, MATH231, MATH230) or equivalent
Integrating course for data science, Statistical knowledge, programming skill, and domain-specific problem solving skill is developed with various area data. Data wrangling, visualization, supervised and unsupervised learning, professional ethics are discussed in class.

IMEN577 Dynamic System ........................................................................................................... (3-0-3)
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 ............................................................................................... (3-0-3)
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.

IMEN582 Game Theory and Business Applications .................................................................... (3-0-3)
This course deals with the interactions among stakeholders (decision makers) in supply chains, such as suppliers, manufacturers, retailers, customers, etc., the strategic behavior of stakeholders, and the resulting dynamics in a market environment. The strategic interaction of a stakeholder with other stakeholders (competitors, customers, and suppliers) can be modeled as a game, and hence, the main tool of analysis in this course will be Game Theory.

IMEN584 Expert Systems ............................................................................................................. (3-0-3)
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 ................................................................................................... (3-0-3)
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 ........................................ (3-0-3)
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** .......................................................... (3-0-3)

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 D egital 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** (3-0-3)
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** (3-0-3)
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** (3-0-3)
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** (3-0-3)
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** (3-0-3)
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** (3-0-3)
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** (3-0-3)
New techniques of solving engineering problems are learned. The subjects includes functional, logic and object-oriented approach.

**IMEN682 Software Engineering** (3-0-3)
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** (3-1-3)
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** (2-2-3)
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** (3-1-3)
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** (3-1-3)
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** (3-1-3)
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** (3-0-3)
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** (3-0-3)
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 and Reinforcement Learning Applications** (3-0-3)
Prerequisite: Operations Research I, II
This course will introduce the art of formulating recursive equations, the theory about how and why dynamic programming can be the method that can solve many of optimization problems involving
sequential decision making in both deterministic and stochastic environment, applications (such as the shortest path problem, equipment replacements, scheduling, optimized control, and inventory control), and computational aspects of dynamic programming. Moreover, the students will have knowledge about approximate dynamic programming and reinforcement learning to handle the critical limit, “curse of dimensionality” of conventional dynamic programming approach.

**IMEN766 Queueing Theory** .................................................................................................................. (3-0-3)
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** .......................................................................................................... (3-0-3)
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** ............................................................................................................ (3-0-3)
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** ......................................................... (3-0-3)
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** ............................................................................................ (3-0-3)
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** ............................................................................................... (3-0-3)
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** ............................................................ (1-0-1)
This course is designed to present and discuss the current researches in the area of common interest in industrial engineering.
IMEN801 IME Seminar I .................................................................(1-0-1)
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.

IMEN802 IME Seminar II .................................................................(1-0-1)
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.

IMEN805 Seminar in Special Topics ..................................................(1-0-1)

IMEN811 Special Topics in Management Engineering A/Z .......................(3-0-3)
This course is designed to present and discuss the current researches in the area of management engineering for acquisition of new knowledge.

IMEN821 Special Topics in Manufacturing Engineering A/Z ......................(3-0-3)
This course is designed to present and discuss the current researches in the area of manufacturing engineering for acquisition of new knowledge.

IMEN841 Special Topics in Human Factors Engineering A/Z .....................(3-0-3)
This course is designed to present and discuss the current researches in the area of human factors engineering for acquisition of new knowledge.

IMEN861 Special Topics in Operations Research A/Z ..............................(3-0-3)
This course is designed to present and discuss the current researches in the area of operations research for acquisition of new knowledge.

IMEN862 Scheduling System ..............................................................(3-0-3)
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.

IMEN881 Special Topics in Information Systems A/Z ................................(3-0-3)
This course is designed to present and discuss the current researches in the area of information systems for acquisition of new knowledge.

IMEN891 Special Topics in Industrial and Management Engineering A/Z .......(1-3)
This course is designed to present and discuss the current researches in the area of industrial and management engineering for acquisition of new knowledge.

IMEN899 Doctoral Dissertation Research ...................................................(1-9)
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,

- **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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<td>24</td>
<td>60</td>
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</table>

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

- 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
  - Graduate courses offered by other Departments
    (Grade type: Grade or S/U, Courses taken under the guidance of an advisor)
  - Up to 6 credits of 200-400 level undergraduate courses offered by the Department of Electrical Engineering and other Departments (Grade type: Grade or S/U)

**[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. Those are including in grade under the POSTECH regulations.
### 3. Course Table

<table>
<thead>
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<td>EECE803</td>
<td>IT Research Paper Presentation Skill</td>
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<td>Control &amp; Power Electronic</td>
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<td>Linear System Theory</td>
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<td>EECE565</td>
<td>Robotics</td>
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<td>EECE672</td>
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<td>EECE577</td>
<td>Information and Coding Theory</td>
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<td>EECE578</td>
<td>Digital Communication</td>
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<td>EECE579</td>
<td>Information and Communication Security</td>
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<td>EECE580</td>
<td>Spread-Spectrum Communications</td>
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<td>EECE581</td>
<td>Advanced Digital Signal Processing</td>
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<td>EECE582</td>
<td>Error-correcting Codes</td>
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<td>EECE589</td>
<td>Modern Coding Theory</td>
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<td>EECE645</td>
<td>Statistical Signal Processing</td>
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<td>EECE646</td>
<td>Introduction to Space-time Communication</td>
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<td>EECE669</td>
<td>High-speed data Communication</td>
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<td>EECE670</td>
<td>Signal Design</td>
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<td>EECE677</td>
<td>Cryptographic Algorithms</td>
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<td>EECE754A/Z</td>
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<td>Processing A/Z</td>
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<td>EECE553</td>
<td>Introduction to Neural Networks</td>
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<td>EECE573</td>
<td>Parallel Programming Using Clusters</td>
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<td>Field &amp; Super High Frequency</td>
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<td>EECE585</td>
<td>Radar System Engineering I</td>
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<td>EECE586</td>
<td>Numerical Techniques in Electromagnetics</td>
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<td>EECE587</td>
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<td>Antenna Theory and Design I</td>
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<td>EECE753A/Z</td>
<td>Special Topic in Electromagnetics A/Z</td>
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<td>Semiconductor &amp; Quantum</td>
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<td>Physics of Semiconductor and Display Devices</td>
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<td>Electronics</td>
<td>EECE555</td>
<td>Properties of Optical Materials and Devices</td>
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<td>EECE556</td>
<td>Semiconductor Devices I</td>
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<td>EECE557</td>
<td>Compound Semiconductor Devices</td>
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<td>EECE558</td>
<td>Semiconductor Crystal Growth</td>
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<td>EECE559</td>
<td>Principles of Biomedical Opt. &amp; Imaging</td>
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<td>EECE560</td>
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<td>Semiconductor devices II</td>
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<td>Applied Quantum Mechanics I</td>
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<td>EECE637</td>
<td>Physics &amp; Characterization of Next-generation Devices</td>
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<td>EECE638</td>
<td>Advanced Digital Integrated Circuit Design</td>
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<td>EECE639</td>
<td>Printed Organic Thin Film Transistor</td>
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<td>EECE642</td>
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<td>EECE653</td>
<td>Semiconductor Fabrication Processing</td>
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<td>EECE657A/Z</td>
<td>Special Topics in Semiconductor Devices A/Z</td>
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<td>EECE676</td>
<td>Guided Wave and Integrated Optics</td>
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<td>EECE752A/Z</td>
<td>Special Topics in Solids and Quanta A/Z</td>
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<td>VLSI</td>
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<td>Analog Integrated Circuits</td>
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<tr>
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<td>EECE572</td>
<td>Circuit Analysis Algorithms and Software</td>
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</table>
### 4. Course Description

**EECE550 Advanced Computer Design**

Prerequisites: Computer Design

Advanced computer design techniques are taught with design implementation practice using Verilog HDL and simulation. High-performance 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**

Prerequisites: 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**

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**

Prerequisites: Signals and Systems, Memory Network, Programming language

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.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Description</th>
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<tbody>
<tr>
<td>EECE554</td>
<td>Physics of Semiconductor and Display Devices</td>
<td>Semiconductor Electronics I</td>
<td>Advanced Nano devices, semiconductors, quantum devices, statistics, and analyses are covered. Displays like LED, OLED, LCD, PQR are treated.</td>
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<tr>
<td>EECE555</td>
<td>Properties of Optical Materials and Devices</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>EECE556</td>
<td>Semiconductor Devices I</td>
<td>Semiconductor Electronics I</td>
<td>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.</td>
</tr>
<tr>
<td>EECE557</td>
<td>Compound Semiconductor Devices</td>
<td>Physics of Semiconductor and Display</td>
<td>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.</td>
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<tr>
<td>EECE558</td>
<td>Semiconductor Crystal Growth</td>
<td>Electronic Materials Engineering</td>
<td>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.</td>
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<tr>
<td>EECE559</td>
<td>Principles of Biomedical Opt. &amp; Imaging</td>
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<td>This course will cover two main topics including the principles of optical photon transport in biological tissues and various optical imaging techniques. The former topic includes an introduction to biomedical optics, Monte Carlo modeling of photon transport, radiative transfer equation and diffusion theory, hybrid Monte Carlo method and diffusion theory, and optical spectroscopy. The later part covers ballistic imaging, optical coherence tomography, diffuse optical tomography, photoacoustic tomography, and ultrasound-modulated optical tomography.</td>
</tr>
<tr>
<td>EECE560</td>
<td>Nanoelectronics</td>
<td>Physics of Semiconductor and Display</td>
<td>This course covers analysis of semiconductor surface, quantum state, conduction mechanism at surface, optical properties and elastic properties, surface processing technique and device application.</td>
</tr>
<tr>
<td>EECE561</td>
<td>Semiconductor devices II</td>
<td>Semiconductor electronics II</td>
<td>Basic principles of semiconductor, junctions and MOS will be reviewed. Then MOSFET device will be studied. The two-terminal, three-terminal and the four-terminal MOS structure, topics on implanted channels and small dimension effect, large signal and small signal modeling will be covered.</td>
</tr>
</tbody>
</table>
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: Automatic Control Theory, 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: 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: Electronic Circuit I, 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: 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** ......................................................................................................................... (3-0-3)

Prerequisite: 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** .......................................................................................... (3-0-3)

Prerequisite: 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** ................................................................................................. (3-0-3)

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 (this type of system is referred to as a cluster). 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** ....................................................................................................... (3-0-3)

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** .................................................................................................................. (3-0-3)

Prerequisite: 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: 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: Probability and Statistics, 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: 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: 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: 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 ................................................................................. (3-0-3)
   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 ........................................................................................................... (3-0-3)
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 ........................................................................................................... (3-0-3)
Prerequisite: 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 ........................................................................................................... (3-0-3)
Prerequisite: 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 ...................................................................................... (3-0-3)
Prerequisite: 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 ................................................................................................................ (3-0-3)
Prerequisite: Electromagnetic Waves
This course covers transmission lines, wave-guides, resonators, coupled mode theory, power divider and combiner, scattering parameter, impedance, matching, and plane wave propagation in ferrite medium.

EECE588 Antenna Theory and Design I ........................................................................................................ (3-0-3)
Prerequisite: 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 .................................................................................................................. (3-0-3)
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 ......................................................... (0–5–3)

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 ............................................................................ (3–0–3)

Prerequisites: 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 ............................................................................ (3–0–3)

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 .............................................................. (1–0–1)

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

EECE596 RFIC design ................................................................................................. (3–0–3)

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 ...................................................................................... (3–0–3)

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 ...................................................................................... (3–0–3)

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 .................................................................. (3–0–3)

Prerequisite: 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.

EECE637 Physics & Characterization of Next-generation Devices

The technology node of devices has been decreasing to nanoscale. As the device size has been smaller, the classical device physics cannot explain structural and physical properties. Therefore, it is necessary for semiconductor classes to be connected with quantum mechanics for understanding and utilizing nanoscale devices. This course will introduce recent device physics and new measurement technologies and also teach some device applications such as photovoltaic devices and semiconductor sensors.

EECE638 Advanced Digital Integrated Circuit Design

We discuss various issues in high-speed/low-power digital circuit design. As the device size becomes smaller and the supply voltage becomes lower, semiconductor logic and memory experience various issues such as stability, leakage and reliability. We focus on understanding the root causes and discussing the state-of-art design techniques. We plan to read research papers and have discussion sessions throughout the course.

EECE639 Printed Organic Thin Film Transistor

This course presents overall discussion of printed organic thin film transistors and their applications. Various topics related to the subject are covered, including printing technology and ink rheology, organic semiconductor, working principles and characterization of organic transistors, and state-of-art examples of printed circuits and system.

EECE642 Advanced MOS Devices

Prerequisites: 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** (3-0-3)

Prerequisites: Digital Communication, 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** (3-0-3)

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** (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.

**EECE654 Plasma Processing** (3-0-3)

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** (3-0-3)

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

**EECE656 Semiconductor Quantum Optics** (3-0-3)

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 ................................................................. (3-0-3)

Prerequisite: 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 ............................................................................................. (3-0-3)

Prerequisite: 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: Introduction to Automatic Control, Mathematics for Electronics and Electrical Engineers A

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: 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: Digital System Design, 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: 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
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. (3-0-3)

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 crypto-systems. Topics include maximal length sequences (or m-sequences), Walsh sequences, Kasami sequences, Gold sequences, quaternary sequences with low correlation and Hadamard matrices. (3-0-3)

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. (3-0-3)

EECE672 Linear Optimal Control
Prerequisite: Linear System Theory
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. (3-0-3)

EECE673 Radar System Engineering II
Prerequisite: 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. (3-0-3)

EECE675 Electromagnetic Compatibility
Prerequisite: 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 ................................................................. (3-0-3)

Prerequisites: 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 .............................................................................. (3-0-3)

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 .................................................................................. (3-0-3)

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 .............................................................................................. (3-0-3)

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 ............................................... (3-0-3)

Prerequisites: Depends on the topics

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

EECE699 Master Thesis Research .................................................................................. (1-9)

A research course for Master’s thesis.

EECE750A/Z Special Topics in Computer Engineering A/Z ...................................... (3-0-3)

A research course for Master’s thesis.

EECE751 Speech Recognition and Synthesis .............................................................. (3-0-3)

This course is related with the aspects of Bio-physiology, Digital Signal Processing, Natural Language Processsign, 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 processsign 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 ....................................................... (3–0–3)

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 ............................................................ (3–0–3)

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.
Department of Computer Science and Engineering

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 image and video processing, non-photo realistic rendering, and 3D curved surface reconstruction. Another area of constant interest and research conducted in the lab is in the development of industrial application and technologies 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. The research goal 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 closely related 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 as a result of the development of processor, memory and other computing components. Nonetheless, this area needs further research as its application expands. 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, operating systems for embedded systems, system performance enhancement using flash memory, and I/O components performance enhancement to match high-speed processing unit.

  Software development has also advanced significantly thanks to the 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 software for embedded systems. For this, our lab is currently conducting research on programming language, software reuse and, software specification action tool to be used in the areas dealing with real-time requirements. In addition, research is underway also on data-mining technology that goes beyond database management and automatically extracts new related information from the stored data.

  As computer systems are used in an increasing number of application areas, user dependency on computer system has also become higher than ever. 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 the 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. Our Lab also conducts research on Software-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 research areas in Multimedia Communication.

[Credits Required for Degree]

<table>
<thead>
<tr>
<th>Programs</th>
<th>Course Credit</th>
<th>Research Credit</th>
<th>Overall Credit</th>
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<tbody>
<tr>
<td>Master’s Program</td>
<td>18</td>
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<tr>
<td>Doctoral Program</td>
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<td>17</td>
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<tr>
<td>MS/PhD Integrated Program</td>
<td>30</td>
<td>30</td>
<td>60</td>
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[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 as course credits)
   - CSE graduate courses
   - Graduate courses from other departments at POSTECH (as per the Department’s internal rules):
     for master’s program up to 6 credits, for doctoral program up to 6 credits, for MS/PhD Integrated Program up to 9 credits can possibly be counted as course credits):
   - 300, 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. CSED 802, 803
      - CSED802 IT Scientific Writing is a required course for all students in the Master’s, PhD, and Integrated programs.
      - CSED803 IT Research Paper Presentation Skill is a required course for students in the PhD and Integrated programs
      * Note: The two required courses above, CSED802 and CSED803, are not counted as part of the credits required for graduation but are included in GPA calculations,
### 3. Program Overview

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<thead>
<tr>
<th>Category</th>
<th>Area</th>
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<tr>
<td>Common Subjects</td>
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<td>CSED802/EECE802</td>
<td>IT Scientific Writing</td>
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<td>CSED803/EECE803</td>
<td>IT Research Paper Presentation Skill</td>
<td>3-0-2</td>
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<td>Common Subject</td>
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<td>Advanced Probability Theory for CSE</td>
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<td>Theory of Computation</td>
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<td>CSED508</td>
<td>Discrete and Computational Geometry</td>
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<td>CSED509</td>
<td>Computer Animation</td>
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<td>CSED511</td>
<td>Introduction to Virtual Reality</td>
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<td>CSED514</td>
<td>Pattern Recognition</td>
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<td>CSED521</td>
<td>Fuzzy and Intelligent</td>
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<td>Advanced topics in Virtual Reality</td>
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<td>CSED617</td>
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<td>CSED518</td>
<td>Linguistics Basis for Natural Language</td>
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<td>Processing</td>
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<td>CSED523</td>
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<td>CSED506</td>
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<td>CSED536</td>
<td>Advanced Algorithms</td>
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4. Course Description

CSED500 Advanced Linear Algebra for CSE............................................................................................................. (3-0-3)

In this course, we study linear algebra theory widely used in various areas of Computer Engineering such as Gaussian Elimination, Vector Space and Linear Equations, Orthogonality, Determinant, Eigen-values and Eigen-vectors, and Positive Definite Matrices, etc.

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 include 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 super scalar 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** .............................................................. (3-0-3)

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** .............................................................................. (3-0-3)

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 modelling, test generation, fault simulation, testable design, and fault-tolerance circuits.

**CSED507 Software Engineering** ............................................................................ (3-0-3)

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** .................................................. (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 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** ............................................................................ (3-0-3)

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................................................................. (3-0-3)

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........................................................................................................ (3-0-3)

Recommended Prerequisites: CSED321 (Programming Language), MATH230 (Probability and Statistics)

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......................................................................................... (3-0-3)

Recommended Prerequisites : MATH230 (Probability and Statistics)

This course deals with pattern classification theory and practice. Among several pattern classification area, 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....................................................................................... (3-0-3)

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 ....................................... (3-0-3)

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 ......................................................... (3-0-3)

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 also those that were not, and students put the concepts to practice through class projects.

CSED521 Fuzzy and Intelligent Systems ................................................................................... (3-0-3)

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 ..................................................................... (3-0-3)

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 ................................................................................... (3-0-3)

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 ................................................................................................................ (3-0-3)

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.

**CSED530 Advanced Probability Theory for CSE**

This course provides a broad overview of probability theory, random variables and random process for the graduate students of Computer Science Engineering.

**CSED532/MATH532 Applications of Mathematics and Big Data**

Recommended Prerequisite: MATH230 (Probability and Statistics)

We understand basic concepts of data analysis and machine learning using mathematical methodology. Based on this, we implement machine learning algorithms directly and analyze the latest trends.

**CSED536 Advanced Algorithms**

Recommended 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.

**CSED537/AIGS537 Artificial Intelligence & Data Science**

Recommended Prerequisites: MATH203 (Applied Linear Algebra), MATH261 (Discrete Mathematics)

This course will introduce the history of artificial intelligence research and recent trends, exploring different topics between two active research areas in AI: Computer Vision (CV), Natural Language Processing (NLP), Computer Graphics (CG), and Data Mining (DM), and Machine Learning (ML). In this course, professors in these areas together will present the relevant core subjects and discuss interdisciplinary topics to form an integrated viewpoint on AI research.

**CSED538/AIGS538 Deep Learning**

Recommended Prerequisites: MATH203 (Applied Linear Algebra), MATH261 (Discrete Mathematics)

The goal of this class is to study basic theory and the practice of deep learning, a branch of machine learning concerned with modern neural networks, which is behind many recent advances in AI. We will cover a range of topics from basic neural network models, training techniques, and their applications to problem domains of vision, linguistics and speech recognition as well as cross-model learning.
CSED551 Computational Photography

Recommended Prerequisites: CSED451 (Computer Graphics)

This course will review recent research papers of computational photography and discuss research trends and directions. The topics will include graphics and vision subjects related to images and videos.

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)

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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 ........................................................................................................... (3-0-3)
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 ......................................................................................................... (3-0-3)
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 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 ................ (3-0-3)
This course provides an broad overview of probability theory, random variables, and random process for the graduate students of computer science engineering.

CSED610 Information Retrieval ....................................................................................................................... (3-0-3)
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 .......................................................................................................................... (3-0-3)
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 ....................................................................................................... (3-0-3)
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

This course introduces the basic concept of multimedia networking and various theories and algorithms that guarantee the quality of multimedia services over both wired and wireless networks. It also covers various technologies that improve the quality of multimedia services over the networks that only support best-effort services such as the Internet.

CSED627/AIGS627 Reinforcement Learning

Recommended Prerequisites : CSED515 (Machine Learning), MATH230 (Probability and Statistics)

This course aims at studying basic theory and practical algorithms of reinforcement learning (RL) so that students are able to understand various research papers on RL, application of RL techniques to problems in other fields, and hopefully, formulating/solving research problems in RL.
CSED699 Master Thesis Research
A research course for Master's thesis.

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

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

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

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

CSED800A/B Computer Science Colloquium A/B
(1-0-1)

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

CSED802/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.

CSED803/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 knowledge 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/ homogeneous/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:

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<tr>
<th>Program</th>
<th>Course Credits</th>
<th>Research Credits</th>
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<td>Ph.D Program</td>
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<td>32</td>
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<tr>
<td>M.S-Ph.D Integrated Program</td>
<td>24</td>
<td>36</td>
<td>60</td>
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</table>

List of offered courses that award research credits.
- CHEB699 Master Thesis Research
- CHEBB11 Graduate Seminar
- CHEBB12 Project Research for R&D of School-Industry Cooperation
- CHEB899 Doctoral Dissertation Research

Candidates must complete the following to earn course credits:
- All major courses offered in the Department of Chemical Engineering with exception to research courses
- Graduate courses offered in other departments
- Selected undergraduate courses with 200~400 level offered in other departments and 300~400 level offered in the Department of Chemical Engineering (Maximum of 6 course credits)
### 3. Course Table

<table>
<thead>
<tr>
<th>Category</th>
<th>Course No.</th>
<th>Course Title</th>
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<td>Major</td>
<td>CHEB511</td>
<td>Catalysis</td>
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<tr>
<td>Elective</td>
<td>CHEB551</td>
<td>Engineering Optimization</td>
<td>2-2-3</td>
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<td>CHEB553</td>
<td>Clean Process and Energy System</td>
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<td>CHEB561</td>
<td>Integrated Circuit Processing</td>
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<td>CHEB611</td>
<td>Advanced Reaction Engineering</td>
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<td>CHEB621</td>
<td>Advanced Thermodynamics</td>
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<td>Advanced Biochemical Engineering</td>
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<td>CHEB641</td>
<td>Advanced Chemical Engineering Mathematics</td>
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<td>Advanced Metabolic Engineering</td>
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<td>Transcriptional Regulation for Synthetic Biotechnology</td>
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<td>Protein Biosynthesis</td>
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<td>CHEB713</td>
<td>Chemical Reactor Analysis and Design</td>
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<td></td>
<td>CHEB722</td>
<td>Surface and Interface of Materials</td>
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<td></td>
<td>CHEB737</td>
<td>Advanced Molecular Biotechnology</td>
<td>3-0-3</td>
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<td></td>
<td>CHEB738</td>
<td>Introduction of Marine Environments and Biotechnology</td>
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<td></td>
<td>CHEB744</td>
<td>Statistical Fluid Mechanics</td>
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<td></td>
<td>CHEB745</td>
<td>Numerical Analysis in Chemical Engineering</td>
<td>3-0-3</td>
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<tr>
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<td>CHEB751</td>
<td>Advanced Process Design</td>
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<td>CHEB752</td>
<td>Process Synthesis and Analysis</td>
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<tr>
<td></td>
<td>CHEB760</td>
<td>Polymer Blends</td>
<td>2-2-3</td>
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<tr>
<td></td>
<td>CHEB763</td>
<td>Conducting Polymers and Characterization</td>
<td>3-0-3</td>
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<td></td>
<td>CHEB766</td>
<td>Advanced Organic Material Chemistry</td>
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<td>CHEB768</td>
<td>Ceramic Materials Processing</td>
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<td>CHEB769</td>
<td>Semiconductor Materials Processing</td>
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<td></td>
<td>CHEB776</td>
<td>Interface and Adhesion for Electronic &amp; Information Materials</td>
<td>3-0-3</td>
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<td></td>
<td>CHEB777</td>
<td>Advanced Functional Nanomaterials</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>CHEB781</td>
<td>Photocatalysis for Energy and Environmental Applications</td>
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<td>Research</td>
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<td>Master Thesis Research</td>
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<td>CHEB811A-Z</td>
<td>Graduate Seminar</td>
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<td></td>
<td>CHEB812</td>
<td>Project Research for R&amp;D of School-Industry Cooperation</td>
<td>0-0-9</td>
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<tr>
<td></td>
<td>CHEB899</td>
<td>Doctoral Dissertation Research</td>
<td>credits varies</td>
</tr>
</tbody>
</table>
4. Course Description

CHEB511 Catalysis

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

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

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

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

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

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

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

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.

CHEB722 Chemical Reactor Analysis and Design ................................................... (3-0-3)
This lecture aims at understanding the surface and interface of materials needed in materials engineering design.

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**

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

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

New research trends in Chemical Engineering are introduced.

CHEB781 Photocatalysis for Energy and Environmental Applications

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

New research trends in Chemical Engineering are introduced.

CHEB811A-Z Graduate Seminar A-Z

Seminars for graduate students, which are related to all areas of chemical engineering are delivered by invited speakers.

CHEB812 Project Research for R&D of School-Industry Cooperation

Experimental research relating to industrial projects together with experts in actual industries. Handling real industrial projects focusing on bioenergy and related areas.

CHEB899 Doctoral Dissertation Research

Experimental and theoretical research in all areas of chemical engineering needed for obtaining Doctoral Degree, methods are introduced for graphical models.
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>
</tr>
</thead>
<tbody>
<tr>
<td>Master’s program</td>
<td>15</td>
<td>13</td>
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</tr>
<tr>
<td>Doctoral program</td>
<td>12</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>MS/PhD integrated program</td>
<td>27</td>
<td>33</td>
<td>60</td>
</tr>
</tbody>
</table>

[Guidelines for Coursework]

1) Course credit requirements for a graduate degree may be fulfilled by:
   A. Graduate courses from CiTE and/or other departments at POSTECH
   B. Undergraduate courses from CiTE and/or other departments at POSTECH

- Note 1: Course credits approval about undergraduate courses
  - To enrolled students until 2018: 400-level undergraduate courses can be counted toward course credits up to a total of 6 credits.
  - To enrolled students from 2019: Undergraduate courses can be counted toward course credits up to a total of 6 credits, but 200,300-level undergraduate courses can be counted up to 3 credits among 6 credits. (100-level courses cannot be counted.)
- Note 2: Credits from Master’s Thesis/Doctoral Dissertation Research courses and Seminar courses may not be counted toward course credits.
- Note 3: It is recommended for students who did not receive an undergraduate degree from CiTE to take undergraduate Creative Studio courses.
Note 4: If a creative IT graduate student takes an undergraduate (excluding liberal arts) or a graduate course in another department, he or she can receive letter grade to S/U. But graduate student of integrated program will be accepted up to six credits, and graduate student of the doctoral and master’s program will be accepted up to three credits with S/U.

2) Required courses:
   A. CITE801 IT Scientific Writing: Mandatory courses for master’s, doctoral and integrated program
   B. CITE802 IT Research Paper Presentation Skill: Mandatory courses for doctoral and integrated program

3) Graduation requirements for master’s degree
   A. Required course: CITE801 IT Scientific Writing
   B. Completion of credits: Total 28 (Course 15 + Research 13)
   C. Passing comprehensive examination and submission of thesis

### 3. Course List

<table>
<thead>
<tr>
<th>Category</th>
<th>Course Number</th>
<th>Course Title</th>
<th>Lec-Lab-Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electives</td>
<td>CITE521/CSED504</td>
<td>Advanced Operating System</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>CITE522/CSED518</td>
<td>Linguistics Basis for Natural Language Processing</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>CITE523/CSED521</td>
<td>Fuzzy and Intelligent System</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>CITE524/CSED526</td>
<td>Introduction to Data Mining</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>CITE531/EECE553</td>
<td>Introduction to Neural Networks</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>CITE532/EECE558</td>
<td>Advanced Materials for Nano Semiconductor</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>CITE533/EECE564</td>
<td>Linear System Theory</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>CITE534/EECE571</td>
<td>VLSI System Design</td>
<td>3-0-3</td>
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<tr>
<td>Electives</td>
<td>CITE535/EECE579</td>
<td>Information and Communication Security</td>
<td>3-0-3</td>
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<tr>
<td>Electives</td>
<td>CITE536/EECE560</td>
<td>Nano Electronics and Quantum Mechanics</td>
<td>3-0-3</td>
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<td>Electives</td>
<td>CITE537/EECE557</td>
<td>Compound Semi, Devices</td>
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<td>Electives</td>
<td>CITE538</td>
<td>Intelligent Robotics</td>
<td>3-0-3</td>
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<td>Electives</td>
<td>CITE539</td>
<td>Quantum Mechanics for Applied Nanotechnology</td>
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<td>Electives</td>
<td>CITE540</td>
<td>Social Problem Solving &amp; Hazardous Robotics</td>
<td>3-2-4</td>
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<tr>
<td>Electives</td>
<td>CITE551/EECE559</td>
<td>Principles of Biomedical Opt. &amp; Imaging</td>
<td>3-0-3</td>
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<tr>
<td>Electives</td>
<td>CITE552/MECH532</td>
<td>Tissue Eng. for mechanical Engineers</td>
<td>3-0-3</td>
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<tr>
<td>Electives</td>
<td>CITE553</td>
<td>Medical Device Design Process</td>
<td>3-0-3</td>
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<tr>
<td>Electives</td>
<td>CITE611</td>
<td>A Study on Interplays of Human,&amp;Tech.</td>
<td>3-0-3</td>
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<tr>
<td>Electives</td>
<td>CITE612</td>
<td>Conv. Imagination &amp; Design Thinking of Eng.</td>
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<tr>
<td>Electives</td>
<td>CITE621/CSED605</td>
<td>Real-time Systems</td>
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<tr>
<td>Electives</td>
<td>CITE622/CSED610</td>
<td>Information Retrieval</td>
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<td>Electives</td>
<td>CITE623/CSED611</td>
<td>Machine Translation</td>
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<td>CITE631/EECE651</td>
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<td>Electives</td>
<td>CITE632/EECE653</td>
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<td>Electives</td>
<td>CITE634/EECE664</td>
<td>System Identification Theory</td>
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<tr>
<td>Electives</td>
<td>CITE635/EECE667</td>
<td>Circuit Analysis Algorithms and Software</td>
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<td>Electives</td>
<td>CITE636/EECE672</td>
<td>Linear Optimal Control</td>
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<td>Electives</td>
<td>CITE637/EECE637</td>
<td>Phys. &amp; characteriz. of next-gen. Devices</td>
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<tr>
<td>Electives</td>
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<tr>
<td>Electives</td>
<td>CITE700A-Z</td>
<td>Special Topics in Creative IT</td>
<td>Variable Credit</td>
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<tr>
<td>Electives</td>
<td>CITE801/EECE802</td>
<td>IT Scientific Writing</td>
<td>3-0-2</td>
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<tr>
<td>Electives</td>
<td>CITE802/EECE803</td>
<td>IT Research Paper Presentation Skill</td>
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</table>
4. Course Description

CITE521/CSED504 Advanced Operating System ................................................................. (3–0–3)

Recommended Prerequisites: CSED312(Operating System)

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)

Prerequisites: Basic Calculus and Linear Algebra, Signals and Systems.

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.

**CITE532/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.

**CITE533/EECE564 Linear System Theory** ........................................................................................................... (3-0-3)

Prerequisites: EECE322(Automatic Control Theory)

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)

Prerequisites: 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 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.

**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.

**CITE538 Intelligent Robotics** ......................................................................................................................... (3-0-3)

The goal is to understand the fundamental of intelligent robot system for practical applications. This course introduces the fundamental of modern robotics and prospective applications. In the aspect of system engineering, essential elements of robot system: sensing, intelligence, behavior will be focused. Various examples of robotic intelligence and implementation technique will be studied. The class includes theoretical and practical aspects of the topic.
CITE539 Quantum Mechanics for Applied Nanotechnology .................................................................. (3-0-3)

Quantum mechanics is widely used in various fields such as nanotechnology, information technology, medical technology, and biotechnology as major understanding tools. As the size of semiconductor devices decreases, academic and engineering approaches should be required to comprehend quantum effects in order to investigate novel physical phenomena different from classical physics. The purpose of this course is to provide students majored in engineering with the background of nanotechnology and the basic knowledge of quantum mechanics for nano devices and their applications, especially on semiconductor devices.

CITE540 Social Problem Solving & Hazardous Robotics ................................................................ (3-2-4)

This class introduces hazardous and extreme environment robotics. The key components, the special features and design method of the robotics will be introduced. To find and solve the social problems, various kinds of knowledge are required such as the humanities, social science as well as various engineering-based knowledge. For this interdisciplinary study, this course adopts the project-based learning method. For the robotics, Prof. Son-Cheol Yu will teach the essential knowledge of the hazardous and extreme environment robotics. For the social science-related field study, Prof. Jin-Taek Kim will teach social science and value design of the proposed idea. Finally, students will design and build an actual robot system for the proposed social solution as a term project.

CITE551/EECE559 Principles of Biomedical Opt. & Imaging ............................................................ (3-0-3)

This course will cover two main topics including the principles of optical photon transport in biological tissues and various optical imaging techniques. The former topic includes an introduction to biomedical optics, Monte Carlo modeling of photon transport, radiative transfer equation and diffusion theory, hybrid Monte Carlo method and diffusion theory, and optical spectroscopy. The later part covers ballistic imaging, optical coherence tomography, diffuse optical tomography, photoacoustic tomography, and ultrasound-modulated optical tomography.

CITE552/MECH532 Tissue Eng. for Mechanical Engineers ................................................................. (3-0-3)

Tissue engineering is the use of a combination of cells, engineering and materials methods, and suitable biochemical and physicochemical 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, biomaterials, 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.

CITE553 Medical Device Design Process ............................................................................................ (3-0-3)

This course focuses on management principles and tools for an effective medical device development process. The course will cover the entire spectrum of the product development process including the market research, technology landscaping, concept generation, prototype development, performance evaluation, product launching and post-market surveillance. Practical aspects in developing a medical device are discussed near the end.

CITE611 A Study on Interplays of Humanities and Technology ......................................................... (3-0-3)
This course introduces new modes of knowledge production that are based on the interplays between humanities, arts, and technology. When engineering knowledge and skills are combined with humanistic, social, and artistic imagination, transformative innovations can emerge. By exploring a diverse range of intersections between technology and arts, humanities, and social sciences, it is expected that students be familiarised with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in brining social, humanistic, and artistic dimensions into science and engineering fields and vice versa.

CITE612 Convergence Imagination & Design Thinking of Engineering .................................................. (3-0-3)

<Convergence Imagination & Design Thinking of Engineering> is a course in which students suggest solutions to specific reality problems by designing multidisciplinary knowledge and practice them, based on humanities knowledge and introspection. Through the this course, students break away from the narrowed, short-sighted worldview of engineers and are trained to understand humans and the world more holistically and practice intuitive insights through philosophy. Graduate students who are on the path of engineers as professionals are sincerely concerned about the meaning and value of their research, but there are few opportunities to work on creative issues and solutions with other field researchers. To solve these problems this class, based on engineering knowledge, both plan and realize the convergence contents and projects of humanities and technologies.

Using multi-disciplinary knowledge fusion, we are planning to implement new project planning in areas such as human-centered design, UX_UI Service, Eco_Sustainability, Biomimetics, communication design and media art.

CITE621/CSED605 Real-time Systems ............................................................................................................. (3-0-3)

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 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)

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. 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)

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.

CITE631/EECE651 Computational Intelligence ............................................................................................................. (3-0-3)
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. 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)
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.

CITE634/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.

CITE635/EECE667 Circuit Analysis Algorithms and Software .................................................. (3-0-3)
Prerequisite: EECE273(Digital System Design), EECE571(VLSI System Design)
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/EECE672 Linear Optimal Control .............................................................................. (3-0-3)
Prerequisite: EECE564(Linear System Theory)
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.

CITE637/EECE637 Physics & Characterization of Next-generation Devices............................. (3-0-3)

The technology node of devices has been decreasing to nanoscale. As the device size has been smaller, the classical device physics cannot explain structural and physical properties. Therefore, it is necessary for semiconductor classes to be connected with quantum mechanics for understanding and utilizing nanoscale devices. This course will introduce recent device physics and new measurement technologies and also teach some device applications such as photovoltaic devices and semiconductor sensors.

CITE638/EECE638 Advanced Digital Integrated Circuit Design.............................................. (3-0-3)

We discuss various issues in high-speed/low-power digital circuit design. As the device size becomes smaller and the supply voltage becomes lower, semiconductor logic and memory experience various issues such as stability, leakage and reliability. We focus on understanding the root causes and discussing the state-of-art design techniques. We plan to read research papers and have discussion sessions throughout the course.

CITE639/EECE639 Printed Organic Thin Film Transistor......................................................... (3-0-3)

This course presents overall discussion of printed organic thin film transistors and their applications. Various topics related to the subject are covered, including printing technology and ink rheology, organic semiconductor, working principles and characterization of organic transistors, and state-of-art examples of printed circuits and system.

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.

CITE801/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.

CITE802/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.

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**

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.

**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.
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. DESE does not have an undergraduate program.

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>
<tr>
<td>Ph.D</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Ms-Ph.D Integrated</td>
<td>24</td>
<td>36</td>
</tr>
</tbody>
</table>

All DESE student should take three or more Environmental core subjects 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>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EVSE510</td>
<td>Introduction to Environmental Engineering</td>
</tr>
<tr>
<td>2</td>
<td>EVSE525</td>
<td>Water Pollution</td>
</tr>
<tr>
<td>3</td>
<td>EVSE540</td>
<td>Environmental Biotechnology</td>
</tr>
<tr>
<td>4</td>
<td>EVSE575</td>
<td>Global Environment</td>
</tr>
<tr>
<td>5</td>
<td>EVSE579</td>
<td>Environmental Statistics</td>
</tr>
<tr>
<td>6</td>
<td>EVSE581</td>
<td>Environmental Physical Chemistry</td>
</tr>
<tr>
<td>7</td>
<td>EVSE583</td>
<td>Environmental Inorganic Chemistry</td>
</tr>
<tr>
<td>8</td>
<td>EVSE584</td>
<td>Earth Environmental Fluid Dynamics</td>
</tr>
<tr>
<td>9</td>
<td>EVSE587</td>
<td>Environmental Organic Chemistry</td>
</tr>
<tr>
<td>10</td>
<td>EVSE680E</td>
<td>Environmental Risk Assessment</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 subjects listed below. However, the examination can be exempted for students obtaining grades above ‘A’ from the courses of selected subject and students will thereby be recognized to have passed the qualification.(from student number 2019, grade above ‘A’ recognized as pass) 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>
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</tr>
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<tbody>
<tr>
<td>Major</td>
<td>EVSE501</td>
<td>Introduction to Environmental Studies</td>
<td>3-0-3</td>
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<td>Elective</td>
<td>EVSE510</td>
<td>Introduction to Environmental Engineering</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE520</td>
<td>Air Pollution</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE525</td>
<td>Water Pollution</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE535</td>
<td>Waste Management</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE540/IBIO665</td>
<td>Environmental Biotechnology</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE550</td>
<td>Environmental Engineering Laboratory</td>
<td>1-6-3</td>
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<tr>
<td></td>
<td>EVSE565</td>
<td>Reaction Engineering</td>
<td>3-0-3</td>
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<tr>
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<td>EVSE575</td>
<td>Global Environment</td>
<td>3-0-3</td>
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<td>EVSE579/MATH538</td>
<td>Environmental Statistics</td>
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<td></td>
<td>EVSE580/IBBT622K</td>
<td>Polymers and the Environment</td>
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<td>EVSE581</td>
<td>Environmental Physical Chemistry</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE582</td>
<td>Introduction to Climate Change</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE583</td>
<td>Environmental Inorganic Chemistry</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE584</td>
<td>Earth Environmental Fluid Dynamics</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE585</td>
<td>Basic Principles in Environmental Materials</td>
<td>3-0-3</td>
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<td></td>
<td>EVSE586</td>
<td>Environmental Nanoporous Materials</td>
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<td>EVSE587</td>
<td>Environmental Organic Chemistry</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td>EVSE590/NUCE546</td>
<td>Bioremediation Engineering</td>
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<td>EVSE621</td>
<td>Wastewater Treatment Engineering</td>
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<tr>
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<td>EVSE655</td>
<td>Mass Spectrometry</td>
<td>3-0-3</td>
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<td>EVSE661</td>
<td>Environmental Instrument Analysis and Experiments</td>
<td>1-6-3</td>
</tr>
<tr>
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<td>EVSE665</td>
<td>Mass Spectrometry</td>
<td>3-0-3</td>
</tr>
<tr>
<td></td>
<td>EVSE667</td>
<td>Pollutant Analysis</td>
<td>3-0-3</td>
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<td>EVSE680 A-Z</td>
<td>Special Topics in Environmental Engineering A-Z</td>
<td>3-0-3</td>
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<td>Research</td>
<td>EVSE681/MEIE655/WE5S587</td>
<td>Alternative Energy</td>
<td>3-0-3</td>
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<td>EVSE711A-D</td>
<td>Advanced Environmental Processes A-D</td>
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<td>EVSE720</td>
<td>Photocatalysis for Energy and Environmental Applications</td>
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<td>EVSE725</td>
<td>Environmental Bioprocess Engineering</td>
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<td>EVSE730/CHEB738</td>
<td>Introduction of Marine Environments and Biotechnology</td>
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<td>EVSE699</td>
<td>Master Thesis Research</td>
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<td>EVSE899</td>
<td>Doctoral Dissertation Research</td>
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<td></td>
<td>EVSE695</td>
<td>On-site Process Study</td>
<td>0-3-2</td>
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<td></td>
<td>EVSE795</td>
<td>Independent Project</td>
<td>0-6-3</td>
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<td></td>
<td>EVSE599</td>
<td>Seminar</td>
<td>1-0-1</td>
</tr>
</tbody>
</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** ........................................................................................................ (3-0-3)

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** .................................................................................................. (3-0-3)

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** .................................................................................................. (3-0-3)

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** ....................................................................................... (3-0-3)

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** ............................................................................................ (3-0-3)

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** ...................................................................................... (3-0-3)

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** .................................................................................... (3-0-3)

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 Bio remediation 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 Biochemical 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)
Graduate School of Artificial Intelligence

1. Educational Aim

Cultivate creative and multifaceted AI experts, equipped with both academic excellence and industry insight. Advance students’ expertise through specialized curriculum in AI and data science, lay the groundwork for convergence research by fostering creative and autonomous research environment, and nurture world-leading AI experts through strengthening global competitiveness.

2. Curriculum Overview

The Graduate School of Artificial Intelligence offers specially designed curriculum in AI and data science for graduate and doctoral students. Required courses are AI source technology and core algorithms, and courses in advanced technology related to main research areas of the school are elective courses. In addition to providing courses to develop well-rounded experts, the school offers separate introductory courses for non-engineering students. The school incorporates the latest AI research trends and its convergence industries into the courses so that the most up-to-date findings and convergence research applications are directly connected to education.

[Credits Required for Graduation]

<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>18</td>
<td>10</td>
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</tr>
<tr>
<td>Ph.D</td>
<td>15</td>
<td>17</td>
<td>32</td>
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<tr>
<td>Integrative</td>
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[Notes on Completion of Course]

1. The graduate school curriculum includes the following subjects:
   (Master’s degree, doctoral dissertation, and seminar subjects are excluded from the faculty)
   - AI graduate school curriculum
   - Graduate classes in other departments
   - Subjects undergraduates from other departments (up to 6 credits in 300 or 400 units)
2. AS a required major, artificial Intelligence, data science, deep learning, and machine learning are applied to master’s and integration courses.
3. You must take at least 3 credits for the major elective course and 12 credits or more for the integrated course.
4. The Ph.D. program must be completed with at least nine credits in the major or optional subject.
5. A required postgraduate course
   - AIGS800 (Computer Engineering or Artificial Intelligence Seminar) is required to complete at
least two semesters of master’s and doctorate courses, respectively, and four semesters of integration courses.

6. TA Obligations: 1 Master, 2 Doctoral, 3 Integrated

### 3. Program Overview

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<th>Area</th>
<th>Course No.</th>
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<td>Major Essential</td>
<td>AIG5515</td>
<td>Machine learning</td>
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<td>AIG5537</td>
<td>Artificial Intelligence and Data Science</td>
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<td>AIG5538</td>
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<td>AIG5500</td>
<td>Advanced Linear Algebra for CSE</td>
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<td></td>
<td>AIG5502</td>
<td>Theory of Computation</td>
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<td>AIG5503</td>
<td>Advanced Computer Architecture</td>
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<td>AIG5504</td>
<td>Advanced Operating System</td>
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<td>AIG5505</td>
<td>Network Performance Analysis</td>
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<td>AIG5506</td>
<td>Digital Logic Testing</td>
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<td>AIG5507</td>
<td>Software Engineering</td>
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<td>Discrete and Computational Geometry</td>
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<td>Computer Animation</td>
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<td>AIG5511</td>
<td>Introduction to Virtual Reality</td>
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<td>AIG5513</td>
<td>Simulation</td>
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<td>AIG5514</td>
<td>Pattern Recognition</td>
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<td>Linguistics Basis for Natural Language Processing</td>
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<td>AIG5527</td>
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<td>AIG5531</td>
<td>Mathematical Statistics</td>
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<td>AIG5532</td>
<td>Applications of Mathematics and Big Data</td>
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<td>AIG5539</td>
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<td>AIG5540</td>
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<td>Parallel Processing</td>
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<td>Real-time Systems</td>
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<td>AIG5607</td>
<td>Network Management Systems</td>
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4. Course Description

AIGS500/CSED500 Advanced Linear Algebra for CSE

In this course, we study linear algebra theory widely used in various areas of Computer Engineering such as Gaussian Elimination, Vector Space and Linear Equations, Orthogonality, Determinant, Eigen-values and Eigen-vectors, and Positive Definite Matrices, etc.

AIGS502/CSED502 Theory of Computation

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.

AIGS503/CSED503 Advanced Computer Architecture

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 super scalar architectures; VLIW machines; vector supercomputers; multi threaded architectures; low-power designs; symmetric multiprocessors; memory models and synchronization; embedded systems; and parallel computers.

AIGS504/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.

AIGS505/CSED505 Network Performance Analysis .............................................................. (3-0-3)
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.

AIGS506/CSED506 Digital Logic Testing .................................................................................. (3-0-3)
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 modelling, test generation, fault simulation, testable design, and fault-tolerance circuits.

AIGS507/CSED507 Software Engineering .............................................................................. (3-0-3)
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.

AIGS508/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 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.

AIGS509/CSED509 Computer Animation .............................................................................. (3-0-3)
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.

AIGS511/CSED511 Introduction to Virtual Reality .................................................. (3-0-3)

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.

AIGS513/CSED513 Simulation .................................................................................. (3-0-3)

Recommended Prerequisites: CSED321 (Programming Language), MATH230 (Probability and Statistics)

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.

AIGS514/CSED514 Pattern Recognition ................................................................. (3-0-3)

Recommended Prerequisites: MATH230 (Probability and Statistics)

This course deals with pattern classification theory and practice. Among several pattern classification area, 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.

AIGS515/CSED515 Machine Learning ................................................................. (3-0-3)

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.

AIGS518/CSED518 Linguistics Basis for Natural Language Processing ............ (3-0-3)

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.

**AIGS519/CSED519 Introduction to Human-Computer Interaction** ................................................................. (3-0-3)

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 also those that were not, and students put the concepts to practice through class projects.

**AIGS521/CSED521 Fuzzy and Intelligent Systems** ................................................................. (3-0-3)

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.

**AIGS523/CSED523 Statistical Natural Language Processing** ................................................................. (3-0-3)

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.

**AIGS524/CSED524 Probabilistic Graphical Models** ................................................................. (3-0-3)

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.

**AIGS526/CSED526 Data Mining** ................................................................. (3-0-3)

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.

**AIGS527/CSED527 Introduction to Haptics** ................................................................. (3-0-3)

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.

**AIGS530/CSED530 Advanced Probability Theory for CSE** ........................................ (3-0-3)

This course provides a broad overview of probability theory, random variables and random process for the graduate students of Computer Science Engineering.

**AIGS531/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

**AIGS532/MATH532 Applications of Mathematics and Big Data** .................................... (3-0-3)

  Recommended Prerequisite : MATH230

  We understand basic concepts of data analysis and machine learning using mathematical methodology. Based on this, we implement the machine learning algorithm directly and analyze the latest trends.

**AIGS536/CSED536 Advanced Algorithms** .................................................................... (3-0-3)

  Recommended 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.

**AIGS537 Artificial Intelligence & Data Science** ......................................................... (3-0-3)

This course will introduce the core topics of recent artificial intelligence research, exploring different areas in AI: Computer Vision (CV), Computer Graphics (CG), and Data Mining (DM), Machine Learning (ML), and Natural Language Processing (NLP). In this course, professors in three AI groups (Media AI, Data AI, AI theory) together will present the relevant subjects and discuss interdisciplinary topics to form an integrated viewpoint on AI research.

**AIGS538 Deep Learning** ............................................................................................ (3-0-3)

This goal of this class is to study basic theory and practice of deep learning, a branch of machine learning concerned with modern neural networks, which is behind many recent advances in AI. We will cover a range of topics from basic neural network models, training techniques, and their applications to problem domains of visual, linguistic, and speech recognition as well as cross-model learning.
AIGS539 Computer Vision

Recommended Prerequisites: MATH203 (Applied Linear Algebra), MATH230 (Probability & Statistics), CSED101 (Programming & Problem solving)

This course addresses a wide range of topics in computer vision, from traditional ones like image processing, interesting points, fitting and matching, to up-to-date visual recognition problems like object detection, semantic segmentation, visual data retrieval, and video recognition. It also introduces basic theories and applications of machine learning that are frequently used in computer vision.

AIGS540 Big Data processing

Recommended Prerequisites: Algorithms, statistics, and programming related courses

Data science incorporates practices from a variety of fields including statistics, machine learning, databases, distributed systems, algorithms, data warehousing, high-performance computing, and visualization. Thus, at a minimum, today’s data scientist needs to have familiarity with: data processing and management tools like relational databases and NoSQL for processing large volumes of data; scripting languages like Python for quickly writing programs to clean and transform messy raw data; basic machine learning and data mining algorithms for analyzing the data; statistical computing environments for writing analysis scripts; and visualization tools for presentation and communication of analysis results. In this course, we study how to store, manage, search and analyze big data by utilizing popularly used solutions such as SQL, MapReduce, Hadoop, Spark, and Kafka. Students will also learn basic concepts of machine learning techniques. As a final team project, students will implement a MOOC service using various big data stacks where students need to predict whether a student will drop out or not.

AIGS551/CSED551 Computational Photography

Recommended Prerequisites: CSED451 (Computer Graphics)

This course will review recent research papers of computational photography and discuss research trends and directions. The topics will include graphics and vision subjects related to images and videos.

AIGS600/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.

AIGS601/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.
AIGS602/CSED602 Advanced Database ................................................................. (3-0-3)
  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.

AIGS603/CSED603 Parallel Algorithm ................................................................. (3-0-3)
  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.

AIGS604/CSED604 Parallel Processing ............................................................... (3-0-3)
  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.

AIGS605/CSED605 Real-time Systems ............................................................... (3-0-3)
  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.

AIGS607/CSED607 Network Management System .............................................. (3-0-3)
  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.

AIGS608/CSED608 Advanced Computer Network ............................................. (3-0-3)
  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 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.

AIGS609/CSED609 Applications of Random Variable and Process in Computer Engineering ......................................................... (3-0-3)
  This course provides an broad overview of probability theory, random variables, and random process for the graduate students of computer science engineering.
AIGS610/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.

AIGS611/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.

AIGS613/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.

AIGS615/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.

AIGS616/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.

AIGS617/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.

AIGS620/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.

AIGS626/CSED626 Multimedia Networking

This course introduces the basic concept of multimedia networking and various theories and algorithms that guarantee the quality of multimedia services over both wired and wireless networks. It also covers various technologies that improve the quality of multimedia services over the networks that only support best-effort services such as the Internet.

AIGS627 Reinforcement Learning

Prerequisites: MATH230 (Probability & Statistics), CSED515 (Machine Learning)

Reinforcement learning (RL) is an area of machine learning about how to find optimal control of given system from sequence of interactions. This course covers various theory and application of RL. A set of assignments and projects are planned to help students’ interest and understanding in RL.

AIGS699 Master Thesis Research

A research course for Master’s thesis.

AIGS700A-Z Topics in Computer Science A-Z

This course covers recent research topics in the area of computer science.

AIGS701A-Z Topics in Computation Theory A-Z

This course covers recent research topics in the area of computer theory.

AIGS702A-Z Topics in Computer Systems A-Z

This course covers recent research topics in the area of computer systems.

AIGS703A-Z Topics in Artificial Intelligence A-Z

This course covers advanced topics in artificial intelligence research.

AIGS800A/B Artificial Intelligence Colloquium A/B

AIGS801 Individual Study

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

AIGS899 Doctoral Dissertation Research

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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<th>Ph.D. Program (35 credits)</th>
<th>M.S-Ph.D. Integrated Program (60 credits)</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>
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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.
ADMS517/CHEM619 Nanochemistry ................................................................. (3-0-3)

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.

ADMS518/CHEM541 Advanced Analytical Chemistry .......................................... (3-0-3)

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.

ADMS519/CHEM535 Physical Methods in Inorganic Chemistry .............................. (3-0-3)

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.

ADMS520/CHEM451 Macromolecular Chemistry ................................................ (3-0-3)

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.

ADMS521 Energy Nanomaterials ........................................................................... (3-0-3)

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.

ADMS522/CHEM542 Analytical Spectroscopy ......................................................... (3-0-3)

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.

ADMS531/PHYS501 Analytical Mechanics ............................................................. (3-0-3)

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)

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.

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/PHYS21,522 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 ferro-electricity, 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/AMSE649 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.

ADMS800 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.

ADMS801 Colloquium ......................................................................................... (1–0–1)

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

ADMS899 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 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)

<table>
<thead>
<tr>
<th>Credit</th>
<th>M.S-Ph.D Integrated Program</th>
<th>Doctoral Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Credits</td>
<td>33 credits (Variable)</td>
<td>14 credits (Variable)</td>
</tr>
<tr>
<td>Mandatory Courses (3 credits)</td>
<td>Current topic in IBB</td>
<td>More than 18 credits (Mandatory: 3 credits)</td>
</tr>
<tr>
<td>Elective (21 Credits)</td>
<td>Bioscience related: more than 9 credits</td>
<td>Biotechnology related: more than 9 credits</td>
</tr>
<tr>
<td></td>
<td>Electives: More than 15 credits</td>
<td></td>
</tr>
</tbody>
</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. Criteria of Credit Recognition for Undergraduate Level Courses/Graduate Level Courses of Non-major Department

- Students may register up to 6 credits from undergraduate level courses in the course number 200-400’s under their advisor’s guidance (with the exception of courses from the Division of Humanities and Social Sciences). In this case, students may choose the grading system between Letter Grade and S/U(Satisfactory/Unsatisfactory) Grades.

- Students may take graduate level courses from a non-major department under their advisor’s guidance (except for the Research courses) In this case, students may choose the grading system between Letter Grade and S/U(Satisfactory/Unsatisfactory) Grades.

4. 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

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

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

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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.

**IBBT519 Integrative Immunology** .............................................................. (3-0-3)

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** ........................................................ (3-0-3)

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** .......................................... (3-0-3)

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** ................................................................. (3-0-3)

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** .......................................... (3-0-3)

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** ............................ (3-0-3)

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** .......................... (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.

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** ................................................................. (3-0-3)
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** ..................................... (3-0-3)
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** .......................... (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.

**IBBT608/IBIO614 Interdisciplinary Biosciences** ........................................... (3-0-3)
This course introduces life science related adjacent academic areas for cooperative research and helps students choose research topics.

**IBBT609 Advanced Biotechnology** ......................................................... (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.

**IBBT610 Experimental Biophysical Chemistry** ........................................... (3-0-3)
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).

**IBBT611/LIFE612 Enzyme Mechanisms** .................................................... (3-0-3)
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.

**IBBT615/LIFE606 Advanced Plant Cell Biology** ............................................. (3-0-3)
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................................................................. (3–0–3)

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 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 bioinformatics.

IBBT622A-Z Special Topics in Integrative Biosciences and Technology.................................(3–0–3)

This course explores special topics in integrative bioscience and biotechnology as the professor’s discretion.

IBBT623/IBIO611 Advanced Systems Biology...................................................................... (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........................................................................ (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................................................................. (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......................................................................................... (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....................................................... (1–4–3)

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

IBBT703/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 bio-informational understanding of communication in bio-systems consisting of such components, experts will give tutorial lectures.

**IBBT704/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.

**IBBT718 Recent Topics in Immunology** ................................................................................. (3-0-3)

This course explores the latest trends and hypothesis in immunology and students present their suggestion and discussion.

**IBBT719 Current Advances in Immunology** ............................................................................ (3-0-3)

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** ................................................................. (1-0-1)

Seminars for graduate students, which are related to all areas of interdisciplinary Bioscience and Bioengineering are delivered by invited speakers.

**IBBT899 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 thesis 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(Appplies to students enrolled since the spring semester of 2017)

<table>
<thead>
<tr>
<th>Category</th>
<th>Course No.</th>
<th>Course Title</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Courses</td>
<td>NUCE501</td>
<td>Nuclear Engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NUCE502</td>
<td>Nuclear Reactor Physics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NUCE718Q</td>
<td>Advances of Nuclear Reactor Physics</td>
<td>Engineering</td>
</tr>
<tr>
<td></td>
<td>NUCE702</td>
<td>Nuclear Reactor Experiment</td>
<td></td>
</tr>
<tr>
<td>Mandatory Courses</td>
<td>NUCE510</td>
<td>Nuclear Power Plant Engineering</td>
<td></td>
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<tr>
<td></td>
<td>NUCE520</td>
<td>Radiation Detection</td>
<td></td>
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<tr>
<td></td>
<td>NUCE530</td>
<td>Radioactive Waste Management</td>
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<tr>
<td>Elective Courses</td>
<td>The tenth digit of Course Number is 1</td>
<td>Nuclear Safety and Energy Conversion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The tenth digit of Course Number is 2</td>
<td>Nuclear Physics and Plasma</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The tenth digit of Course Number is 3</td>
<td>Radioactive Waste Management</td>
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<tr>
<td>Research Courses</td>
<td>NUCE800A</td>
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<td>NUCE69901-09</td>
<td>Master Thesis Research</td>
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<tr>
<td></td>
<td>NUCE89901-09</td>
<td>Doctoral Dissertation Research</td>
<td></td>
</tr>
</tbody>
</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
- Students enrolled prior to 2019
  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.
- Students enrolled from 2019
  Master Program students should take minimum two semesters of the DANE seminar courses.
  M.S.-Ph.D. Integrated Program students should take minimum five semesters of the DANE seminar courses are required.
  Ph.D. Program students should take minimum three semesters of the DANE seminar courses are required.

[Credit Requirements]
- Students enrolled prior to 2014

<table>
<thead>
<tr>
<th></th>
<th>Course Credits</th>
<th>Research Credits</th>
<th>Total Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master Program</td>
<td>15</td>
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<tr>
<td>Ph.D Program</td>
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<td>M.S.-Ph.D. Integrated Program</td>
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</table>
- Students enrolled from 2014

<table>
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<th></th>
<th>Course Credits</th>
<th>Research Credits</th>
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</thead>
<tbody>
<tr>
<td>Master Program</td>
<td>18</td>
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<tr>
<td>Ph.D Program</td>
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<tr>
<td>M.S.-Ph.D. Integrated</td>
<td>30</td>
<td>30</td>
<td>60</td>
</tr>
</tbody>
</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>
<thead>
<tr>
<th>Classification</th>
<th>Course No.</th>
<th>Course Title</th>
<th>Credits</th>
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<tr>
<td>Elective (Common)</td>
<td>NUCE501</td>
<td>Nuclear Engineering</td>
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<td>NUCE502</td>
<td>Nuclear Reactor Physics</td>
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<td>NUCE718Q</td>
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<td>Radioactive Waste Management</td>
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<td>NUCE511</td>
<td>Heat Transfer Physics</td>
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<td>NUCE611</td>
<td>Two Phase Flow</td>
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<td>Probabilistic Safety Analysis</td>
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<td>NUCE718M</td>
<td>Particle Accelerator Technologies</td>
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<td>NUCE526</td>
<td>Synchrotron Radiation Science and Applications</td>
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<td></td>
<td>NUCE721</td>
<td>Radiation Shielding and Monte Carlo Simulation</td>
<td>2-2-3</td>
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<td>Elective (Radioactive Waste Management)</td>
<td>NUCE533</td>
<td>Radioactive Contaminants in the Environment</td>
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<td>NUCE534</td>
<td>Noncrystalline Ceramics</td>
<td>3-0-3</td>
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<td>NUCE731</td>
<td>Advances of Radioactive Waste Management</td>
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<td>NUCE732</td>
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<td>NUCE89901-09</td>
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<td>Seminar A</td>
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</table>
4. Course Description

NUCE501 Nuclear Engineering ........................................................................................................ (3-0-3)

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 .................................................................................................. (3-0-3)

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 .............................................. (3-0-3)

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 ........................................................................................... (1-0-1)

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 .................................................................................... (3-0-3)

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 ....................................................................................................... (3-0-3)

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................................................................. (3-0-3)

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.................................................................................. (3-0-3)

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........................................................................ (3-0-3)

NUCE519 Nuclear Thermal-Hydraulics-2........................................................................ (3-0-3)

NUCE611 Two Phase Flow............................................................................................ (3-0-3)

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.......................................................................... (3-0-3)


NUCE523 Plasma Physics.............................................................................................. (3-0-3)

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

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 include 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, further, the usage of radioactive tracers in chemical kinetics, the separation chemistry, and the environmental chemistry will also be 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

NUCE699 Master Thesis Research

Students will conduct Master Thesis Research under the guidance of advisors.

NUCE899 Doctoral Dissertation Research

Students will conduct Doctoral Dissertation Research under the guidance of advisors. Students will conduct Master Thesis Research under the guidance of advisors.

NUCE718A-Z Special Topics in Advanced Nuclear Engineering

Selected topics reflecting the latest trend in nuclear engineering research will be dealt with in depth.

NUCE800A Seminar A

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.
School of Interdisciplinary Bioscience & Bioengineering

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

<table>
<thead>
<tr>
<th>Major Requirement (3 credits)</th>
<th>Research Credits</th>
<th>MS/PhD Integrated Program</th>
<th>Major Electives (21 or more credits)</th>
<th>Doctoral Program</th>
<th>Master’s Program</th>
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<tr>
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<td>33</td>
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<td>18 course credits (required course: 6 credits &amp; elective course: 12 credits)</td>
<td>21 course credits (required course: 6 credits &amp; elective course: 15 credits)</td>
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<td>Required Electives (3 or more credits)</td>
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<td>Advanced Bio-Imaging(IBIO711)</td>
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<td>Advanced Metabolic Engineering(IBIO650)</td>
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<td>Advanced Molecular Genetics(IBIO528)</td>
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<td>Tissue Engineering (IBIO657)</td>
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2020 School of Interdisciplinary Bioscience & Bioengineering
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 ................................................................. (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.

IBIO512 Biostatistics ................................................................. (3-0-3)
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 ............................................. (3-0-3)
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 .......................................................... (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-bio-materials for nano-medicine in terms of life science, chemistry, physics, and materials science.

IBIO515/MECH579 Introduction to Microfluidics ................................................................. (3-0-3)
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 fl in a micro channel, including convection diffusion.
IBIO516 Method in Interdisciplinary Research ................................................................. (2-0-1)

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 ............................................................................. (3-0-3)

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 ....................................................................... (3-0-3)

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 .................................................................................... (3-0-3)

The course offers basic principles of computational skills that are needed to study neural networks. Perceptron, RRB, Kohonen 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 ................................................................................... (3-0-3)

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 .......................................................................................... (3-0-3)

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 ..................................................................... (3-0-3)

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 ....................................................................... (3-0-3)

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** ...................................................... (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.

**IBIO530/CITE551 Principles of Biomedical Opt.& Imaging** ............................................. (3-0-3)

This course will cover two main topics including the principles of optical photon transport in biological tissues and various optical imaging techniques. The former topic includes an introduction to biomedical optics, Monte Carlo modeling of photon transport, radiative transfer equation and diffusion theory, hybrid Monte Carlo method and diffusion theory, and optical spectroscopy. The later part covers ballistic imaging, optical coherence tomography, diffuse optical tomography, photoacoustic tomography, and ultrasound-modulated optical tomography.

**IBIO531/IBBT501 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 microstructure of living organisms. The course also offers in-vivo dynamic research of the microstructure of cells and living organisms.

**IBIO532/IBBT530 Principles Biology** .............................................................................. (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.

**IBIO534/CHEB801H Advanced Synthetic Biology** ......................................................... (3-0-3)

Cutting-edge scientific researches in the field of synthetic biology will be lectured and discussed in this ‘Advanced Synthetic Biology’ course as outlined in the course plan. Throughout the course, the students gain a deeper knowledge of synthetic biology. This knowledge will lead the students to understand recent trends in synthetic biology. After completing the course, students can conceptually design synthetic biological circuits, devices, and/or systems.

**IBIO612/PHYS667 Quantitative Theoretical Biology** ..................................................... (3-0-3)

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** ................................................................................. (3-0-3)

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** ....................................................... (3-0-3)

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 nondestructive 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 ......................................................... (3-0-3)

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 ......................................................................................... (3-0-3)

The course illustrates ways of search and analysis of biological data and describes modern trends and prospects of bio-informatics.

IBIO639/LIFE620 Advanced Biostatistics ............................................................................. (3-0-3)

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 Bioseparation 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** ............................................................................................... (3-0-3)

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** ......................................................................... (3-0-3)

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** ............................................................................. (3-0-3)

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** .................................................................................. (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.

**IBIO654/CHEB644 Transcriptional Regulation for Synthetic Biotechnology** ........................................ (3-0-3)

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** ....................................................................................................... (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.
IBIO656/LIFE508 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.

IBIO657/MECH532 Tissue Engineering .............................................................................. (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-materis, 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 ............................................................................ (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.

IBIO659/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.

IBIO661 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.

IBIO662/CHEM542 Analytical Spectroscopy ..................................................................... (3-0-3)
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.

IBIO663/LIFE611 Biomacromolecular Structures ............................................................... (3-0-3)
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.
Sports AIX Graduate Program

1. Learning Goals

The education objective of the Sports AIX Graduate Program is to foster specialists in the Sport Science and Technology related to the 4th industrial revolution. In order to foster a Master Degree in engineering that is centered on artificial intelligence in the sports industry, we divided the current educational fields into three main categories: [AI X Sports Big Data & Data Analysis], [AI X Sports Multimedia] and [AI X New Technology: Sports Technology Initiative].

2. Program Overview

The Sports AIX Graduate Program offers a multidisciplinary graduate system and in-depth training to foster world-class talent specialized in three key fields: Sports AIX Big Data & Data Analysis, Sports AIX Multimedia and Sports AIX New Technology. The educational objectives and related research areas of each field are as follows.

Track 1 [Sports AIX Big Data & Data Analysis]

As technology advances, the data available increases, and in particular, the big data generated in the sports sector is changing the face of the sports industry, including elite sports. By analyzing the sports data, data scientists help in making decisions about strategies and tactics for games and optimal training programs for athletes, etc. and this is the determining factor in winning or losing the competition. The sports data science field is receiving a lot of attention lately, because it analyzes unstructured and structured data such as big data and text from sports teams/athletes and examines factors affecting their performance. As the market develops the use of data in sports we are conducting research on the analysis methods and content development in the sports field.

Track 2 [Sports AIX Multimedia]

Research in this field aims to study computer vision and voice technology, and to conduct research in which computers understand images, recognize people, sense and express emotions, and use meta data to analyze images. Specifically, we are studying algorithms and platforms for effective interaction with multimedia content, developing image-based recognition models, and researching deep running models for video sports data summary and content detection.

Track 3 [Sports AIX New Technology]

Cutting-edge advanced technologies are revolutionizing the way sports teams and athletes train and compete and how fans engage and consume content, they are also transforming the global stadium. The program of New Technologies is carrying out various research including new types of sensors, equipment development, sports IoT, and facility automation systems, as well as research on next-generation virtual and augmented reality hardware, displays, and interactive content. In addition to that, the program is conducting research that aims to create new values and innovations in the
era of the 4th industrial revolution through convergence of research with humanities and social sciences such as Human–Computer Interaction (HCI), Design Thinking, and Media Studies.

[Credits Required for Graduation]

<table>
<thead>
<tr>
<th>Courses</th>
<th>Sports AIX Graduate Program Required Courses</th>
<th>Students Main Department</th>
<th>Overall Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credits</td>
<td>6 Credit Points</td>
<td>At least 1 credit</td>
<td>The rule of Main department will be applied</td>
</tr>
</tbody>
</table>

[Notes on Completion of Course]

SAIX501 ~ 503 Required Courses
- Sports ICT Convergence Technology (SAIX501)
- Understanding of Global Sports Industry (SAIX502)
- Sports Convergence Leadership (SAIX503).

INTN800 Internship Program
- Internship at sport industry companies.
- At least 1 Credit

3. Course Table

<table>
<thead>
<tr>
<th>Completion</th>
<th>Division</th>
<th>Course Number</th>
<th>Course Title</th>
<th>Lecture Scoring</th>
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<tr>
<td>Core Course</td>
<td>Common</td>
<td>SAIX501</td>
<td>Sports ICT Convergence Research</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td></td>
<td>SAIX502</td>
<td>The Business of Sports</td>
<td>2-0-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAIX503</td>
<td>Leadership: A Coach, What is a Leadership?</td>
<td>1-0-1</td>
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<tr>
<td></td>
<td></td>
<td>CSED532/ MATH532</td>
<td>App. of Mathematics and Big Data</td>
<td>3-0-3</td>
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<tr>
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<td>Track 1</td>
<td>EECE803</td>
<td>IT Research paper Presentation Skill</td>
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<td>EECE651</td>
<td>Computational Intelligence</td>
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<td></td>
<td>IMEN87A</td>
<td>Business Process Management and Process Mining</td>
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<td>CSED703B</td>
<td>Vision and Language</td>
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<td>Track 2</td>
<td>IMEN443</td>
<td>UX Design Concept</td>
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<td>CSED441</td>
<td>Introduction to computer Vision</td>
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<td></td>
<td>CITE490K</td>
<td>Digital Fabrication Studio</td>
<td>3-0-3</td>
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<tr>
<td></td>
<td></td>
<td>CSED442</td>
<td>Artificial Intelligence</td>
<td>3-0-3</td>
</tr>
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<td></td>
<td></td>
<td>CSED514</td>
<td>Pattern Recognition</td>
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<td></td>
<td>IMEN446</td>
<td>Affective Design and Engineering</td>
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<td>Track 3</td>
<td>EECE411</td>
<td>Optoelectronics Display Engineering</td>
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<td>MECH439</td>
<td>Introduction to Robotics</td>
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<td>EECE490W</td>
<td>Flexible Electronic Materials and Applications</td>
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<td>EECE490V</td>
<td>Embedded SoC Design</td>
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<td>MECH701G</td>
<td>Advanced ME AI</td>
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<td>Common</td>
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<td>Internship Program</td>
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<td>EECE699(1-9)</td>
<td>Master Thesis Research</td>
<td>Variable Credit</td>
</tr>
</tbody>
</table>
4. Course Description

SAIX501 Sports & ICT Convergence Technology

It provides the knowledge to understand the innovation and change of the paradigm of the high-tech-based global sports industry and obtains insights and original ideas for sports convergence technologies. It also focuses on specific technical issues and management challenges faced by the sports convergence industry. Sports technology, which combines advanced IT and science and technology, is developing as a new advance engine of the future by creating synergy with various industries such as Manufacturing / Distribution, Information and Communication, Tourism, Entertainment, and Media. Based on close consideration of the numerous projects connected with the sports industry, it provides the necessary insights for the development of sports technology.

SAIX502 The Business of Sports

The multibillion dollar business of sports & entertainment has become pervasive in our economy and society. The business is increasingly global, reflected in the worldwide coverage of the business dimensions of mega-events such as the Olympics and the World cup, blockbuster movie releases, global concerts and new media market entrants. Understanding the landscape of the business of sports & entertainments calls for both the recognition of how to apply broad business principles to sustain and grow the industry, as well as successfully analyze the technology, marketing and distribution trends that are redefining the business of sports & entertainment.

The objective of this course is to introduce students to the concepts, analysis, and activities that comprise the management of global sports & entertainment enterprises and brands, and to provide practice in assessing and solving related business problems.

This course provides students with unique learning opportunities to gain insight into various management functions within the sports entertainment industry. As such, the course provides a balanced approach to the business, providing a value-added, "real world" education in the marketing of sports & entertainment products with a considerable focus on customer or use experience.

SAIX503 Leadership: A Coach, What is a Leadership

The core values of sports leadership consist of empowerment, global mindset, accountability, collaborative relationship and authenticity. In particular, sports leadership aims to improve people’s abilities and focuses on the changing global sports environment, making responsible decisions and emphasizing on the creation of team-centered relationships through the highest levels of thoughtful behavior.

While the lectures on existing leadership mainly analyzes and conceptualizes the leadership of leaders in politics and economy, this class is an important concept in sports’ intrinsic value, fairness, justice, integrity, and respect for rights and sports. It introduces and analyzes the leadership of the great sports leaders who have emerged based on inspiration and motivation. Not only does it break the framework of thinking and making the students think critically and creatively about leadership, it also raises their interest and curiosity about sports convergence leadership.
POSTECH-Samsung semiconductor Education Program (PSEP)

1. Learning Goal

POSTECH-Samsung Semiconductor Education Program (PSEP) is an industry-academia co-operative graduate school program sponsored by Samsung Electronics Company. The program targets to educate the graduate students to pursue leading roles in the technology developments of Samsung Electronics Company.

2. Program Overview

The PSEP program consists of inter-disciplinary education as the key requirements by admitting students in all departments related to semiconductor technology, including engineering departments (Electrical, Materials, Computer-Science, Chemical, Mechanical, Industrial-Management) and basic science departments (Mathematic, Physic and Chemistry). The students are strongly recommended to take courses to get conceptual understanding of all aspects of semiconductor technology other than their major topics.

[Credits Required for Graduation]
follow the rules of the students’ department.

[Requirements]

<table>
<thead>
<tr>
<th>Programs</th>
<th>Course Credit</th>
<th>Research Credit</th>
<th>Overall Credit</th>
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<td>Common Subjects</td>
<td>Major Elective</td>
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<td>Master’s Program</td>
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<tr>
<td>Doctoral-MS/PhD Integrated Program</td>
<td>5</td>
<td>6</td>
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</tr>
</tbody>
</table>

( * : follow the rules of the department to which students belong)

[Special Remarks on Graduation Requirements in Areas of PSEP]
- For students who took the required courses, “POSTECH-Samsung Semiconductor Education program” is added to the Diploma.
- For PSEP students who pursue the PhD course after the Master course, the courses taken for Master course are exempt from requirements
3. Course Table

<table>
<thead>
<tr>
<th>Category</th>
<th>Area</th>
<th>Course No</th>
<th>Title</th>
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<td>PSEP501</td>
<td>Introductory Semiconductor Engineering</td>
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<td></td>
<td>PSEP502</td>
<td>CMOS Fabrication Laboratory</td>
<td>2-2-3</td>
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<td>PSEP401</td>
<td>Samsung Semiconductor Device</td>
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<td>Major Elective</td>
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<td>PSEP503</td>
<td>Design Thinking Studio on Intelligence Weaved</td>
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<td>PSEP504</td>
<td>Design Thinking Studio on Intelligence Weaved</td>
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<td>PSEP801</td>
<td>IT Scientific Writing</td>
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<td>PSEP802</td>
<td>IT Research paper Presentation Skill</td>
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</tr>
</tbody>
</table>

4. Course Description

PSEP501 Introductory Semiconductor Engineering ......................................................... (3-0-3)
By taking the inter-disciplinary curriculum, students get the conceptual understanding of all aspects of semiconductor technology including semiconductor fabrication, devices, circuits and systems.

PSEP502 CMOS Fabrication Laboratory ................................................................. (2-2-3)
Recently, the fabrication of semiconductor device has become more important as the minimum feature size is approaching the atomic scale. In this course, students will learn theories as well as practical know-how through lab sessions at the cutting-edge semiconductor fabrication facilities on campus.

PSEP503 Entrepreneurship and Leadership Seminar ............................................. (1-0-1)
When we graduate from POSTECH and begin social career life, there is a sense of admiration for the new world and some fears. Based on my 30 years of experience at a semiconductor company that worked its way from the very bottom to the world’s top. This is a course in providing to set up our future plan, lecturing on how to grow as an excellent core talent in the company. We invite Samsung senior engineers and executives who have managed present and past organizations to share their experiences, discuss future talents, and have a broader perspective to establish our own future life designs.

PSEP504 Design Thinking Studio on Intelligence Weaved .................................. (2-0-2)
Future engineering talents that companies want are those who realize the creation of new value through their ability to solve professional problems through creative engineering and convergent thinking. Therefore, training is needed to fuse and design multidisciplinary knowledge beyond the field of research. This class develops the ability to creatively solve specific problems and design future society through design thinking that encompasses humanities, society, and art on various knowledge-based platforms.
PSEP601(EECE695K) Samsung Semiconductor Device ........................................ (3-0-3)

Through the lectures taught by Samsung Electronics Company Executive Members, students are exposed to the state-of-the-art semiconductor technology to strengthen motivation for active research.

PSEP801(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.

PSEP802(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.